JINR Б1-2-80-850
Dubna, 1980

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FIFTY YEARS OF DIRAC MONOPOLE: COMPLETE BIBLIOGRAPHY

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POINCARE INVARIANCE OF CHARGE-MONOPOLE COMPOSITES AND PARITY VIOLATION

In reviewing angular momentum suggestions find Poincare invariance violated unless parity violation introduced.

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MAGNETIC MONOPOLES AND COSMOLOGY

The product of the mass m and annihilation σv for magnetic monopoles is obtained through a naive calculation and is shown to be greater than about 10^{20}(normalized to the proton). One concludes that either monopoles have remarkably large masses and / or σv, or that the calculation is invalid. Possible explanations of this results are discussed.

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THOMSON'S MONOPOLES

The angular momentum L of the electromagnetic field due to an electric point charge e , and a magnetic point charge(pole) g , is calculated by several methods to obtain J.J.Thomson's result that $L = e g / c$ and L is directed along the line joining the electric monopole to the magnetic monopole. The relation to Dirac's monopoles is discussed, and particle size is considered.

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MAGNETIC CHARGE IN GENERAL RELATIVITY

We consider a dual-charged test particles with electric charge e_0 and magnetic charge g_0 moving in the field of a dual-charged massive cental body with charges e and g . A simple method used by Schwinger to study charge quantization in that space can be generalized to this situation

to show that $e_0 g - g_0 e$ is an integer multiple of $\hbar c$. It is remarkable that the curvature of the space plays no role and that this is the same result that is obtained for that space. We then show that the test particle can remain at rest in the field only if $ee_0 + gg_0 = kM\mu$ and $e^2 + g^2 = kM^2$, where k is the gravitational constant and M and μ are the mass of the central and test body, respectively.

823. Agarwal G.S., Pramamna (India),1976, vol.6, No 6, pp.349-362.

TRAPPING ENERGY OF A MAGNETIC MONOPOLE IN MAGNETIC MATERIALS

Analytical methods to investigate the interaction of magnetic monopoles with known magnetic media have been developed. Trapping energies of monopoles inside ferromagnetic or superconducting materials of size greater than about 10^{-6} cm are found to be of the order of several kiloelectron volts. These are two to three orders of magnitude higher than in paramagnetic materials. Thus if stable magnetic monopoles exist at all in the universe, they are perhaps trapped in these magnetic materials. The effect of the finite size of the magnetic bodies is taken into account explicitly in calculations of the trapping energy.

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MONOPOLE-TRACK CHARACTERISTICS IN PLASTIC DETECTORS

Total and restricted energy loss rates are calculated for magnetic monopole of charge g=137e in lexan polycarbonate. Range-energy curves are also presented. The restricted energy loss model is used to estimate the apperance of a monopole track in plastic detectors. The results are applied to the event observed by Price et al. and identified by them as a monopole. It is found that the observed etch rate is consistent with what one would expect for a slow magnetic monopole ($\beta \sim 0.5c$,g=137e). These results should also be of use to other investigators for both the design and analysis of monopole experiments.

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USES OF SOLID STATE ANALOGIES IN ELEMENTARY PARTICLE THEORY IN GAUGE THEORY AND MODERN FIELD THEORY

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ROTATIONAL COVARIANCE AND THE YANG-MILLS MONOPOLE

Rotational covariance in the monopole vector of the SU(2) Yang-Mills model with a triplet of Higgs scalars and the possible addition of fermions is examined. Ansatz about the boding-order behaviour of monopole-monopole matrix elements are shown to be consistent with rotational symmetry spin identification of monopole states is done for all cases.

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MONOPOLES, DUALITY, TRIALITY

The existence of magnetic monopoles could provide an explanation not only of the quantization of electric charge, but also of the zero trielity and of the string model with Y chaped baryons. First we review the classical magnetic monopole theory with strings and the Dirac least action principle. Two possible interaction terms, the standart one $j \cdot A$ and a path dependent interaction a la Mandelstam give the same classical equation of motion and the strings are not observable. At the quantum level, this is not true any more. Assuming a linear combination of the two interac'-tion, terms, we determine the conditions under which a string attached to the dyon (e_1, g_1) is not observable by a dyon (e_2, g_2) using a "sum over histories" approach. We get $(1-x)e_2 g_1 - x e_1 g_2 = 2\pi x$ integer. The Dirac and Schwinger-Zwanziger quantization rules are special cases, with $x=0$ and $1/2$, respectively. Then,assuming

the existence of magnetic charges, we look for all possible models where: 1) the string attached to an electron is not observable,2) the string attached to a quark is observable, 3) the electric charge has to be quantized in with $e/3$. We find a denumerable set of models where the magnetic charges may also be connected with physical strings.

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KINEMATICAL CONSTRAINTS ON THE OBSERVATION OF SLOW MONOPOLES AT THE TOP OF THE ATMOSPHERE

Relativistic kinematics of monopole production and propagation in Earth's atmosphere and magnetic field have been examined in the light of the observation of a magnetic monopole by Price et al. It has been shown that the observed monopole cannot result from nuclear interactions in the atmosphere and that the extraterrestrial origin of this monopole is very unlikely.

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INTEGRAL EQUATIONS FOR EXTENDED SOLUTIONS IN FIELD THEORY: MONOPOLES AND DYONS

In this paper we give a simple method to obtain extended solutions of unlinear classical field theories. The technique applies to problems where the boundary values of either and of the domain are specified, and consists of converting the set of field equations to a system of coupled nonlinear integral equations that can be solved numerically by simple interaction. As an illustration, the 't Hooft monopole and the Julia-Zee dually charged monopole system are studied in detail. The principle structure of these extended solutions and the possible effects of quantum fluctuations are briefly discussed.

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CONFIGURATIONS OF SO(3) MONOPOLES WITH MULTIPLE MAGNETIC CHARGE

In this paper we consider configurations of monopoles with multiple magnetic charge in nonabelian gauge theory. Explicit gauge transformations are constructed which eliminate the string singularities for single monopoles of multiple magnetic charge, and for an arbitrary number of monopoles lying along a line. The question of finding nonsingular solutions is discussed.

831. Bais F.A. Physics Department University of California, UCSC 76/106, Santa Cruz, California,1976.

CONFIGURATION OF SO(3) MONOPOLES WITH MULTIPLE MAGNETIC CHARGE

In this paper we consider configurations of monopoles with multiple magnetic charge in nonabelian gauge theory.Explicit gauge transformations are constructed which eliminate the string singularities for single monopoles of multiple magnetic charge, and for an arbitrary number of monopoles lying along a line. The question of finding nonsingular solutions is discussed.

832. Badhwar G.D., Golden R.L., Lacy J.L., Stephens I.A., Proceedings of 14-th International Conf., Miscellany,1975, vol.12, pp.4068-4071.

ENERGETICS OF MONOPOLE PRODUCTION

833. Balachandran A.P., Ramachandran R., Schechter J.,Wali K.C., and Rupertsberger H. Phys.Rev.,1976, vol. D13, No 2, pp.354-360.

HAMILTONIAN FORMULATION OF MONOPOLE THEORIES WITH STRINGS

We consider the Hamiltonian formulation of the theory resulting from Dirac's monopole action supplement by a mass term for the gauge field. The original (zero-,mass gauge field) theory is also discussed and its Hamiltonian is show to be essentially the same as that of the two-potential

formalism. In this case the coordinates of the string are absorbed into what turn out to be the physically meaning ful variables for the particles and the field. In the massive case, the string does play a significant role and gives rise to a static linear potential and a Yukawa potential between the monopoles. Such a potential has also been found by Nambu and others and may lead to an acceptable model for interactions of quarks.

834. Balachandran A.P., Ramachandran R., Schechter J., Wali K.C., Rupertsberger H. In: GROUP THEORETICAL METHODS IN PHYSICS. Fourth International Colloquim, Nijmegen, 1975. Lecture Notes in Physics, 1976, vol. 50, pp.24-28.

MONOPOLE THEORIES WITH STRINGS AND THEIR APPLICATIONS TO MESON STATES

Short communication only.

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STRINGS, MONOPOLES AND MESON STATES

Dirac's formulation of the monopole theory modified by an additional mass term for the gauge field has been considered as a possible simplified model for quark bindings. We discuss methods for the consistent regularization of the infinites present in the resulting action and equations of motion. In this way we are led to an action which is the same as that suggested by previous authors. We show that the expression for the energy of the modified action still has infinites unless the mass of the gauge field is infinite. Thus the regularization procedure is incomplete when the gauge field has finite mass. Applications of the regularized model to charmonium and other meson states are discussed.

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ROTATIONALLY INVARIANT APPROXIMATION TO CHARGE-MONOPOLE SCATTERING

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ELEMENTARY PARTICLES AND HIGH ENERGY PHENOMENA

The rapid-cycling, bubble chamber film was measured for the study of K°(sub L)p yields K°(sub S)p and related reactions at SLAC. The presence of neutrons in the beam permits one to study several new interactions. The analysis programs were written and checked, and one is now processing the data tapes. The data-taking phase for a tachyon monopole search at Fermilab was completed. A limit was found on the flux of such monopoles in cosmic rays that is approximately 300 times lower than the previous limit. In a simple bench-top experiment, one has shown that the charge of an electron is independent of its velocity down to a level of $10^{-5}v^2/c^2$. One found that natural gas rather than more exotic mixtures is the best hydrocarbon to use in drift chambers. Theoretical efforts were devoted to continuing the study of dynamica symmetry breaking, to detrmining the effect of neutral currents on solar neutrinos, and to supproting the kaon experiments. A list of publications is included.

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DE RHAM CURRENTS, EXTENDED SINGULARITIES OF FIELDS AND MAGNETIC MONOPOLES

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CHARGE QUANTIZATION CONDITION WITH N STRINGS-
A NEW INTERNAL QUANTUM NUMBER OF CHARGE-MONOPOLE SYSTEMS

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ANGULAR MOMENTUM OF SYSTEMS OF ELECTRIC AND MAGNETIC CHARGES AND OF SINGULAR FLUX SURFACES

The angular momentum of a system consisting of an electric charge e and a magnetic charge g is as well known, (e g). We drive general formulas for systems consisting of arbitrary electric and magnetic charges dyons and of singular magnetic flux lines or surfaces of arbitrary integrable topological shapes. The total angular momentum is then quantized and related to the quantized flux.

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COVARIANT FIELD THEORY OF THE MAGNETIC MONOPOLE

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COVARIANCE OF THE FIELD THEORY OF THE MAGNETIC MONOPOLE

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MAGNETIC CHARGE AND HYPERFINE SPLITTING IN HYDROGEN

The large spatial size of magnetic charges(or dyons) and parity considerations are used to show that in models of the proton mased on dyons the hyperfine splitting must be due to the magnetic moment produced by the electric charge. The contributions of the magnetic monopoles conceal,otherwise,

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AN EXPERIMENTALLY ACCESSIBLE ANALOG OF THE MAGNETIC MONOPOLE IN He-A

We show that pointed singularities, vortices, in the A phase of superfluid ^{3}He exhibit a close analog to magnetic monopoles. Just as vortices in ^{4}He are analogs to strings in Abelian-Higgs models, we find vortons in ^{3}He-A to be analogous to magnetic monopoles in the non-Abelian Higgs model of 't Hooft.

846. Blaha S. Phys.Rev.Lett., 1976, vol. 36, No 15, pp.874-876

QUANTIZATION RULES FOR POINT SINGULARITIES IN SUPERFLUID ^{3}He AND LIQUID CRYSTALS

I shaw that pointlike singularities can exist in superfluid ^{3}He . Integer qunatum numbers are associated with these singularities. The qunatization rules follow from the single valuedness of the order parameter and quantities derived from it. The results are also easily extended to the quantization of point singularities in nematic liquid crystals. The pointlike singularities in ^{3}He-A are experimentally accessible analogs of the magnetic monopole.

847. Bludman S.A. Bull.Amer. Phys.Sci., 1976, vol.21, No 1, p.61.

MAGNETIC MONOPOLES: CAN THEY BE SEEN?

848. Bludman S.A. and Ruderman M.A. Phys.Rev.Lett., 1976, vol. 36, No 15, pp.840-843.

THEORETICAL LIMITS ON INTERSTELLAR MAGNETIC POLES SET BY NEARBY MAGNETIC FIELDS

The interstellar magnetic field limits the monopole flux to $< 10^{-16}$ pole cm^{-2}sec^{-3} and gives the average monopole energy 10^{21}GeV. They can be detected nonrelativistically only if their mass is $\geq 10^{11}$GeV/c^2 and, being

produced at $E > 10^{22}$ GeV, require 10^{21}g cm^{-2} matter for ionization loss to make them nonrelativistic. Massive monopoles can only by primordial of cosmological produced. Low-mass monopoles trapped in dual grai s and released in the atmosphere are possible.

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CALCULATIONS OF THE MONOPOLE MASS IN GAUGE THEORY

In gauge field theory with spontaneously broken O(3) symmetry the mass is calculated of monopole with unite magnetic charge. The calculations are fulfilled by means of numerical solving of a set of nonlinear differential equ tions.

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STABILITY OF A STRING IN GAUGE ABELIAN THEORY

The mass of strings with different circulation is calculated in the Abelian gauge theory. The calculations are made by numerical solution of the system of nonlinear differential equations. By choosing a trial function it is shown that the strings with a large circulation are classically unstable at high coupling constants.

852. Bogomolny E.B. Yadern.Fiz.,1976, vol.24, No 4, pp.861-870.

STABILITY OF CLASSICAL SOLUTIONS

The masses of classical string-like solutions are obtained analytically for monopole of at $\beta=1$ and for dyon of at $\beta \to 0$. (The parameter β equals the ratio of the squares of masses of scalar and vector fields). By an appro riate choice of the trial function it is shown that for $\beta >$

the string with the vector field circulation $|n| \geq 2$ are not classically stable.

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STABILITY OF CLASSICAL SOLUTIONS

Obtains an analytic value for the mass of a monopole based on a stability criterion. Similar in character to Prasad-Sommerfield.

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ON THE GAUGE FIELD OF MAGNETIC MONOPOLES

A formulation of electromagnetism with magnetic charges is given by means of a (non uniform) a vector defined in the whole space, whose divergence gives the magnetic charge.

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SCATTERING ON MAGNETIC CHARGE

The nature of magnetic monopole in an SU(3) gauge theory is explored by examining how they scatter charged particles. Peripheral scattering where the momentum trasfer is much less the mass of the charged vector bosons is just as it is in the earlier theory of Dirac. The scattering wave function is discussed with some vigor since its behaviour is not uniform in the forward direction. The correspondence between the classical and quantum-mechanical scattering is displayed explicitly by relating scattering by the noncentral monopole force to the central force scattering by an attractive 1/2 potential for both the quantum-mechanical and classical systems. For deep scattering, the non-Abelian monopole exhibits features absent in exchange processes occur,exciting the monopole into an electrically charged state.This process which corresponds to the weak interaction of unified SO(3)

theory, is calculated in the distorted-wave Born approximati The relation between the monopole in the non-Abelian gauge theory and that in Dirac's theory is investigated by carefully regulating the gauge transformation which connects the This resolves some seeming paradoxes in the connection between two theories.

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MAGNETIC CONFINEMENT IN NON-ABELAIN-GAUGE FIELD THEORY

A confined magnetic flux solution of finite length and finite energy, arising from non-Abelian-gauge theory, is presented.

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FLUX LINE AND MONOPOLE MECHANISM OF CONFINEMENT

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CHARGE-MONOPOLE SCATTERING; A COVARIANT PERTURBATION THEORY

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GAUGE FIELD MODEL OF COMBINED GRAVITATIONAL, ELECTROMAGNETIC AND MAGNETIC MONOPOLE FIELDS

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The quoted flux in a recent report of a detected magnetic monopole is inconsistent by factors on the order of 500 000 with ocean-bottom searches. One resolution of this incongruit is that monopoles are trapped somewhere between the top o

the atmosphere and the ocean bottom. We have searched for monopoles in the atmosphere and ocean water and have found none at levels substantially below the numbers expected if the monopoles were trapped.

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NO MONOPOLES IN WEINBERG-SALAM THEORY

In contrast with a recent work where static free-singularity solutions of the Weinberg-Salam classical field theory are presented, we suggest that such solutions are only a particular case of the instanton problem in Eucledian space.

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THE ELUSIVE MONOPOLE

General review of magnetic monopole including PSOP event.

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COVARIANT PROBLEM OF THE MAGNETIC MONOPOLE THEORY

In the local quantum field theory of magnetic monopoles proposed by Hagen, not all of the equations of motion are covariant under the Lorentz transformation. In this note we show that with the introduction of a shadow electromagnetic field quantized with a "wrong sign", the locality in the sence of local commutation relations and local equations of motion is still retained, while the equations of motion become covariant under the Lorentz transformation for physical fields

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CANONICAL FORMALISM FOR GAUGE THEORIES WITH APPLICATION TO MONOPOLE SOLUTIONS

We develop a canonical formalism, using the method of Dirac brackets, which may be applied to classical Yang-Mills

theories with 't Hooft-Polyakov type magnetic monopole solutions. We argue that the axial gauge, $W_3=0$, is superior to other common gauges. However, it is necessary to modify the convetntional treatment of the axial gauge in order to avoid anomalous commutation relations among the transformations generated by the angular momentum. We discuss the implications for the quantum theory, including the appearance of fermion states in a field theory containing only Bose fields.

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CAN ONE DENT A DYON?

Studies non-spherically symmetric solutions a la Julia and Zee to see if they are stable. Proves stability for Prasad-Sommerfield.

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COLOUR AND MAGNETIC MONOPOLES

If the exact gauge symmetry of nature consists of the U(1) sub (EM) generated by the electric operator Q and the colour group K, with Q a colour singlet, then, if g is a possible magnetic charge, $\exp(4\pi igQ)$ must equal an element of the colour group. For colour singlet particles this reduces to Ditac's condition $eg=n/2$. In general, possible monopoles correspond to points of intersection of the colour and electromagnetic groups. If the colour group is semi-simple and compact, there can at most be a finite number p of such points ($p=N$ if $K=SU(N)$). The existence of non-trivial (not equal to unity) solutions to our condition means that there must be fractionally charged (with p the fraction) coloured particles and magnetic monopoles emanating colour magnetic flux as well as electromagnetic flux.

867. Corrigan E. , Olive D.I., Fairlie D.B., and Nuyts J. Nucl.Phys.,1976, vol.B106, No 3, pp.475-492.

MAGNETIC MONOPOLES IN SU(3) GAUGE THEORIES

't Hooft constructed a finite mass unite monopole by a) embending the electromagnetic U(1) gauge theory in a SU(2) theory via a Higgs triplet mechanism ,b) seeking solutions invariant under simultaneous rotations in ordinary and SU(2) space. We consider an SU(3) gauge theory broken down to U(2) by an octet Higgs vector and find two finite-mass stable solutions corresponding to the two ways of embending SU(2) in SU(3). One solution is the pure unit monopole but the other, which promises to be lighter, has 1/2 unit of magnetic charge (thus violating Dirac's condition,naively applied)as well as being a source of isomagnetic flux (associated with the unbroken SU(2)).

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COLOUR AND MAGNETIC MONOPOLES

869. Cornwall J.M. and Hilton H.H. Phys.Rev.,Lett.,1976, vol.36, No 15, pp.900-903.

RELATION BETWEEN MONOPOLE MASS AND PRIMARY MONOPOLE FLUX

We give quantitative results concerning the simple idea that the probability of observing a monopole at Earth with β =0.5 decreases as the monopole mass decreases, for masses $\leq 10^4$ GeV/c^2. The effective cross section of Earth is roughly the geometric cross section times the ratio of the monopole mass to 8000 GeV/c^2.

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UNIQUENESS OF THE 'T HOOFT-POLYAKOV MAGNETIC MONOPOLE SOLUTION

In the O(3) gauge theory with a triplet of scalars, we show the uniqueness of the Wu-Yang-'t Hooft-Polyakov-Julia-Zee solution under the assumptions: 1) static, finite energy solution, 2) separability of radial and angular variables.

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SU(3) / SO(3) MAGNETIC MONOPOLES

SU(3) magnetic monopoles based on the SO(3) subgroup are given. The charge quantization conditions are $e \cdot g = \pm 1$.

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THEORY OF MAGNETIC MONOPOLE

The treatment of magnetic monopole theory involves the Maxwell equations in a theory allowing both charges and monopoles co-existing and interacting with one another and involving the idea of string defined as a line extending from the monopole to infinity or terminating on a equal and opposit monopole. The change of gauge, the kinematics, and an action principle are considered. It is noted that the force on the monopole comes simply from the monopole being constrained to lie at the end of string and the string variables occurring in the expression for the action of the field.

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MAGNETIC MONOPOLES (In French)

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MAGNETIC MONOPOLES AND HIGGS FIELD
(In Chinese)

It is shown that if magnetic monopoles exist their space distribution and motion define the four dimensional space-time transformation and topological structure of Higgs field.

876. Englert F. and Windey P. Phys.Rev., 1976, vol.D14, No 10, pp.2728-2731.

QUANTIZATION CONDITION FOR 'T HOOFT MONOPOLES IN COMPACT SIMPLE LIE GROUPS

The quantization conditions for 't Hooft monopoles and their related conserved topological charges are obtained for all compact simple Lie groups. In addition, all possible Dirac monopoles are classified.

877. Ezawa Z.F. and Tze H.C. J.Math.Phys., 1976, vol. 17, No 12, pp.2228-2231.

MONOPOLES, VORTICES AND THE GEOMETRY OF THE YANG-MILLS BUNDLES

A topological classification of monopoles and vortices is formulated in terms of fibre bunbdles. The distinction between Dirac and 't Hooft monopoles is made in the light of the energy finiteness problem. Finite-length vortices with Dirac monopoles at the end points are also discussed.

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MONOPOLES, VORTICES AND THE GEOMETRY OF THE YANG-MILLS BUNDLES

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A THEORY OF DIRAC MONOPOLES WITH A NON-ABELAIN SYMMETRY

Lagrangian theory of non-Abelian classical Dirac monopoles that is free of such problems as the "Dirac veto".

880. Fadeev L.D. Fourth International Symposium on Non-local Field Theories, Alushta, USSR, 1976. Joint Inst. for Nucl. Research, JINR D2-9788, Dubna, 1978, pp.207-223.

IN SEARCH FOR MANY-DIMENSIONAL SOLUTIONS

Certain techniques used in the search of multidimensional solutions are discussed. The role of scale transformations is clarified during discussion of the problem of solution existence. It is explained why the existence of stationary localized solutions of non-linear equations is a rule for one-dimensional space and an exception for three-dimensional space The importent role of topological charges for solutions is noted in connection with the fact that solutions as a rule, possess the nonzero values for them. Moreover, sometimes the topological charge gives the estimate underneath for the energy of stationary solutions. This property can be used both for the proof of the existence of solutions itself and for the evaluation of their mass. The author believes that the most appropriate solution for the gauge-invariant theory of chiral fields is the 't Hooft-Polyakov monopole which is not really localized.

881. Frampton P.H. Phys.Rev., 1976, vol.D14, No 2, pp.528-530.

UNIQUENESS OF s-WAVE NON-ABELIAN MAGNETIC MONOPOLE

A systematic search for spherically symmetric magnetic-monopole solutions of an SU(2) Yang-Mills theory is reported. After a qualitative discussion based on a mechanical analog model the quantitative search is described. The result is that the s-wave monopole discovered by 't Hooft is unique; no radial excitations exist. Thus, if there exist any alternative solutions to the 't Hooft solution, they are not spherically symmetric.

882. Frampton P.H. University of California, Dept. of Phys., UCLA/76/TEP/12, Los Angeles, 1976.

'T HOOFT MONOPOLES AND SINGULAR GAUGE TRANSFORMATIONS

States non-Abelian monopoles are not sources and have no attached strings. Also non-Abelian monopoles may terminate dual strings of magnetic flux, but it seems unlikely.

883. Frenkel A. and Hrasko P. Kozponti Fizikai Kutato Intezet, KFKI-75-82, Budapest, Hungary, 1976.

INVARIANCE PROPERTIES OF THE DIRAC MONOPOLE

Shows, in part, that one gets rotational invariance and correct space reflection for e, g system with Dirac quantization.

884. Friedman K.A. and Kaku M. Phys.Rev., 1976, vol. D14, No 8, pp.2023-2028.

TIME-DEPENDENT GENERALIZATIONS OF 'T HOOFT TYPE MONOPOLES

We construct new classical monopole and dyon solutions of the 't Hooft type, which have particlelike properties and are time-dependent. These new solutions are constructed out of the tensors arising out of the classical electrodynamics of pointlike charged particles, and hence describe pointlike particles which can perform arbitrary space-time motions. When the monopoles come to rest, they reduce to the monopoles found by 't Hooft abd by Julia and Zee.

885. Galitski V.M. Priroda (Russ.), 1976, No 4, pp.27-31.

MONOPOLE DISCOVERY?
(In Russian)

886. Gervais J.L., Sakita B. and Wadia S. Phys.Lett., 1976, vol. 63B, No 1, pp.55-58.

THE SURFACE TERM IN GAUGE THEORIES

The importance of the surface term in the action-integral in gauge theories is pointed out. In contains additional dynamical variables other than those contained in the Lagrangian density. The additional variables play the role of collective coordinates for the quantization of 't Hooft-

Polyakov monopole solutions. In general they are necessary if the generalized total charge of the system is non-zero. They serve to select a boundary condition of the solution of classical equations of motion, about which the quantum mechanical perturbative expansion should be done. We obtained the Schwinger quantization condition for the dyon $Q \cdot g$ = integer.

887. Gervais J.L., Neven A. Phys.Reports (section C of Phys. Lett.),1976, vol.23, No 3, pp.240-244. Introductory paper to the Proceeding of the meeting held at Ecole Normale Supérieure, Paris, 1975.

EXTENDED SYSTEMS IN FIELD THEORY

888. Goldhaber A.S. In: NEW PATHWAYS IN HIGH-ENERGY PHYSICS, Proc. of Orbis Scientiae University of Miamy, Ed. A.Perlmutter Plenum, New York, 1976, vol.1, pp.121-123.

ELECTRIC CHARGE IN COMPOSITE MAGNETIC MONOPOLE THEORIES

It is observed that the spin approach to the interaction of electric charges with magnetic monopoles leads naturally to theories with composite monopoles made from SU(2) gauge fields. The key steps are to express the "electromagnetic field angular momentum associated with a charge-pole system as a quantum-mechanical spin operator (as was done some year ago) and then to identify this spin operator as the generator of SU(2) transformations on charged particle wave functions. It is emphasized that composite monopoles may not occur unless electric charge is one of the operators of an SU(2) symmetry. The formalism for conservation of electric charge and quantization of the electric charge of a monopole, is developed at a " first-quantized"level. Speculations are given on high energy charge-pole scattering .Some problems with second quantization are discussed and the possibility is raised that there may be an infinite mass renormalization of a composite monopole which has finite mass in the classical approximation.

889. Goldhaber A,S. Phys.Rev.Lett., 1976, vol.36, No 10, pp.1122-1125.

CONNECTION OF SPIN AND STATISTICS FOR CHARGE-MONOPOLE COMPOSITES

An object composed of a spinless electrically charged particle and a spinless magnetically charged particle may bear net half-integer spin, but the wave function of two such clusters must be symmetric under their inter change. Nevertheless, a careful study of the relativistic motion of the clusters shows that this symmetry condition implies the usual connection between spin and statistic.

890. Goldhaber A.S., Wilkinson D. Nucl.Phys.,1976, vol. B114, No 2, pp.317-333.

COMPOSITE MAGNETIC MONOPOLES FOR SU(N) SPONTANEOUSLY BROKEN TO U(1).

The point monopole solution found by Corrigan, Olive, Fairlie and Nuytz for SU(3) broken down to U(2) by an octet Higgs field is shown to survive when the symmetry is further broken to U(1), and therefore is a magnetic monopole in the traditional sense. The demonstration exploits a singular trans formation from the Abelian gauge with a Dirac string, to a non-singular gauge in which the vector field has a manifect rotational symmetry. The procedure is generalized to SU(N) broken to U(1), always yielding the smallest strength monopole consistent with the Dirac quantization condition, and in some cases higher - strength monopoles as well. The manifect symmetry of the vector field corresponds to an angular momentum J^0, different in general from the physical charge-pole angular momentum J. The latter generates a symmetry of the whole system of Higgs and vector fields. Even that symmetry fails for the interior of a finite-energy solution unless J and J^0 coincide, which happens only for the minimal monopole coupled to a charge in an SU(2) subgroup of SU(N). If SU(N) is not broken all the way to U(1), there can be solutions with exact J^0 symmetry whose possible significance is discussed. A theorem of Georgi and Glashow is used to show that SU(3) $\longrightarrow$ U(1) could occur in a natural way if there were

two Higgs fields.

891. Gürsey F. Conference on "Gauge Theories and Modern Field Theories", Boston, 1975. Ed. R. Arnowitt and P. Nath, MIT Press, Cambridge, 1976, pp. 369-376, (in collaboration with L. J. Swank

SUPERSYMMETRIC ANSATZ FOR SPONTANEOUSLY BROKEN GAUGE FIELD

It is shown that a new type of ansatz involving spinors in a gauge theory with Higgs fields based on SU(3) leads to 't Hooft type monopole solutions with finite energy which carry fractional charges of the quarks.

892. Hagen C.R., Schwinger J., and Zwanziger D. Phys. Today, Apr. 1976, p. 15.

LORENTZ INVARIANCE QUESTION

Hagen states he showed non-covariance of monopole and that Schwinger is incorrect. Good review of fundamental problems concerning monopoles.

893. Hagen C.R. In : NEW PATHWAYS IN HIGH-ENERGY PHYSICS, Proc. of Orbis Scientiae University of Miamy, Ed. A. Perlmutter, Plenum Press, New York, 1976, vol. 1, pp. 135-149.

NONCOVARIANCE OF THE SCHWINGER MONOPOLE

It is shown that a canonical formulation of the magnetic monopole cannot be covariant if one allows only couplings which are manifestly invariant under three dimensional rotation. Although Schwinger's monopole theory allows a more general class of interaction terms, Lorentz invariance is found to be violated there as well. One is forced to conclude that there does not exist a consistent field theory of the monopole of the present time.

894. Hanni R.S. and Ruffini R. Nuovo Cimento Lett., 1976, vol. 15, No 6, pp. 189-194.

SCHWARZSCHILD BLACK HOLE IN AN ASYMPTOTICALLY UNIFORM MAGNETIC FIELD

A study of the structure of the magnetic field in the neighbourhood of a black hole is reported. The physical components of the Lorentz force acting in a magnetic monopole of unit strength at rest at a given period of the Schwarzschild background are locally analyzed. Then the lines of forces as seen from a far away observer are studied. Finally, the lines of constant flux which coincide with the lines of free flux are given. They are spaced in order that their density is proportional to the physical component of the Lorentz force.

895. Hasenfratz P. and 't Hooft G. Phys.Rev.Lett.,1976, vol.36, No 19, pp.1119-1122.

FERMION-BOSON PUZZLE IN A GAUGE THEORY

It is argued that magnetic monopoles in an SU(2) gauge theory may bind with an ordinary boson with isospin, to give bound states with spin. If the isospin of the free boson is integer or half-odd-integer, the total angular momentum of the bound state is integer or half-odd-integer, respectively. According to the spin-statistics theorem we can obtain fermions this way in a theory that started off with bosons only.

896. Hasenfratz P. and Ross D.A. Nucl.Phys.,1976, vol.B108, No 3, pp.462-482.

ANOMALOUS ANGULAR MOMENTA IN A QUANTIZED THEORY OF MONOPOLES

In this paper a gauge theory with a classical solution corresponding to a magnetic monopole is quantized. By careful handling of the zero frequency modes, it is shown that the monopole is capable of absorbing both momentum and charge. The angular momentum operator is considered and it is shown that if the original theory contains an isodoubled scalar field, the quantum excitations may be half integer eigenvalue eigenstates of this operator.

897. Hasenfratz P. and Ross.D.A. Utrecht preprint, March,1976.

ANOMALOUS ANGULAR MOMENTA IN A QUANTIZED THEORY OF MONOPOLES

898. Hietarinta J., Takasugi E. and Tanaka K. Dept. of Phys. The Ohio State University, COO-1545-185, Columbus, 1976.

MAGNETIC MONOPOLE SOLUTION IN NON-ABELIAN GAUGE THEORY

We propose an approximate analytic solution of the equations of motion of the 't Hoof magnetic monopole model. Virial type global tests are carried out for the solution. Then the monopole mass, energies of the vector field A^a_μ, Higgs field Φ^a and interaction are computed in closed form. The form factors of A^a_α and ϕ^a in a quantized version are also calculated.

899. 't Hooft G. Lect. Notes Phys., 1976, vol. 50, No 3,

MAGNETIC MONOPOLES AND NON-ABELIAN GAUGE GROUPS

It is shown that in all gauge theories where a gauge group of electromagnetic interactions U(I) is considered to be a sub-group of a wider group with a compact covering (e.g SU(2) or SU(3)), the production of true magnetic monopoles which are represented by regular solutions of field equation is admissible. The mass of these monopoles can be calculated and it is of the 137 m_W order, where m_W is an average mass of the vector boson.

900. 't Hooft G. Nucl. Phys., 1976, vol. B105, pp. 538-

MAGNETIC CHARGE QUANTIZATION AND FRACTIONALLY CHARGED QUARKS

If magnetic monopole with Schwinger's value of the magnetic charge would exist then that would pose serious restrictions on theories with fractionally charged quarks, even if they are confined. Weak and electromagnetic interactions must be unified with colour, leading to a Weinberg angle θ_W close to 80°.

901. Horvath Z. and Palla L. Phys.Rev., D14, No 6, pp.1711-1714.

DYONS IN CLASSICAL SU(3) GAUGE THEORY AND A NEW TOPOLOGICALLY CONSERVED QUANTITY

By extending the work of Marciano and Pagels we construct solutions to the classical pure Yang-Mills SU(3) gauge field equations which have a new topologically conserved quantity. The nonzero value of this quantity stabilizes dyons.

902. Horvath Z. and Palla L. Inst. of Theor.Phys.,Roland Eötvösh Univ.,ITP-361, Budapest, Hungary,1976.

MONOPOLES, DYONS AND OTHER TOPOLOGICALLY STABLE SOLUTIONS IN GAUGE THEORIES

903. Horvath Z. and Palla L. Inst. of Theor.Phys.,Roland Eötvösh Univ., ITP-362, Budapest, Hungary,1976.

ON THE STRUCTURE OF GENERALIZED MONOPOLE SOLUTIONS IN GAUGE THEORIES

Present a method for constructing generalized 't Hooft monopole solutions in a gauge theory with an arbitrary gauge group.
Prediction
Charge quantization spans $g_o \leq kg_o \leq (N-1)g_o$ in SU(N) gauge theories.

904. Horvath Z., Palla L. Nucl.Phys.,1976, vol.B116, No 2, pp.500-524.

ON THE STRUCTURE OF GENERALIZED MONOPOLE SOLUTIONS IN GAUGE THEORIES

A method is presented for constructing generalized 't Hooft monopole solutions in a gauge theory with an arbitrary gauge group. We derive restrictions arising from the condition of finite energy. The radial oscillation of the solution is discussed. Using our method we reproduce all the SU(3) solutions known in the literature. Finite energy monopoles possessing magnetic charge in the range $g_o \leq kg_o \leq (N-1)g_o$ are

found in SU(N) gauge theories. Different charge quantization conditions are analyzed to understand the structure of our solutions.

905. Horváth Z. and Palla L. Inst. of Theor. Phys., Roland Eötvösh University, ITP-364, Budapest, Hungary, 1976.

MONOPOLES AND GRAND UNIFICATION THEORIS

Shows a method for constructing static extended monopole solutions in grand unification theories.

906. Hrasko P. Kozponti Fizikai Kutato Intezet, KFKI-76-32, Budapest, Hungary, 1976.

QUASICLASSICAL QUANTIZATION OF THE MAGNETIC CHARGE

To investigate the Dirac's quantization condition for the magnetic charge a kind of spherical pendulum is considered in the quasiclassical approximation. This pendulum differs from ordinary spherical one in that the moving point mass possesses an electric charge e while the center of the pendulum has a magnetic charge g. Using the Einstein-Keller method for quantization it is shown that the assumption of spherical symmetry leads to the Dirac quantization condition $egc^{-1}=0.25\ \pi^{-1}hn$ with an arbitrary integer n.

907. Hsu J.P. Phys.Rev.Lett., 1976, vol.36, pp.646-649.

MIXING ANGLE THETA AND MAGNETIC MONOPOLE IN WEINBERG'S UNIFIED GAUGE THEORY

Gauge symmetry admits a local unit isovector and leads to the magnetic monopoles in Weinberg's unified theory. I predict $\sin^2\Theta = 1/2$ for the mixing angle Θ on the basis of Dirac's condition for charge quantization. This intersting result should be tested experimentally.

908. Hsu J.P. Phys.Rev.Lett.,1976, vol.36, No 26, pp.1515-1518.

FORMS OF GAUGE FIELDS AND NON-INTEGRABLE PHASE FACTORS

I show the connection between magnetic monopoles with quantized strengths and the form of solutions of gauge fields. A generalized electromagnetic field tensor $\bar{f}_{\mu\nu}$ and its physical implications in a unified gauge theory are discussed.

909. Huang K. and Stump D.R. Phys.Rev.Lett.,1976, vol.37, No 9, pp.545-548.

MIXING OF INTERNAL AND SPACE TIME SYMMETRIES

In a general Yang-Mills theory with self-interacting boson and/or fermion source fields, it is shown that the angular momentum operator is $\vec{J} = \vec{I} + (2\pi)^{-1} Q_a \vec{\Phi}_a$,where $\vec{I}$ is the free-field angular momentum (i.e., that for zero gauge coupling constant), Q_a is the total charge, corresponding to the internal symmetry index a , and Φ_a^k is the total flux of $\nabla \times \vec{A}_a$ along the x^k direction, in the gauge $\nabla \cdot \vec{A}_a = 0$.

910. Ishikawa K. Tohoku Univ., TU/76/141, Sendai, Japan,1976.

EXTENDED OBJECTS IN GAUGE THEORIES

A technique of relativistically covariant collective coordinates is applied to gauge theories in relativistic space-time dimensions which have solutions of classical Euler-Lagrange equations. Masses and form factors of extended objects in such theories are calculated.

911. Jackiw R. and Rebbi C. Phys.Rev.Lett.,1976, vol.36, No 19, pp.1116-1119.

SPIN FROM ISOSPIN IN A GAUGE THEORY

It is shown that in an SU(2) gauge theory with isospin symmetry broken by a triplet of scalar mesons, isospinor degrees of freedom are converted into spin degrees of freedom, in the field of a magnetic monopole.

912. Jackiw R. In:"GAUGE THEORIES AND MODERN FIELD THEORIES, Ed.R. Arnowitt and P.Nath, MIT Press, Cambridge,1976,pp.377-401.

CHARGE AND MASS SPECTRUM OF QUANTUM SOLITIONS

A perturbative method for solition sectors in quantum field theory is reviewed and the solution mass spectrum is discussed. It is shown that quantizing the Yang-Mills monopol forces the presence of charge-bearing monopoles, which are almost degenerate in mass.

913. Jackiw R. and Rebbi C. Phys.Rev.,1976, vol.D13, No 12, pp.3398-3409.

SOLITIONS WITH FERMION NUMBER 1/2

We study the structure of solition- monopole systems when Fermi fields are present. We show that the existence of a nondegenerate, isolated, zero-energy, e-number solution of the Dirac equation implies that the solition is a degenerate doublet with Fermi number $\pm 1/2$. We find such solutions in the theory of Yang-Mills monopoles and dyons.

914. Jacobs L. Phys.Rev.,1976, vol.D14, No 10, pp.2739-2746.

SU(3) THEORY OF FERMION-MONOPOLE SYSTEMS

It is shown that, when Fermi fields are introduced in the SU(3) generalizations of the 't Hoof-Polyakov model, the existence of any topologically stable solution to the pure Yang-Mills-Higgs system necessarily implies that the corresponding Dirac equations possess, for any nonzero value of the solition-fermion coupling costant, an isolated, normalizable solution at exactly zero energy.

915. Kaku M. Phys.Rev.,1976, vol.D13, No 10, pp.2881-2883.

SU(4) AND A NEW CLASS OF EXACT,TIME-DEPENDENT, CLASSICAL SOLUTIONS TO GAUGE THEORIES

We construct an exact, time-dependent, classical solution to the Yang-Mills equation with SU(4) symmetry,generalizing the static solutions of Wu and Yang. This solution

describing a pointlike particle which can execute arbitrary space-time motions is constructed out of Lienard-Wiechert potentials. The solution opens the door to an entirely new class of classical ansatz to gauge theories, including 't Hooft monopoles. Time- dependent classical solutions of this type may prove useful in constructing quantized bound-state hadronic systems.

916. Kalman G. and Ter Haar D. Nature, Lett. to the Editor, 1976, vol.259, p.467.

PULSARS AND MAGNETIC MONOPOLES

Considers the effect of monopoles on persistence of pulsar fields. Not able to set significant upper limits on flux.

917. Kazama Y. and Yang C.N. Institute for Theor.Phys., State Univ. of New-York, SUNY-Stony Brook ITP/SB 76-65, Stony Brook, New-York, 1976.

EXISTENCE OF BOUND STATES FOR A CHARGED SPIN 1/2 PARTICLE WITH AN EXTRA MAGNETIC MOMENT IN THE FIELD OF A FIXED MAGNETIC MONOPOLE

918. Kazawa Y., Yang C.N. and Goldhaber A.S. Institute for Theor.Phys., State Univ. of New-York, SUNY-Stony Brook, ITP/SB 76-73, Stony Brook, New-York, 1976.

SCATTERING OF A DIRAC PARTICLE WITH CHARGE Ze BY A FIXED MAGNETIC MONOPOLE

Adds an infinitesimal extra magnetic moment to charged particle. Find helicity flip and helicity non-flip amplitudes.

919. Khlebnikov V.I. Vestnik Mosk.Univ., ser. phys.-astron. 1976, vol.17, No 5, pp.590-597.

GRAVITATIONAL FIELD OF QUASISTATIONARY CONCENTRATED SYSTEMS WITHOUT ROTATION (I)

A series of solutions of Einstein-Maxwell equations with term ahs been obtained which describes the gravitational field

of quasistationary concentrated systems with electromagnetic and magnetic charges. The metrix found belong to type D according to Petrov-Pirani and possess zero rotation and shift. The physical interpretation of the solutions obtained is given. The first part of the investigation contains the setting of the problem in terms of the spin coefficient method.

920. Kim B.R. Phys.Rev.,1976, vol.D13, No 11, pp.3156-3158.

COLOR AND MAGNETIC CHARGE

Schwinger's conjecture that the color degree of freedom of a quark is equivalent to its degree of freedom of taking different magnetic charges provides a plaussible motivation for extending color to leptons. Leptons are just quarks with zero magnetic charge. It is shown that baryon number and lepton number can be replaced by fermion number and magnetic charge.

921. Kimon Nam, Yongduk Kim J.Korean Phys.Soc.,1976, vol.8, No 1, pp.5-8.

THE SCALING INVARIANCE OF THE ELECTRON-MAGNETIC MONOPOLE SCATTERING AMPLITUDE

922. Krolokowski W. Bull.Acad.Pol Sci.Ser.Sci.Math.Astron., and Phys.(Poland),1976, vol.24, No 6, pp.449-453.

A COMMENT ON MAGNETIC MONOPOLES AND PARITY VIOLATION

The connection between the parity conservation in electromagnetic interaction and the absence of magnetic monopoles carried by spin-1/2 particles is commented on.

923. Kursunoglu B. In: NEW PATHWAYS IN HIGH ENERGY PHYSICS, Proceedings of the third Orbis Scientiae, Univ. of Miami, 1976. Ed. by Perlmutter et al., Plenum Press, New-York, and London, 1976, pp.15-110.

ELEMENTARY PARTICLES IN THE GENERALIZED THEORY OF GRAVITATION

924. Kursunoglu B. Phys.Rev.,1976, vol.D13, No 6, pp.1538-1560.

CONSEQUENCES OF NON-LINEARITY IN THE GENERALIZED THEORY OF GRAVITATION

Magnetic charge in no way related to Dirac or Schwinger charge. Model has shells of magnetic charge of alternating signs. Monopoles don't exist in theory.

925. Kyriakopoulos E., Ramachandran R. Lett.Nuovo Cim.,1976, vol.15, No 5, pp.161-165.

MONOPOLE-ANTIMONOPOLE BOUND STATE

In this note an attempt is made to estimate the mass and other properties of monopole-antimonopole bound state arising purely out of a magnetic interaction and relate it to the form factor of the monopole.

926. Lee B.W. In: NEW PATHWAYS IN HIGH ENERGY PHYSICS. Proc.of Orbis Scientiae Univ. of Miami, Ed. A.Perlmutter, Plenum, New-York, 1976, vol.2, pp.359-398.

MY PERSPECTIVES ON PARTICLE PHYSICS, SUMMARY OF ORBIS SCIENTIAE,1976

A review of contemporary theory touching on magnetic monopoles. Short, but interesting remark on charge quantization.

927. Leinaas J.M. Fra Fys.Verden/Norway/,1976, vol.38, No 4, pp.78-82.

MAGNETICALLY CHARGED PARTICLES(In Norwegian)

Magnetic monopoles and Dirac's quantum conditions for electric and magnetic charges are discussed.A magnetic monopole field is visualized as the field of a solenoid of infinite length and vanishing cross-section.The theoretical consequences of the existence of magnetic monopole particles are briefly mensioned;they may form part of the structure of the proton or neutron.

928. Lugo V.A. University of California, Dept. of Phys.,UCLA/7 /TEP/25, Los Angeles,1976.

THE STRICT EQUIVALENCE OF THE ABELIAN MONOPOLE AND ITS NON-ABELIAN STRINGLESS COUNTERPART BY USE OF SECTIONS

In an SO(3) theory shows Dirac monopole under certain conditions can be properly transformed to global,nonsingular gauge field. For Dirac monopole means 't Hooft solution is equivalent to Abelian monopole.

929. Maetzler C. Z.Angew.Math.Phys.,1976, vol.27, p.137.

GYRO-SYNCHROTRON RADIATION IN A MAGNETIC MONOPOLE AS A SOURCE OF SOLAR MICROWAVE BURSTS

930. Maetzler C. Sol.Phys.,1976, vol.49, No 1, pp.117-140.

CONTINUOUS INJECTION MODEL FOR HARD X-RAY CORRELATED MICROWAVE BURSTS

Asymmetric magnetic field configurations in solar active regions hinder mildly relativistic electrons with magnetic moments suitable to produce microwave radiation from being trapped. Therefore the duration of stay of electrons in the microwave source region is much shorter ($<$ 0.2s) than in the usually assumed trapping models. On this basis a consiste model of hard (x-ray) correlated microwave bursts due to continuous injection of electrons into a pole field of an asymmetric magnetic loop is constructed. This resolves the discrepancy of the numbers of electrons needed to produced x-ray and radio emission. Gyro-synchrotron spectra are computed with the assumption of conservation of the magnetic moment M in the microwave source. The consequence is an anticorrelation between the low frequency power index a of the microwave spectrum and the power index γ of the hard x-ray spectrum.(In fact during the flow of may 18,1972) increase with time while a is decreasing , so that $\gamma + A$ constant. Furthermore, it is shown that electrons with energies below 100 keV contribute significantly to the microwave radiation; they determine the low frequency spectrum comple-

tely. The model is able to explain the most of ten observed type c-spectra but also that spectra over one frequency decade.

931. A MAGNETIC POLE DISCRIMINATOR. Sci.News,1976, vol.109, No 2, pp.25-27.

932. Maison D. and Orfanidis S.J. Dept. of Phys., New York Univ., NYU Pth 31/76, New York,1976.

SOME GEOMETRICAL ASPECTS OF MONOPOLE THEORIES

Connects Kaluza's theory of electromagnetism and its non-Abelian generalizations to a geometrical formulation in terms of fiber bundles.

933. Majernik V. and Nagy M. Lett.Nuovo Cim.,1976, vol.16, No 9, pp.265-268.

QUATERNIONIC FORM OF MAXWELL'S EQUATIONS WITH SOURCE

Treatment of Maxwell's equations with source including magnetic monopoles. This attack is supposed to offer an easier approach to curved spaces.

934. Mandelstam S. Phys.Reports (Section C of Phys.Lett.), 1976, vol.23, No 3, pp.245-249.

II. VORTICES AND QUARK CONFINEMENT IN NON-ABELIAN GUAGE THEORIES

Discussion somewhat following Physics Letters article. Suggests an alternate color confinement model.

935. Marciano W. and Pagels H. Phys.Rev.,1976, vol.D14, No 2, pp.531-534.

CHIRAL-CHARGE CONSERVATION AND GAUGE FIELDS

An example of a gauge field theory with classical dyon solutions which violates anomaous chiral-charge conservation

is presented. We also show that the pseudoparticle solution to the four-dimensional pure Yang-Mills equations is equivalent to a link solution in one dimension. The net change in chirality, the Pontryagin index, and kink number are equivalent. This suggests an intimate connection between the spherically symmetric four-dimensional Euclidean gauge field theory and one-dimensional scalar field theories.

936. Marciano W., Pagels H. Dept. of Phys., The Rockfeller Univ.,COO-2232B-108,New York,1976.

MULTIPLY CHARGED MAGNETIC MONOPOLES, SU(3) PSEUDOPARTICLES AND GRAVITATIONAL PSEUDO-PARTICLES

We construct a topologically stable solution to the pure Yang-Mills SU(3) gauge field equations (without scalar fields) which corresponds to a point magnetic monopole. There is no SU(2) analog to this solution.

937. Matsumoto H., Umezawa H., Papastamatiou N.J. Phys.Rev., 1976, vol.D14, No 12, pp.3536-3547.

A DETAILED STUDY OF RELATIVISTIC STRINGS

Presented is a detailed analysis of the dynamics of the relativistic vortex by means of the boson transformation method. General formulas for the energy and momentum of the string are derived. It is shown that a vortex of finite length creates a superposition of a short-range field associated with the body of the vortex and a field coming from the end points. This end-point field decomposes into a short-range and a long-range component, and the latter can be eliminated by attaching Dirac magnetic monopoles at the end-points. It turns out that the monopole-string system has a finite negative binding energy.

938. Michel L., O'Raifeartaigh and Wali K.C. Syracuse Univ., SU-4210-83, Syracuse, New York,1976.

STATIC FINITE-ENERGY SOLUTIONS OF GAUGE FIELDS WITH SEPARATED,RADIAL VARIABLE

For the above system, the radial and angular equations are exhibited for any Yang-Mills group G, and the angular equations are solved for G=SU(2). For all the solutions in this case, the magnetic charge is $4\pi/e$.

939. Micu M. Inst. of Atomic Phys., Bucharest, Publ.No 123, Romania, 1976.

GROUP THEORETICAL APPROACH TO MONOPOLE THEORIES

940. Mignani R. Lett.Nuovo Cim., 1976, vol.16, No 1, pp.6-8.

STRONG BLACK HOLES AND QUARK-MONOPOLE IDENTIFICATION

It is shown that the metric describing a hadron as a stro black hole essentially coincides in the case of massless gluon exchange with the metric generated by a 't Hooft's magnetic monopole is curved space-time. Therefore, the result further supports the hypothesis that quarks inside hadrons share o the properties of magnetic monopoles.

941. Mignani R. Phys.Rev., 1976, vol.D13, No 8, pp.2437-2440.

SYMMETRIES OF ELECTRODYNAMICS WITH MAGNETIC MONOPOLES AND THE HERTZ TENSOR

We discuss discrete symmetries of the Maxwell equations with Dirac poles, written in manifestly duality-invariant form by means of the Hertz tensor. It is shown that in this framework the theory may give rise to parity and time-reversal violation only for systems without electric charges. When both electric and magnetic charges are present, the pseudovector character of the magnetic current-insuring parity and time-reversal invariance of the Maxwell equations- is a direct consequence of the vector transformation properties of the electric current.

942. Mikhailov V.F. Izv.Akad.Nauk Kazakhsk.SSR, ser. fiz.-mat.,1976, No 6, pp.88-90.

EVALUATIONS OF POSSIBLE CONCENTRATION OF THE DIRAC MONOPOLES IN GEOLOGICAL FORMATIONS

943. Milton K.A. and DeRaad L.L.,Jr. University of California, Dept. of Phys.,UCLA/76/TEP/16,Los Angeles,1976.

STRINGS AND GAUGE INVARIANCE

Studies charge quantization by solving two-body Schrodinger equation with arbitrarily oriented string. Some results on dyon-dyon scattering.

945. Moffat J.W. Toronto preprint,1976.

A GENERAL STATIC SPHERICALLY SYMMETRIC SOLUTION IN A UNIFIED THEORY OF GRAVITATION AND ELECTROMAGNETISM

The static spherically symmetric solution for a general electromagnetic point source is derived in a theory unifying gravitation and electromagnetism. The solution excludes the existence of magnetic monopoles.

946. Nambu Y. Phys.Reports (Section C of Phys.Lett.),1976, vol.23, No 3, pp.250-253.

MAGNETIC AND ELECTRIC CONFINEMENT OF QUARKS

Says faced with two problems in looking at Nielsen-Olsesen model; (1) to get a non-Abelian generalization,(2) quantization. Discusses some problems with magnetic confinement.

947. Nauenberg N, Bartlett D.F. Progress Report,May 1976 - to December 1976, COO-2114-23.

ELEMENTARY PARTICLES AND HIGH ENERGY PHENOMENA

Summerises of research activities at Colorado University.

948. van Nieuwenhuizen P., Wilkinson D., Perry M.J.
Phys.Rev.,1976, vol.D13, No 4, pp.778-784.

REGULAR SOLUTION OF 'T HOOFT'S MAGNETIC MONOPOLE MODEL IN CURVED SPACE

A regular solution of ' t Hooft's magnetic monopole model in curved space is presented. As in flat space, an analytical solution seems impossible, but by using the Einstein equations to eliminate the gravitational degrees of freedom, a positive-definite energy functional is constructed, which at its minimum gives both the required solution and the energy of the system. To first order in the gravitational constant G, the energy can be expressed in terms of the first-space solutions only, whereas for general G a positive lower bound is derived.

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J.Phys., A.(London),1976, vol.9, pp.547-554.

ELECTRIC AND MAGNETIC GRAVITATIONAL MONOPOLES
I. THE EQUATION OF MOTION OF POLES

In this paper we propose the existence of a new class of particles that we call H poles. Tidal forces that govern the behaviour of nearby H poles in gravitational fields is given by the dual of the Riemann tensor. Consequently, the equivalence principle is not satisfied by these H poles. A physical property of conformal trasformation is shown to exist, by means of which the H poles are mapped into particle of geodesic motion. Einstein 's equations for the gravitational field in a vacuum are shown to have a larger symmetry group.

950. Okabayashi T. Fortschr.Phys.,1976, vol.24, No 11,pp.619-632.

QUANTUM THEORY OF PATH-DEPENDENT FIELD OPERATOR BASED ON CHARACTERISTICS OF DISPLACEMENT OPERATORS

The path-dependent operator formalism of quantum electrodynamics proposed by Mandelstam is reformulated through quantum field theory based on characteristics of displacement

operators in Minkovski space. It is shown that total energy- and total angular-momentum operators can generate in homogeneous Lorentz transformations on any local operator including path-independent bilinear forms constructed of path-dependent electron operator as $\psi(x,\rho)$,but that generators for $\psi(x,\rho)$ itself are only their $\psi(x,\rho)$ -dependent parts. Such an unfamiliar feature is characteristic of the path-dependent operator formalism. The present approach possesses unique merits in making the logic of the formalism transparent as described in the following. Some restriction, which can be used to discuss propriety of gauge conditions, can be figured out. By introducing a path-rearrangement operator, we can keep infinite variety of space-like paths with the same and point throughout our formulation as they stand. Several points which must be modified in the presence of magnetic monopole are closed up.

951. Olive D.I. Nucl.Phys.,1976, vol.B113, No 3, pp.413-420.

ANGULAR MOMENTUM,MAGNETIC MONOPOLES AND GAUGE THEORIES

When an exact gauge symmetry group H is embedded in a larger group G ehich is broken back to H spontaneously, there are situations in which the angular momentum operator acquires a new term t, where t_1, t_2, t_3, generate an angular momentum subalgebra of G. Thus internal and external symmetries are coupled. It is shown, that the radial component of t is a linear combination of the generators of H. When H consists of a color group and an electromagnetic U(1) generated by the electric charge operator Q which is a colour singlet, then the coefficient of Q in this decomposition is minus the magnetic charge occurring in the situation. For general H the structure of the decomposition is minus the magnetic charge occurring in the situation. For general H the structure of the decomposition of the radial component of t into genrators of H completely determines the topological quantum numbers of the solution considered. The result provides a useful new tool for the model building of monopoles.

952. Opat G.I. Phys.Lett.,1976, vol.60B, No 2, pp.205-206.

LIMITS PLACED ON THE EXISTENCE OF MAGNETIC CHARGE IN THE PROTON BY THE GROUND STATE HYPERFINE SPLITTING OF HYDROGEN

If the proton contained equal amounts of opposite magnetic charges, as is required by certain "quark" models, the fermi contact part of the hyperfine interaction would change markedly. This is turn would affect the ground state hyperfine splitting of atomic hydrogen. Comparison of the theoretical and experimental values of the hyperfine splitting yields $\delta = -(1.6 \pm 2.7) \times 10^{-6}$, where δ is the fraction of the proton magnetic moment due to the magnetic charges. δ is well consistent with zero.

953. O'Raifeartaigh L. Dublin Institute for Advanced Studies, DIAS-TP-76-36,Dublin,1976.

GAUGE AND REPRESENTATION INDEPENDENT PROOF OF THE GUTH-WEINBERG THEOREM

954. Ore F.,Jr. Phys.Rev.,1976, vol.D13,No 8, pp.2295-2299.

LORENTZ INVARIANCE OF CHARGE-MONOPOLE SCATTERING

The eikonal approximation is applied to the scattering of an electric charge by an infinitely massive scalar magnetic charge using Schwinger's model for the interactions. The resulting scattering amplitude is seen to be Lorentz-invariant if the charges satisfy the Schwinger condition $eg/4\pi$ =integer

955. Otgonsuren O., Perelygin V.P., Stetsenko S.G., Gavrilova M.N., Fieeni C.,Pellas P. Astrophys.J.,1976,vol.210,No 1,pp.258-66.

ABUNDANCES OF $Z > 52$ NUCLEI IN GALACTIC COSMIC RAYS: LONG-TERM AVERAGES BASED ON STUDIES OF PALLASITES

Principally a heavy experiment. Get an upper limit of 10^{-18} $cm^{-2}s$ sr for flux of monopoles with $g \geq 4$ in interstellar space.

956. Pagels H. Phys.Rev,1976, vol.D13, No 2,pp.343-445.

SOME REMARKS ON THE U(1)-AXIAL PROBLEM OF QUANTUM CHROMODYNAMICS

Previously proposed solutions to the $U_A(1)$ problem or ninth axial-vector current problem, are reviewed and a new solution proposed. We point out that in the presence of magnetic gauge charges the anomalous term $F^a_{\alpha\beta} {}^*F^a_{\alpha\beta}$ is not a total divergence. This implies that the $U_A(1)$ symmetry is explicitly broken.

957. Parkash O., Rajput B.S. Indian J.Phys.,1976, vol.50, No 11, pp.929-941.

STUDY OF FIELDS ASSOCIATED WITH SPIN-I PARTICLES CARRYING ELECTRIC AND MAGNETIC CHARGES

It has been shown that electric and magnetic fields due to spin-1 particles carrying electric and magnetic charges are symmetrical. In order to avoid the arbitrary string variables in the solution of field equations, two four-potentials are introduced and it has been shown that their components are proportional to electric and magnetic currents source densitie reprectively.

958. Patkós A. Nucl.Phys.,1976, vol.B112, No 2,pp.333-348.

SEMISTRONG COUPLING IN THE HIGGS MODEL

The semistrong coupling limit of the Higgs model is defined. The existence of approximate curved flux-tube solutions is exhibited, also in the theory with "magnetic" monopoles. The quantization of the small oscillations of the infinitely long; stright vortex is investigated. Its quantum-mechanical stability is discussed.

959. Patkós A. Roland Eötvös Univ.,ITP-366, Budapest,1976.

NON-ABELIAN VORTEX-BOND MODEL OF HADRONS

Points out problems of extending magnetic quark confinement to non-Abelian theories.

960. Patrascioiu Calif.Univ.,UCSD-10P10-169,San Diego,1976.

CLASSICAL EUCLIDEAN SOLUTIONS

961. PHYSICS NEWS IN 1976, p.38.

FERMIONS MADE OF BOSONS-A SURPRISING THEORETICAL CONSTRUCT

Jackiw and Rebbi and Hasenfratz and 't Hooft get 1/2 integer spin from integral spin. Goldhaber then showed composite had proper statistics.

962. Prasad M.K. and Sommerfield C.M. Nucl.Phys.,1976,vol.B11 No 1, pp.153-172.

SOLUTIONS OF CLASSICAL GAUGE-FIELD THEORIES WITH SPIN AND INTERNAL SYMMETRY

We examine finite-dimensional matrix solutions to the equations of classical gauge field theories and interpret them in terms of solitions with spin and internal symmetry. The equations are reduced to relations among scalar quantities which turn out to be the same as those obtained for spinless solitions with no internal degrees of freedom, both for spherically symmetric and cylindrically symmetric situations. General formulas are derived for the invariant magnetic field associated with the theory. In the spherical case with degrees of freedom corresponding to spin 1/2 and isospin 1/2 we find that the solitions are monopoles with magnetic charge satisfying the quantization condition eg=1/2. Finally, we discuss the difficulties with our interpretation.

963. Price P.B. In: MAGNETISM AND MAGNETIC MATERIALS-1976, 1st Joint MMM-INTERMAG Conference, Pittsburg, USA,15-17 June, 1976, No 34, p.394.

THE MAGNETIC MONOPOLE

In a complex stack of balloon-borne track detectors, one fast particle left tracks consistent with those expected for a magnetic monopole of strength 137e, traveling with about half the speed of light. The evidence has been criticized,

and it has been argued that the tracks could have been left by a doubly fragmenting platinum nucleus traveling with 0.7 times the speed of light. Extensive tests and calibrations of the various detectors are still in progress. They appear, however, to rule out the doubly fragmenting platinum nucleus and to set extremely low confidence levels. for any known particle to have produced the track. It can never be "proved" that this event was caused by a monopole, but the evidence is now strong that the event is unique and warrants further searches.

964. Price P.B. In: NEW PATHWAYS IN HIGH ENERGY PHYSICS, Proc. of Orbis Scientiae held by the Center for Theoretical Studies, University of Miamy. Ed. A. Perlmutter, Plenum, New York, 1976. vol.1, pp.167-214.

STATUS OF THE EVIDENCE FOR A MAGNETIC MONOPOLE

Very thorough review of PSOP in light of critics comments and later experimental data.

965. Price P.B. Bull.Amer.Phys.Soc.,1976, vol.21, No 1,p.61.

THE MAGNETIC MONOPOLE: FACT OR FICTION?

966. Price P.B., Shirk E.K., Hagstrom R., and Osborne W.Z. Lawrence Berkeley Laboratory, LBL-5355, Berkeley,1976.

FURTHER STUDIES OF THE MONOPOLE CANDIDATE

Calibration with cosmic rays suggests $\beta > 0.7$ in Lexan but $0.35 \lesssim \beta \lesssim 0.58$ in emulsion. Suggest event is monopole, highly charged particle or highly charged anti-particle.

967. Rajasekavan G. Madras Univ., preprint,1976.

FIELD THEORY OF EXTENDED OBJECTS

968. Prokhvatilov E.V., Frank, V.A. Yad.Fiz.(SSSR), vol.2, No 4, pp.856-860(1976) (In Russian).

English translation in : Sov.J.Nucl.Phys.(USA). received: Nov.1976.

FERMIONS IN FIELD OF THE 'T HOOFT-POLYAKOV MONOPOLE

A possibility of fermion binding by the 't Hooft-Polyakov classical monopole is discueed. It is shown that such bound states exist if the fermions interact with the Higgs field.

969. Recami E., Mignani R. Phys.Lett.,1976,vol.62, No 1, pp.41-43.

MAGNETIC MONOPOLES AND TACHYONS IN SPECIAL RELATIVITY

The mere special relativity does not explicitly predict existence of (sub-luminal) monopoles, but on the contrary explicitly predict existence of super-luminal (tachyon) monopoles, with magnetic charge about 100 times less than usually assumed. This fact is relevant also at the light of current experiments looking for magnetic poles.

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ABOUT TACHYONS AND MAGNETIC MONOPOLES IN QUANTUM FIELD THEORY AND CLASSICAL PHYSICS

971. Recami E. and Mignani R. In the 1976 volume in honour of Professor W.Heisenberg.

972. Riegert R.J. Int.J.Theor.Phys.,1976, vol.15, No 2, pp.121-155.

QUANTIZED SINGULARITIES IN THE GRAVITATIONAL FIELD

The Cabibbo-Ferrari derivation of the Dirac charge quantization condition in electromagnetism is extended to the gravitational field. This is accomplished by use of the path-dependent formalism pioneered by Mandelstam. As a result, we

find that the Bianchi identity generalizes to include a quantized, singular source term for the dual Riemann tensor. Under reasonable assumptions, this source term is proportional to the divergence of the energy-momentum tensor, leading to a quantized violation of local energy conservation. Specifically, it is found that the magnitude of the time rate of appearance of three-momentum in any volume of three-space must be an integer multiple of $3c^4/2G$. Some physical aspects of this energy non-conservation are briefly considered.

973. Rosenbaum D., Barut A.O. Phys.Today, Dec.1976, p.46.

MORE ON MONOPOLES

974. Ross R.R. In: NEW PATHWAYS IN HIGH ENERGY PHYSICS. Porc. of ORBIS SCIENTIAE, held by the Center for Theoretical Studies, University of Miami, 1976. Ed. Perlmutter, Plenum Press, New York and London, 1976, pp.151-166.

EXPERIMENTAL SEARCHES FOR MAGNETIC MONOPOLES

Analysis of the sensitivity of previous negative searches for magnetic monopoles shows that they constitute prior evidence against the monopole interpretation of the event reported as "evidence for detection of a moving magnetic monopole". The strength of th evidence varies with the unknown mass of the monopole. For M less than/or equal to 10^5 GeV, odds are greater than 10^6: 1 agianst. For larger masses, the limits depend strongly on assumptions about the range of monopoles and the threshold for detection of monopole tracks in obsidian. In no case are the odds less than 8 : 1 and they may be no less than 8000 : 1 against. Since the reported event may also be due to an electrically charged heavy particle, it is probably not due to a monopole.

975. Ross R,R. Lawrence Berkely Lab., LBL-4665-Berkeley, 1976.

EXPERIMENTAL SEARCHES FOR MAGNETIC MONOPOLES

976. Sawada T. Department of Physics, Tokyo University of Education, TUETP-76-6, Tokyo, Japan, 1976.

PROPOSAL TO CONFIRM THE STRONG VAN DER WAALS INTERACTION IN THE LOW ENERGY P-P SCATTERING

It is shown that the low energy p-p data, especially the Wisconsin data, already indicate the existence of the strong long-range force exerting between the nucleons, which is expected to occur in the magnetic monopole model of hadrons. In arriving at the conclusion, the detailed information concerning the two-pion exchange spectrum is not required. It is proposed to measure accurately the angular distribution of the proton-proton scattering at low energy (0.1 MeV $\lesssim$ T $\lesssim$ 20 MeV), and to estimate the power β of the long-range tail of the extra nuclear potential: $V(R) \sim -CR^{-\beta}$.

977. Schaposhnik F.A. Lett. Nuovo Cim., 1976, vol. 17, No 7, pp. 246-249.

A POWER SERIES SOLUTION OF THE 'T HOOFT-POLYAKOV MONOPOLE

The purpose of this note is to show that, with the aid of conservation laws, one can easily decouple the equation of motion corresponding to the magnetic-monopole solution of 't Hooft-Polyakov, thus obtaining analytical solutions in the form of series expansions and asymptotic behaviour of vector and scalar fields.

978. Schechter J. Phys. Rev., 1976, vol. D14, No 2, pp. 524-527.

YANG-MILLS PARTICLE IN 'T HOOFT GAUGE FIELD

We investigate the classical motion of a Yang-Mills test particle in an external field given by 't Hooft's monopole solution. For large distances the space motion is that of a charged particle in a magnetic-monopole field. It is different at small distances though. We also find the asymptotic solution for the motion of the particles isospin vector and discuss its interpretation.

979. Schwartz A.S. Nucl.Phys.,1976, vol.B112, No 2, pp.358-364.

MAGNETIC MONOPOLES IN GAUGE THEORIES

Magnetic monopoles in gauge theories are investigated. Let G be the gauge group and H the group of symmetries which are not spontaneously broken. The existence of magnetic monopoles is proved in the case when the group G has a compact covering group but the covering group of H is non-compact.

980. Schwartz A.S. 4-th International Symposium on Nonlocal Field Theories, Alushta,USSR,1976. Joint Institute for Nuclear Research,1976, JINR,D2-9788, pp.224-240.

TOPOLOGICALLY NONTRIVIAL SOLITIONS OF CLASSICAL EQUATIONS AND THEIR ROLE IN QUANTUM FIELD THEORY

Some applications of topology especially for treatment of solitions are discussed. The extremals of euclidean action for the Yang-Mills field are considered. The existence of the magnetic monopoles in the gauge theories is discussed. In conclusion some two-dimensional models are studied.

981. Schwinger J., Milton K.A., Wu-Yang T., DeRaad L.L.,Jr., Clark D.C. Ann.Phys.(USA), 1976, vol. 101, No 2, pp.451-495.

NON-RELATIVISTIC DYON-DYON SCATTERING

The non-relativistic problem of the scattering of two dyons (including the case of electron scattering by magnetic monopoles) is systematically studied, both classically and quantum -mechanically, with a view toward the discrimination between various combinations of electric and magnetic charges. The classical cross section is analysed with particular attention to the interesting phenomena which occur for large angle scattering, the "rainbows" and "glory", where the cross section becomes infinite. Quantum-mechanically, these infinities do not occur and, when the partial wave scattering amplitude is summed, a very elaborate structure emerges for the cross section, which depends sensitively upon the electric and magnetic charges of the particles, as well as on their relative speed.

982. Senjapovic P.I. Ann.Phys.,1976, vol.100, pp.227-261.

PATH INTEGRAL FORMULATION OF FIELD THEORIES WITH SECOND-CLASS CONSTRAINTS

Faddeev's Hamiltonian path integral method for singular Lagrangians is generalized to the case when second-class constraints appear in the theory. The genral formalism is then applied to several problems: quantization of the massive Yang-Mills field theory, light-cone quantization of the self-interacting scalar field theory, and quantization of a local field theory of magnetic monopoles.

983. Shankar R. Phys.Rev.,1976, vol.D14, No 4, pp.1107-1116.

MORE SO(3) MONOPOLES

A recipe is presented for constructing solutions within spontaneously broken gauge theories of Lorentz scalars and non-Abelian gauge bosons, to higher dimensional scalar fields which are (2n + 1)-dimensional irreducible representations of the gauge group SO(3), given the topologically stable static solution of 't Hooft and Polyakov (1974) for the n=1 field. Details are given for the n=2 case, and the generality of the approach is discussed.

984. Shankar R. Lyman Lab.of Phys., Harward Univ.,Harward preprint, Cambridge,1976.

THE SO(3) MONOPOLE CATALOG

Exploration of monopoly, the study of topologically stable solutions like the 't Hooft-Polyakov monopole.

985. Sharma S.P. J.Phys.Educ.,1976, vol.4, No 1, pp.6-10.

MAGNETIC MONOPOLES: RETROSPECT AND PROSPECT

The historic developments connected with the search for a magnetic monopole are traced. The theoretical considerations which lead to the belief of its existence are outlined. The symmetry achieved in the Maxwell's equations by the introduction of the concept of a magnetic monopole is brought out. Experimentsl investigations carried out in search of the

monopole, the production and extraction area, etc. are described. Work done by the Berkeley-Houston group on monopole and the various criticism appearing on these investigations, the present status and future prospects, etc. are reported.

986. Singh V. Phys. News, 1976, vol. 7, No 3, pp. 78-87.

APPROACHES TO HIGH ENERGY PHYSICS

An overview of the present state of the art in high energy physics is presented highlighting the development of electrodynamics. The role of the quantum numbers signed to quarks are explained. Lepton-hadron scattering and hadron-hadron scattering are discussed. The quark-parton model of the nucleon is explained. The recently discovered ψ resonances and the consequent introduction of new quantum number "charm" are mentioned. Next, Yang-Mills gauge theories, the unification of weak and electromagnetic interactions and the concept of weak neutral currents are discussed. Gauge theories of strong interactions, quantum chromodynamics and the concept of "bags" are explained. Magnetic monopoles (solitions) are described with basis on non-linear field theories. High energy bounds in the axiomatic field theory are formulated. The general properties of S-matrix elements obtained in a quantum local field theory are mentioned. Lastly, the shifting of the reliance on field concepts to other approaches, especially through S-matrix and the application of Regge poles and cuts is explained. The duality hypothesis is postulated to explain processes such as $pp > \bar{p}p$ with the pomeron exchange concept. Dual models of strong interactions are discussed. Future trends are indicated.

987. Sinha A. Phys. Rev., 1976, vol. D14, No 8, pp. 2016-2022.

SU(3) MAGNETIC MONOPOLES

We obtain the simplest examples of monopole solutions in an SU(3) gauge theory, corresponding to the generators of the homotopy groups π_2 (G/H). These monopoles are characterized either by two Abelian magnetic charges when the residual symmetry group H is U(1) x U(1) or by combined Abelian and non-Abelian magnetic charges when the residual symmetry group

is U(2). The magnetic charges do not always satisfy the Dirac quantization condition, but do satisfy a generalized "quantization" condition.

988. Snyder R. Amer.J.Phys.,1976, vol.44, No 12, pp.1181-1183.

MAGNETIC MONOPOLE AND CHARGED PARTICLE IONIZATION CROSS SECTIONS

Classical mechanics is used to show why magnetic monopoles can be distinguished from charged particles by their ionization properties. Also, simple derivations are given of ion-atom ionization cross sections.

989. Sokolov V.V. Yad.Fiz.,1976, vol.23, p.628.

THEORY OF MAGNETIC MONOPOLES AND THE DIRAC-SCHWINGER QUANTIZATION CONDITION WITHOUT STRINGS

Motion of non-relativistic system consisting of a point charge and a monopole is considered. The Lagrangian and canonical formalism free from difficulties of the usual Dirac string theory is constructed with no introduction of a potential singular on the string. In particular, the theory is invariant under rotations from the very beginning. The equations of motion are quantized by means of the standard methods. The known Dirac condition $eg/4\pi = n/2$ (n is an integer) is obtained as a consequence of quantization of the angular momentum projection of the system on its symmetry axis.

990. Sokolov V.V. Sov.J.Nucl.Phys.,1976, vol.23, p.330.

THEORY OF MAGNETIC MONOPOLES AND THE DIRAC-SCHWINGER QUANTIZATION CONDITION WITHOUT STRINGS

991. Sokolov V.V. Inst. of Nucl.Phys,Siberian Branch of Acad. of Sci.SSSR, INP 76-30, Novosibirsk,1976.

ON THE THEORY OF MAGNETIC CHARGE

The cause of appearance of magnetic field singularity

line(string) in the theory of Dirac monopole is assertained. It is shown that this singularity is connected with multiple-valued dependence of azimuth angle on a point of space and is therefore, purely kinematic. After the mentioned dependence is taken into account, the continuation of string is removed from classical and quantum equations of motion and Poisson brackets.

992. Stevens D.M., Collins G.B., Ficenec J.R., Trower W.P., Fischer J. and Iwata S. Phys.Rev.,1976, vol.D14,No 9, pp.2207-2218.

SEARCH FOR MULTIPHOTON EVENTS FROM PROTON-NUCLEI INTERACTIONS AT 300 GeV/c

We have measured angular energy, and multiplicity distributions of multiphoton events produced in proton-nuclei interactions at 300 GeV/c. The dominant features at thes these events are explained by known processes; however, a few multiphoton events inconsistent with known processes are found at a level at $\sim 10^{-7}$ per proton interaction.

993. Strazhev V.I., Kruglov S.I. Izv.Akad.Nauk Belorussk.SSR, ser. fiz.-mat.,1976, No 2, pp.71-76.

CHARGE QUANTIZATION CONDITION AND ERENFEST THEOREM(In Russian)

It is shown that realization of charge quantization condition is necessary to correlate quantum-mechanical and classical description of magnetic charge interaction .

994. Strazhev V.I., Shkol'nikov P.L. Izv.Akad. Nauk Belorussk. SSR, ser. fiz.-mat., 1976, No 3, pp.80-84.

ON LAGRANGIAN FORMULATION OF DUALLY-SYMMETRIC CLASSICAL ELECTRODYNAMICS(In Russian)

Variational princip for classical electrodynamics of dually-charged particles is formulated on the basis of a two-potential approach. It is shown that at a corresponding redetermination of the potentials the developed formalism is equivalent to singularity potential approach.

995. Strocchi F. Phys.Lett.,1976, vol.65B, No 5, pp.447-449.

SPONTANEOUS BREAKING OF ELECTRIC-MAGNETIC CHARGE-SYMMETRY IN LOCAL QUANTUM FIELD THEORY

It is shown that in local quantum field theory with electric and magnetic currents, duality transformations are always spontaneously broken.

Possible implications are discussed leading to the screening of magnetic charge and the failure of the cluster property as in two-dimensional quantum electrodynamics.

996. Strocchi F. Princeton,1976.

SPONTANEOUS BREAKING OF ELECTRIC-MAGNETIC CHARGE SYMMETRY

997. Sugawa H. Phys.Rev.,1976, vol.D14, No 10, pp.2764-2772.

THEORY OF QUARK CONFINEMENT BASED ON AN ANALOGY WITH A THEORY OF MAGNETIC MONOPOLES

A nonlocal theory of quark confinement is proposed. The confinement is achieved by genralizing the theory of magnetic monopoles. Monopoles and quarks satisfy similar equations of motion, at least formally, except that the string attached to the monopoles is unphysical whereas the string which originates from the quarks carries the energy.

998. Sugawa H. Proceedings of INS Winter Meeting on Particle Physics, Institute for Nuclear Study,University of Tokyo, INS-PT-29, Tokyo,1976, pp.93-95.

QUARKS AND MAGNETIC MONOPOLES

999. Sugawa H. KO-ENERUGI BUTSURIGAKU KENKYUSHO (National Laboratory for High Energy Physics), Tsukuba,1976.

THEORY OF QUARK CONFINEMENT BASED ON ANALOGY WITH MAGNETIC MONOPOLE

1000. Tayler R.J. Mon.Not.R.Astron. Soc.,1976, vol.176, No 3, pp.69P-71P.

MAGNETIC MONOPOLES AND COSMOLOGY

If particles can exist bearing magnetic monopoles, it seems very unlikely that many could have survived the early stages of a hot big-bang universe. This conclusion follows from the assumption that magnetically charged particles carry no other quantum numbers, which are not carried by conventional particles. The unimportance of such magnetically charge particles is due to the samll value of the fine structure constant. If magnetically charged particles carry additional quantum numbers substantial numbers may have survived the big-bang but it is difficult to discuss this possibility quantitatively except to say that most are probably in the form of magnetic atoms.

1001. Tarashenkov V.I., Tomol'chik L.M. Preprint Inst.of Phys., Akad.Nauk Belorussk.SSR, No 96,1976.

SOME PROBLEMS OF THE THEORY OF ELECTRIC AND MAGNETIC CHARGE INTERACTION

The work is dedicated to the analysis of quantum-mechanical aspects of electric and magnetic charge interaction. The existence of a classical limit of magnetic charge theory in Lagrangian and Hamiltonian form is investigated. The arguments for the benefit of a non-classical character of the "Dirac veto are given. Differentiation procedure of singular potentials is built in terms of generalized function theory and a corresponding generalization of Poisson classical brackets is suggested. It is shown that algebraic model of electric and magnetic charge interaction not connected with a definite determination of singular potentials is internally opened. Pulse-transfer cross section theorem is generalized for the case of electric charge non-relativistic scattering in a monopole field. The preserving angular moment and generalized operator of the space inversion are built and the states diagonalizing them are found for the Barut non-relativistic dyon model with pseudoscalar magnetic charge.

1002. Thebaud L.R. Phys.Rev.,1976, vol.D14, No 6, pp.1673-1680.

NON-ABELIAN MAGNETIC CHARGE AND LORENTZ INVARIANCE

Attempts are made to construct a generalization of magnetic-charge theory to non)Abelian groups, retaining the symmetry of electric and magnetic charge dynamics.It is shown why the automatically gauge- and Lorentz-invariant path-dependent formalism of Mandelstam does not allow such a generalization. Strict gauge invariance and manifest Lorentz invariance are then abandoned in favour of a fully quantized field theory with all required properties, including a generalized charge quantization condition. It is concluded from the failure of locality in this model that such a generalization is probably inmocpatible with Lorentz invariance.

1003. Thomsen D.E. Sci.New ,1976, vol.109, No 8, pp.122-123.

MONOPOLES OUGHTN'T BE A MONOPOLY

1004. Tomboulis E. and Woo G. Nucl.Phys.,1976, vol.B107, p.221.

SOLITION QUANTIZATION IN GAUGE THEORIES

A collective coordinate method is developed to construct a perturbation expansion for the single solition sector of a gauge theory. As a preliminary, in order to illustrate the details of the method, it is first used in the context of a simple two-dimensional Abelian gauge model. It is then applied to the study of the spectrum of charged monopole states in the SU(2) Yang-Mills model with a triplet of Higgs scalars.

1005. Tomil'chik L.M. Phys.Lett.,1976, vol.B61, No 1,pp.50-52.

SPACE REFLECTION SYMMETRY AND THE PSEUDO-SCALAR MAGNETIC CHARGE

Conserned angular momentum and generalized space

reflection operators are built for the non-relativistic dyonium with the pseudoscalar magnetic charge and states diagomalizing them are found. These states belong to different spinor classes provided one uses integer or half-integer numbers in the charge quantization condition.

1006. Tomil'chik L.M. The works of the 4-th Soviet Conference on Classical and Qunatum Theory of Gravitation, Minsk, 1976, p. 68.

ON GEOMETRICAL SENSE OF DUALLY-INVARAINT FIELDS IN RYINICH-WHEELER-MIZNER THEORY

1007. Toussaint D. and Wilczek F. Princeton University, Print-76-0989, Princeton, New Jersey, 1976.

'T HOOFT MONOPOLES IN LARGER GAUGE GROUPS

1008. Troost W. and Vinciarelli P. European Organization for Nuclear Research, CERN-TH-2195, Geneva, 1976.

MONOPOLES FROM DIPOLES

Monopole-solitions exist in a wide class of theories of vector or spinor fields in interactions with the c.m. field, of which non-Abelian gauge theories are only a special example. Their existence does not rely on any specific mechanism of spontaneous symmetry breakdown, such as the Higgs mechanism. It originates from the non-linear dynamics of the e.m. field in interaction with matter fields carrying an elementary magnetic moment. The monopole charge is built from an accumulation of magnetic dipoles at one point, with an energy expense which is finite if the anomalous component of the magnetic moment is positive. New examples of monopole solitions are presented with monopole charge equal to the Dirac unit (spinor case) or twice this unit (vector case). The identification of spinors with electrons and positrons leads to a relatively light monopole: the calculation based on non-relativistic spinors, yields $E = (\sqrt{2\pi}/\alpha^2) \cdot m_e = 43$ GeV, which is expected to provide an upper bound on the actual mass.

1009. Troost W. and Vinciarelli P. Phys.Lett.,1976,vol.63B, No 4, pp.453-455.

SPIN AND ISOSPIN IN A GAUGE THEORY WITH MONOPOLES

The mechanism by which systems of spinless bosons with isospin and spinless magnetic monopoles acquire a spin in their ground states is investigated in the context of SU(2) gauge models. Contrary to recent claims, it is demonstrated that isospin degrees of freeedom are not converted into spin degrees of freedom. For a spin 1/2 state, solutions are explicitly constructed exhibiting the isospin degree of freedom.

1010. Tze H.C. and Ezawa Z.F. Phys.Rev.,1976, vol.D14, No 4, pp.1006-1020.

GLOBAL SIGNATURES OF GAUGE INVARIANCE: VORTICES AND MONOPOLES

A comprehensive topological classification of vortices and their end-point Dirac monopoles is formulated in gauge theories with an arbitrary compact Lie group. By way of homotopy theory, a simple analysis is presented for the global groups U(1), O(3) and SU(2), then $SU(N)/Z_N$ and SU(N). Finite vortices are achieved through the complementarity of Dirac strings and the model lines of the Higgs fields. In general, the varieties of topologically distinct vortices or monopoles are determined solely by the connectivity of the global group specified by a discrete fundamental group. The close connection between our work and the Wu-Yang global formulation of gauge fields is pointed out.

1011. Vasilenko A.T., Zrelov V.P.,Kollarova L.,Lupil'tsev V.P., Pavlovič P.,Ružička J., Sidorova V.I., Shabashov M.F., Šulek P., Janik R. Joint Institute for Nuclear Research, JINR-13-10074, Dubna,1976.

INSTALLATION FOR DIRAC MONOPOLE SEARCH ON VAVILOV-CHERENKOV RADIATION AT THE 70 GEV IPHE PROTON SYNCHROTRON

An installation is described which is used for the

Dirac monopole search on the internal beam of the 70 GeV proton synchrotron of Vavilov-Cherenkov radiation and its characteristic polarization. The idea of the experiment is briefly described, and its advantages over the other experiments on magnetic charge search are noted. The characteristics of the main units of the installation is given. Brief data on its efficiency are presented. A conclusion on the prospects for the use of such installations on larger accelerators is made.

1012. Venturi G. Nuovo Cimento,1976, vol.31A, No 1,pp.79-88.

MONOPOLES AND THE HIGGS MODEL

The introduction of magnetic charges in a Higgs Lagrangian is studied in the limit for which the gauge field becomes very massive. It is found that in such a case the scalar Higgs field may be confined to the string.Further, the equivalent of the Dirac condition is found for the case of a point charge and a massive gauge field and it is seen that there is no constraint between "electric and magnetic charges". Rather it appears that the world area traced out by the string on looping it around an electric charge is quantized.

1013. Villarroel D. Nuovo Cimento Lett.,1976, vol.15, No 14, pp.507-511.

A NEW TWO-POTENTIAL APPROACH FOR ELECTRIC AND MAGNETIC CHARGE

It is reconsidered the two-potential formalism for the treatment of the electromagnetic field interacting with electric and magnetic charges. The latter introduces a new approach to the problem which like in the Zwanziger's procedure, integrates directly Maxwell equations but uses a different particular solution of the inhomogeneous Maxwell equations. The properties of the obtained solutions are discussed.

1014. Villarroel D. Phys.Rev.,1976, vol.D14, No 12, pp.3350-3357.

HAMILTONIAN FORMULATIONS WITHOUT AND WITH STRINGS FOR ELECTRIC AND MAGNETIC CHARGES

We do not introduce potentials in either case. This allows us to see very clearly the necessity of and the role played by the string in a canonical formalism. The ten generators of the Poincare group are explicitly shown. However, "proof" of the relativistic covariance of the canonical formulation is based on the highly singular equation defining the string. The quantum theory associated with our canonical description is the Schwinger field theory.

1015. Vinciarelli P. In: UNDERSTANDING THE FUNDAMENTAL CONSTITUENTS OF MATTER, Proc. of the 1976 Int.School of Subnuclear Phys. (NATO-MPI-MRST Advanced Study Inst.) held in Evice, Trapani, Sicily, July 23-August 8,1976. Plenum Press, New York,1978, pp.799-839.

MONOPOLES

1016. Vinciarelli P. European Organization for Nuclear Research, CERN-TH-2246, Geneva,1976.

MONOPOLES

Review of paper "MONOPOLE FROM DIPOLES" in more detail.
Prediction:
Several mass prediction including E= $(\sqrt{2\pi}/\alpha^2)\cdot m_e$ =43 GeV.

1017. Vinciarelli P. Second Adriatic Summer Meeting on Particle Physics,1976,p.185.

MONOPOLES

1018. Wang M.Y. Nuovo Cimento Lett.,1976, vol.15, No 14, pp.505-506.

MAGNETIC MONOPOLE,QUARK CONFINEMENT AND GRAVITATIONAL EFFECTS

Recent discoveries of heavy particles indirectly

support the existence of quarks, but attempts to isolate and observed the quarks have failed to date. This leads to the suggestion that possibly quarks can never appear singly and istead are confined. The note wants to demonstrate that due to the magnetic monopole of the quarks, quarks are confined by the gravitation. The results are followed by a recently found exact solution of Einstein-Maxwell equations.

1019. Weaver D.L. Ann.Phys.(USA),1976, vol.101, No 1, pp.52-61.

GENERALIZED CHIRAL SYMMETRY

A generalized chiral symmetry is shown to exist for all massless particles and for some descriptions of massive particle theories. In addition, symmetries analogous to the generalized chiral symmetry are described, especially for spin one-half.

1020. Weinberg E.J. and Guth A.H. Phys.Rev.,1976, vol.D14, No 6, pp.1660-1662.

NON-EXISTENCE OF SPHERICALLY SYMMETRIC MONOPOLES WITH MULTIPLE MAGNETIC CHARGE

We show that in a spontaneously broken SU(2) gauge theory there are no field configurations with magnetic charge > 1 which are both spherically symmetric and of finite energy.

1021. Winterberg F. Z.für Naturforschung,1976, vol.31A,p.498.

OCCURRENCE OF ULTRASTRONG MAGNETIC FIELDS IN NUCLEAR SHOCK WAVES

Suggests transient magnetic fields up to 10^{18} gauss may be present in fast heavy nuclei collisions resulting in monopole production.

1022. Wu T.T. and Yang C.N. Nucl.Phys.,1976, vol.B107, No 8, pp.365-380.

DIRAC MONOPOLE WITHOUT STRINGS: MONOPOLE HARMONICS

Using the ideas developed in a previous paper which are barrowed from the mathematics of fibre bundles, it is shown that the wave function ψ of a particle of charge Ze around a Dirac monopole of strength g should be regarded as a section. The section is without discontinuities. Thus the monopole does not possess strings of singularities in the field around it. The eigensections of the angular momentum operators are monopole harmonics which are explicitly exhibited.

1023. Wu T.T. and Yang C.N. Institute of Theoretical Physics, ITP SB 76-11, Stony Brook, 1976.

DIRAC MONOPOLE WITHOUT STRINGS: MONOPOLE HARMONICS

1024. Wu T.T. and Yang C.N. Phys.Rev., 1976, vol.D14, No 2, pp.437-445.

DIRAC'S MONOPOLE WITHOUT STRINGS: CLASSICAL LAGRANGIAN THEORY

The non-quantum-mechanical interaction of a Dirac magnetic monopole and a point charge through the electromagnetic field is studied. A classical action integral which is multiple-valued is found. Stability of this action integral against variations of the world lines of the point charge and the monopole and against variations of the electromagnetic potentials, yields the correct Lorentz equations of motion of the particles and the Maxwell equations for the field. No strings are introduced in the formalism.

1025. Wyld H.W. and Cutler R.T. Phys.Rev., 1976, vol.D14, No 6, pp.1648-1659.

FLUX TUBES, MONOPOLES AND THE MAGNETIC CONFINEMENT OF QUARKS

A numerical study is made of the gauge field model of magnetic confinement. The nonlinear differential equations describing a flux tube are solved by a relaxation method. Particular attention is paid to the boundary conditions at the center of the flux tube. We also study numerically

the 't Hooft monopole and a flux tube of finite length, e.i. a quark-antiquark pair a finite distance apart.

1026. Yang C.N. In: UNDERSTANDING THE FUNDAMENTAL CONSTITUENTS OF MATTER. Proc. of the 1976 Int.School of Subnuclear Phys. (NATO- PI-MRST Advanced Study Inst.) held in Erice, Trapani, Sicily, July 23-August 8,1976. Plenum Press, New York,1978, pp.53-84.

MONOPOLES AND FIBRE BUNDLES

1027. Yock P.C.M. Phys.Rev.,1976, vol.D13, No 5, pp.1316-1321.

NEW WEAKLY DECAYING PARTICLES AND SUBNUCLEONS

A model of heavy, highly electrically charged hadron constituents termed "subnucleons" was proposed previously. Recently experimental evidence has been obtained for new particles with lifetimes $\sim 10^{-12} - 10^{14}$ sec. Here a possible classicifation for them is given in terms of above-mentioned model. The most prominent of the new particles is predicted to have a mass slightly below 990 MeV and to decay into $\pi^{\pm}\pi^{0}$, $\pi^{\pm}\eta$, $e\nu$ and $\mu\nu$. Experimental searches for highly electrically charged subnucleons are also discussed. It is pointed out that a very recently observed highly ionizing particles of a Berkeley-Houston group may be a subnucleon. Scaling $e^{+}e^{-}$ interactions and the J and ψ resonances are briefly discussed. Comments on quarks, charm, the quark-parton model, and monopoles are also made.

1028. Yougn K. Nuovo Cimento,1976, vol.B35, ser.2, No 2, pp.195-202.

MONOPOLES AND DIRECT ACTION

A direct action, dependent only on particle paths, is constructed to describe the interaction of changes and monopoles.This disproves a recent claim that such a direct action does not exist.

1029. Zrelov V.P., Kollarova L., Kollar D., Lupil'tsev V.P., Pavlovic P., Ruzicka J., Sidorova V.I., Shabashov M.F., Janik R. Czech.J.Phys.,1976, vol.B26, No 11, pp.1306-1318.

SEARCH FOR THE DIRAC MONOPOLE BY MEANS OF VAVILOV-CHERENKOV RADIATION AT THE 70 GEV IHEP PROTON SYNCHROTRON

A search was made for magnetic charges by means of Cherenkov radiation and characteristic polarization at the proton energy of 70 GeV on the internal target of the IHEP (Inst. for High Energy Physics, Serpukhov) proton synchrotron. Eight Cherenkov counters of a special construction served as detectors. Possible events were recorded with two fast five-ray oscillographs trigged by 6-fold coincidences. The efficiency of magnetic charge recording was about 10%. The proton beam of 6.4×10^{14} intensity traversed the target-radiator; not a single case was recorded of the production of the Dirac monopole with magnetic charge within the region of 2/3 g(g=68.5e) to 2g. This means that in the conditions of the Experiment the upper boundary of the cross section of the Dirac monopole production by 70 GeV protons per nucleon of Si and O nuclei for magnetic charges of masses between 3 and 5.5 m_p was found to be σ (95%) $\lesssim 10^{-40}$ cm^2.

1030. Adawi I. Phys.Rev.,1977, vol.D16, No 4, pp.1232-1234.

INTERACTION OF ELECTRIC AND MAGNETIC CHARGES

It is shown classically that in a head-on collision between an electric and magnetic charge a repulsive polarization force of the form r^{-5} results(where r is the distance between the charges), if one (both) charge(s) is (are) assigned a finite spherical size. This force leads to a minimum distance of approach and prevents one particle from going through the other, and thus guards against the violation of the conservation of angular momentum. This polarization force is a manifestation of the diamagnetism (diaelectricity) of extended electric(magnetic) charges.

1031. Anderson S.K. Noval Postgradual School,Monterey,California, USA,1977, AD-A-042119.

THEORY OF DUAL-CHARGED PARTICLES
MASTER'S THESIS

In studying the interaction of dual-charged particles (with both electric and magnetic charge), the introduction of a two-dimensional charge space results in a set of dynamical equations governing the behaviour of the system that are invariant under rotation in charge space. Systems in which all particles have the same magnetic to electric charge ratio are indistinguishable from conventional electro-dynamic systems consisting of ordinary electric charges and electromagnetic fields. However, systems consisting of particles with different charge ratios behave differently. It is shown that for a hydrogen-like atom consisting of two-dual-charged particles with different charge ratios, some of the degeneracy within the hydrogen atom energy states is removed.

1032. Argyres E.N., Lam C.S. New York State University,preprint Plattsburgh,1977.

PHYSICAL MECHANISM FOR QUARK CONFINEMENT VIA PSEUDOPARTICLES

1033. Artru X. Nucl.Phys.,1977, vol.B129, No 3, pp.415-428.

MONOPOLES, DUALITY, TRIALITY

The existence of magnetic charges could be a raison d'etre not only for the quantization of electricity in units 1/3e but also for the confinement of the quarks at the end of "observable", "electric" Dirac strings (quarks have no magnetic charge in this scheme). The Dirac quantization condition is reviewed using a "sum over histories" approach, and a more general result presented. A string attached to the dyon (e_1, g_2) is observable by a dyon (e_2, g_2) unless $(1-x)e_2g_1 - xe_1g_2 = nh$, where x is an arbitrary parameter which reflects an ambiguity in the action principle. The Dirac and Schwinger-Zwanziger quantization rules are special cases, with x=0 and 1/2, respectively.

1034. Artru X. Laboratoire de Physique el Hautes Energies, LPTHE 77-18, Orsay,1977.

MONOPOLES, DUALITY, TRIALITY
(Revised version)

1035. Bais F.A., Primack J.R. Nucl.Phys.,1977, vol. B123, No 2, pp.253-274.

SPHERICALLY SYMMETRIC MONOPOLES IN NON-ABELIAN GAUGE THEORIES

A method for constructing point-singular spherically symmetric monopoles in theories with an arbitrary compact simple gauge group is developed.

1036. Ballachandran A.P., Borchardt S., Stern A. Syracuse University, SU-4211-102, New York,1977.

LAGRANGIAN AND HAMILTONIAN DESCRIPTION OF YANG-MILLS PARTICLES

1037. Ballachandran A.P., Borchardt S., Chang S.S., Stern A., Cahalan R., Ramachandran R., Rupertsberger M. Syracuse University, SU-4211-97, New York, 1977.

ANALYCITY OF THE CHARGE-MONOPOLE SCATTERING AMPLITUDE

1038. Banks T., Myerson R., Kogut J. Nucl.Phys.,1977, vol.B129 No 3, pp.493-510.

PHASE TRANSITIONS IN ABELIAN LATTICE GAUGE THEORIES

We study the Euclidean partition function of Abelian lattice (gauge) theories in various dimensions. Using generalization of mathematical methods developed recently to study the XY model in two dimensions, we obtain useful expressions for the partition functions and physical pictures of the phases of these more complicated theories. Approximat duality relations dilute gas approximations yield estimates of critical coupling constants which separate confining and non-confining phases for the rotor model in three dimensions and Abelian lattice gauge theory in four dimensions. Generalizations of this work to non-Abelian continuum theories are discussed.

1039. Banks T., Myerson R., Kogut J. Princeton Inst. Advanced Study, COO-2220-112,1977.

PHASE TRANSITIONS IN ABELIAN LATTICE GAUGE THEORIES

1040. Barut A.O. Lett.Math.Phys.,1977, vol.1, No 5, pp.367-370.

CHARGE QUANTIZATION CONDITION WITH N STRINGS: A NEW INTERNAL QUANTUM NUMBER OF CHARGE-MONOPOLE SYSTEMS

Dirac theory of magnetic poles is equivalent to a Maxwell electrodynamics in which besides the point singularities (electric charges), extended singularities (e.g. stri strings) occur. The nature of singularities determine completely the theory, hence Betti numbers of space must occur as quantum numbers. Magnetic charge is one of the fundamental periods of the 2-form F.

1041. Barut A.O. Rep.Math.Phys. (GB),1977, vol.11, No 3, pp.415-422.

DE RHAM CURRENTS, EXTENDED SINGULARITIES OF FIELDS AND MAGNETIC MONOPOLES

The author applies De Rham's concept of "currents" to the treatment of extended singularities or discontinuities of physical fields in a coordinate independent way . In particular, he obtains a generalization of the theory of magnetic monopoles when applied to the electromagnetic field.

1042. Barut A.O. Colorado University, Boulder,1977.

DE RHAM CURRENTS, EXTENDED SINGULARITIES OF FIELDS AND MAGNETIC MONOPOLES

1043. Bassetti B., Butera P., Cicuta G., Zanon D., Riva F. Lett.Nuovo Cim.,1977, vol.20, No 1, pp.21-24.

DO SCALAR FIELDS MAKE INSTANTOS?

1044. Bassetti B., Butera P., Cicuta G., Zanon D., Riva F. Instituto di Scienzi Fisiche Universita Degli Studi Di Milano, IFUM-207-FT, Milano,1977.

DOSCALAR FIELDS MAKE INSTANTOS?

1045. Beker H. Bogazici Univ., FB-77-03, Istanbul,1977.

SPATIALLY EXTENDED DYONS AND HADRON COLLISIONS

Using a hadron model with spatially extended dyon constituents, hadron-hadron interactions are investigated at a semi-classical level. It is seen that the model predicts a Van der Waals type force between two hadrons. Also computed are the elastic scattering amplitudes and form factors.

1046. Bender C.M., Egudi T., Pagels H. Washington University St.Louis,Preprint,1977.

GAUGE-FIXING DEGENERACIES AND CONFINEMENT IN NON-ABELIAN GAUGE THEORIES

1047. Benguria R., Cordero P., Teitelboim C. Nucl.Phys.,1977, vol.B122, No 1, pp.61-99.

ASPECTS OF THE HAMILTONIAN DYNAMICS OF INTERACTING GRAVITATIONAL GAUGE AND HIGGS FIELDS WITH APPLICATIONS TO SPHERICAL SYMMETRY

We discuss some aspects of the Hamiltonian dynamics of interacting gravitational Yang-Mills-Higgs fields. Special attention is paid to the difference between proper and improper gauge and coordinate transformations and their relation to surface integrals in the Hamiltonian and gauge generators. The Hamiltonian formalism is specialized to spherically symmetric fields and the main points of the general theory are illustrated and discussed in detail in that case. Two kinds of spherically symmetric fields are considered: "manifest spherical symmetry" and "spherical symmetry up to a gauge". In the former case the Yang-Mills-Higgs potentials themselves are spherically symmetric whereas in the latter (which deals with SO(3) only) a rotation in physical space is compensated for by a gauge rotation of the same magnitude. The 't Hooft-Polyakov monopole and the Julia-Zee dyon belong to the latter class.

1048. Biza Yu.S. Izv.Akad.Nauk Belorussk.SSR, ser. fiz.-mat., 1977, No 2, pp.104-107.

NON-UNIVERSALITY OF THE G/E RATIO IN KEPLER'S PROBLEM FOR THE KLEIN-GORDON EQUATION

The effect of non-universality of the g/e ratio on the energy levels of a relativistic hydrogen-like system has been investigated on the basis of the Klein-Gordon equation. The corrections of the first approximation to the energy eigenvalue for a spinless case have been calculated. The results of calculations have been compared to the correspond-

ing results for a non-relativistic variant.

1049. Bollini C.G.,Giambiagi J.J. Nucl.Phys.,1977, vol.B123, No 2, pp.311-319.

ON THE GAUGE FIELD OF MAGNETIC MONOPOLES

A formulation of electromagnetism with magnetic charges is given by means of a (non-uniform) A defined in the whole space, whose divergence gives the magnetic charge.

1050. Bollini C.G., Leal Ferriera P. Sao Paulo Inst. Fisica Theorica, IFT 266-77, Sao Paulo,1977.

ON THE MOTION OF A CHARGED PARTICLE IN THE FIELD OF A MAGNETIC MONOPOLE

1051. Brandt R.A., Neri F., Zwanziger D. New York Univ., NYU-TRG-77, New York,1977.

LORENTZ INVARIANCE OF THE QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

1052. Brandt R.A., Nevi F. New York Univ., NYU-TR5-77, New York,1977.

REMARKS ON ZWANZIGER'S LOCAL QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGES

1053. Brandt R.A., Primack J.R. Phys.Rev.,1977, vol.D15, No 6, pp.1798-1802.

AVOIDING "DIRAC'S VETO" IN MONOPOLE THEORY

Using ideas introduced by Wu and Yang in their recent nonsingular formulation of an action principle for classical Dirac magnetic monopoles, we modify Dirac's original formulation of the problem so as to avoid the difficulties encountered when charged-particle trajectories intersect aingular strings.

1054. Brandt R.A. and Primack J.R. Phys.Rev.,1977, vol.D15, No 4, pp.1175-1177.

DIRAC MONOPOLE THEORY WITH OR WITHOUT STRINGS

It is shown that in Dirac formulation of the quantum-mechanical interaction of a magnetic monopole and an electric charge the singular string h_e attached to the monopole can be moved arbitrarily by an acceptable gauge transformation and hence is not physically observable, and that this formulation of the theory is equivalent to the recent formulation of Wu and Yang in which the use of potentials with strings is avoided.

1055. Brihaye Y., Nuyts J. J.Math.Phys.(USA),1977, vol.18, No 11, pp.2177-2190.

MAGNETIC MONOPOLES IN SU(4) GAUGE THEORIES

The authors find all spherically symmetric monopoles in SU(4). The importance of the little group which transforms spherically symmetric solutions into spherically symmetric solutions is discussed. All the possible embeddings of SU(2) into SU(4) are found. The eigenvalues of G are shown to be integers or half-integers.

1056. Callan C.G., Dashen R.,and Gross D. Institute for Advanced Study, Princeton,1977.

TOWARD A THEORY OF THE STRONG INTERACTIONS

1057. Callias C.J. Phys.Rev.,1977, vol.D16, No 10, pp.3068-3077.

SPECTRA OF FERMIONS IN MONOPOLE FIELDS:
EXACTLY SOLUBLE MODELS

We investigate the structure of the energy spectrum of an isospin-1/2 Dirac particle in the field of the SU(2) magnetic monopole of 't Hooft and Polyakov. We show that aside from the zero-energy mode, which is always present, there are at

most a finite number of bound states. To clarify the interaction of the fermion with the various components of the monopole field, we consider two different extrapolations of the background field to limiting forms. The corresponding Dirac equations turn out to be exactly soluble. In the first limiting model, only the Higgs field is retained, and the Dirac equation is found to be equivalent to the non-relativistic Coulomb problem. The second model is just the point monopole, and our problem is equivalent to a doublet of massive Dirac particles interacting with an Abelian magnetic monopole. This classical problem admits a simple treatment in the context of non-Abelian gauge theories; we present its solution in this formulation; we point out the hitherto uunoticed fact that the Hamiltonian is not self-adjoint on the customary domain of non-singular wave functions and we study its self-adjoint extensions and bound states.

1058. Collias C., Center for Theoretical Physics, MIT, CTP-624, Cambridge,1977.

SPECTRA OF FERMIONS IN MONOPOLE FIELDS - EXACTLY SOLUBLE MODELS

1059. Callias C. Center for Theoretical Physics, MIT,CTP-694, Cambridge,1977.

INDEX THEOREM ON OPEN SPACES

1060. Campbell W.B. Wesleyan University, Lincoln,Nebraska, 1977.

QUANTUM ELECTRODYNAMICS WITH CHARGES AND MONOPOLES: A CORAVIANT PERTURBATION THEORY

Derives manifestly covariant Feynman rules for a QED with magnetic and electric charges. Needs two component spinors for this. Approach does not include Dirac quantization.

1061. Campbell W.B. Wesleyan University, Lincoln,Nebraska, 1977.

FIELD SPIN IN CHARGE - MONOPOLE INTERACTIONS

Using studies charge monopole scattering and pair annihilation into amgnetic poles. Suggests he can find regions where perturbation theory hold even though g is large.

Predictions

Elastic scattering amplitudes.
Annihilation cross sections into monopoles with angular distributions.

1062. Carmeli M., Kaye M. Nuovo Cimento,1977, vol.B39, Ser.2, No 1, pp.187-192.

GAUGE FIELD MODEL OF COMBINED GRAVITATIONAL ELECTROMAGNETIC AND MAGNETIC-MONOPOLE FIELDS

It has been shown (see Carmeli et al.,ibid.,1976, vol.B34, p.225) that the gravitational and electromagnetic fields can be combined into a unified gauge theory invariant under the group $SL_{2,c} \otimes U_1$. This generalization is extended by allowing for the presence of magnetic-monopole fields resulting in a theory invariant under the gauge group $SL_{2,c} \otimes U_1 \otimes U_1$.

1063. Carmeli M. Phys.Lett., 1977, vol.B68, No 5, pp.463-465.

MONOPOLE SOLUTION OF YANG-MILLS EQUATIONS

A monopole solution of the classical Yang-Mills field equations is presented. The new solution includes both "electric" and "magnetic" parts.

1064. Carrigan R.A., Jr., FERMILAB-77/42, Batavia,1977.

MAGNETIC MONOPOLE BIBLIOGRAPHY(1973-1976)

This classified and annotated bibliography is preceded by a review of magnetic monopole research both theoretical

and experimental. An author index is included.

1065. Carrigan R.A.,Strauss B.P., Giacomelli G. Fermi National Accelerator Laboratory, FERMILAB-Pub-77/111-EXP, Batavia, 1977.

SEARCH FOR MAGNETIC MONOPOLES AT THE CERN-ISR

1066. Carrigan R.A.,Jr. In: COLLIDINGS BEAM PHYSICS AT FERMILAB: DETECTOR CONSIDERATIONS, GENERAL TOPICS. Summer Study, Aspen, CO, USA,1977. Ed. Walker J.K.,1977, pp.197-217.

SEARCHES FOR MAGNETIC MONOPOLES AND FRACTIONALLY CHARGED QUARKS AS AN AUXILIARY FUNCTION FOR A LARGE DETECTOR AT THE COLLIDER

The use of transition radiation in a magnetic field to help identify electrons is examined. Some of the characteristics of and attempts to optimize the design of the transition radiation scheme are described.

1067. Cerrero J.M. Harvard Univ.,HUTP-77-A011, Cambridge, 1977.

EXACT MONOPOLE SOLUTION AND EUCLIDEAN YANG-MILLS FIELDS

1068. Chakrabarti Amitabha, Dipoko Jongwane Phys.Rev.,1977, vol.D15, No 10, pp.3011-3023.

CLASSICAL SOLUTIONS FOR SU(4) GAUGE FIELDS: INTERACTING MONOPOLES

The notion of local idempotents is introduced and their relation to a class of solutions for SU(n) gauge fields is pointed out. This class includes the known monopole-type solutions for SU(2) and SU(3) gauge fields-coupled to scalars and spinors. Next, these ideas are used to study solutions for SU(4) gauge fields. The following classes of solutions are studied. Corresponding to two commuting SU(2) subgroups of SU(4) one has two monopole-

type contributions from the space components W (x), of the gauge field. They are directly coupled among themselves, the remaining SU(4) components providing a tensor-type interaction. They are also coupled to a scalar field $\Phi(x)$ and the time component $W_0(x)$. Two different possibilities for $\Phi(x)$ and $W_0(x)$ are considered in detail. An exact solution is given for a point monopole interacting with a particular system of finite mass. Simple variational calculations are used to obtain finite mass for the total system. Brief remarks are added concerning other possibilities; e.g. how pseudoparticles can be studied from our point of view.

1069. Cheng Kuo-Shung. J.Math.Phys.(N.Y.),1977, vol.18, No 4, pp.746-749.

MONOPOLE THEORY WITHOUT STRING

We propose a Schrödinger equation for the non-relativistic charge-monopole system without using strings and demonstrate that it is a correct equation for this system.

1070. Cheng Kuo-Shung J.Natl.Chiao Tung Univ.(Taiwan),1977, vol.3, pp.55-60.

CLASSICAL LAGRANGIAN THEORY WITH RADIATIVE REACTION: EXTENSION OF ROHRLICH TWO FIELD FORMALISM TO INCLUDE MONOPOLES

Presents an action integral $L(x,X,A_\mu,a_\mu)$. The stabilities of L against the variations $\delta A_\mu(\xi)$, $\delta a_\mu(\xi)$, $\delta X_\mu(\theta)$ and $\delta X_\mu(\tau)$, give the coupled Maxwell equations an the Lorentz Dirac equation for the positron and monopole.

1071. Coleman S., Parke S., Neveu A., Sommerfield C.M. Phys.Rev.,1977, vol.D15, No 2, pp.544-545.

CAN ONE DENT A DYON ?

The stability of the exact monopole and dyon solutions found by Prasad and Sommerfield (1975) is demonstrated by showing that they are absolute minima of energy.

1072. Coleman S. In: NEW PHENOMENA IN SUBNUCLEAR PHYSICS, Proc. of the 1975 International school of Subnuclear Physics,NATO-MPI-MRST Advanced Study Institutes Erice, Sicily, 11 July,1975. Ed. Zichichi.A., New York,1977, part A, pp.297-421.

CLASSICAL LUMPS AND THEIR QUANTUM DESCENDANTS

Dissipative field theory is considered in which there are time-independent solutions, lumps of energy holding themselves together by their own self interactions, also periodic solutions, oscillating or quirering lumps, and steadily moving lumps. Some lumps are called solitions. A survey is given of this knowledge. The topics considered include a set of classical field theories by which lumps are found by quandrature, topological conservation laws that deal with non-dissipative solutions and such lump as flux lines of superconductivity and or monopoles, the quantum problem for time-independent and periodic classical solutions, and lastly the quantum fine-Gordon equation.

1073. Coleman S. Harvard University preprint, Cambridge,1977.

CLASSICAL LUMPS AND THEIR QUANTUM DESCENDANTS

1074. Cordero P. Nucl.Phys.,1977, vol.B131, No 4-5, pp.525-546.

ROTATIONALLY INVARIANCE SOLUTIONS OF THE YANG-MILLS-HIGGS SYSTEM FOR A GENERAL GAUGE GROUP: MAGNETIC MONOPOLES

A genral form that the fields take in a spherically symmetric solution is derived by demanding that the field variables by spherically symmetric up to a local gauge transformation. The gauge group is any compact, semi-simple Lie group and the matter field Φ belongs to a generic orthogonal representation of the gauge group. The angular dependence of the field variables becomes explicit and new field variables are defined. Replacing the field variables in the equations of motion the static case and its solutions

are considered. A finite-energy solution which generalizes both the monopole solution of 't Hooft (1974) and Polyakov (1974) and the dyon solution of Julia -Zee (1975) is studied. The behaviour of the Yang-Mills field near the origin is related to the "angular momentum" content of the adjoint representation of the gauge group while the corresponding behaviour of the Higgs field is related to the "angular momentum" content of the Φ representation.

1074. Cordero P., Villarroel D. Nuovo Cim.,1977, vol.40B, No 1, pp.90-98.

REMARK ON THE CABIBBO-FERRARI TWO-POTENTIAL APPROACH TO ELECTRIC AND MAGNETIC CHARGES

A covariant two-potential formalism is introduced after integrating the Maxwell equations with electric and magnetic charges. These two potentials essentially correspond to those of Cabibbo and Ferrari. The Cabibbo-Ferrari local expression for F in terms of the two potentials is derived instead of being put in as an ansatz. As a by-product of this derivation we obtain a natural covariant gauge in which the formalism is much simpler, the remaining gauge group being $U_1 \times U_1$. There are no external and artificial ingredients in this formalism (as there were none in the Cabibbo-Ferrari formalism either) and the basic equations are completely equivalent to the Maxwell equations.

1075. Cremmer E., Scherk J. Nucl.Phys.,1977, vol.B118, No 1-2, pp.61-75.

SPONTANEOUS COMPACTIFICATION OF EXTRA SPACE DIMENSIONS

The phenomenon of spontaneous compactification has been discovered previously in the case of gravitation coupled to SO(3) gauge fields and for scalar fields. Here it is shown that it exists in arbitrary space-time dimensions when the gauge group is SO(N). The method used here, is applied also to recover the known magnetic monopole (SO(3)) and instention (SO(4)) solutions.

1076. Cox P.H., Yildiz A. Harvard University, HUTP-77-A053, Cambridge,1977.

BOUND STATES WITH A GAUGE MONOPOLE

1077. Czechowski A. European Organization for Nuclear Research, CERN-TH-2282, Geneva,1977.

SU(3) MONOPOLES SATURATING THE BOGOMOLNY BOUND

We use the Bogomolny equations to identify the lowest energy, maximum-symmetry monopole solutions of the SU(3) symmetric gauge field theory with the Higgs field in the adjoint representation. We show that, for each embedding of the isospin group in the SU(3) gauge group, there is only one regular maximum-symmetry solution saturating the absolute lower bound for the monopole energy.

1078. Dattoli G., Mignani R. Comitato Nazionale per L'Energia Nucleare, Laboratory Nazionaly, CNEN, LNF-77-58(P),Frascati, 1977.

FORMULATION OF ELECTROMAGNETISM IN A SIX DIMENSTIONAL SPACE-TIME

1079. Dattoli G., Mattioli M., Mignani R. Lett.Nuovo Cimento, 1977, vol.20, ser.2, No 18, pp.686-687.

MASSIVE PHOTONS AND TACHYON MONOPOLES

Starting from the Proca field equations for a massive photon, written in a form like the Maxwell equations, the authors discuss the possibility of nonzero rest mass for photons. The introduce a self-dual electromagnetic tensor to extend Maxwell's equations to tachyon charges.

1080. Dirac P.A.M. In: DEEPER PATHWAYS IN HIGH ENERGY PHYSICS, Proceed. of Orbis Scientiae Univ. of Miami, Coral Gables, 1977. New York,1977,pp.1-11.

THE DYANMICS OF STREAMS OF MATTER (Talk)

1081. Drell S.D. Stanford Linear Accelerator Center, SLAC-Pub-2043, Stanford, California, 1977.

ELEMENTARY PARTICLE PHYSICS

1082. Einhorn M.B. Fermi National Accelerator Laboratory, FERMILAB-Pub-77/97-THY, Batavia, 1977.

TOPOLOGICAL EXCITATION IN THE ABELAIN HIGGS MODEL

1083. Englert F. Lectures given at the Cargese Summer School, Cargese, France, 1977.

ELECTRIC AND MAGNETIC CONFINEMENT SCHEMES

1084. Englert F., Windey P. Université Libre de Bruxelles, Bruxelles, 1977.

ELECTRIC CONFINEMENT AND MAGNETIC SUPERCONDUCTORS

1085. Eglert F. Université Libre de Bruxelles, Bruxelles, 1977.

ELECTRIC AND MAGNETIC CONFINEMENT SCHEMES

1086. Ezawa Z.F., Tze H.C. Phys.Rev., 1977, vol.D15, No 6, pp.1647-1654.

THEORY OF DIRAC MONOPOLES WITH A NON-ABELIAN SYMMETRY

From the viewpoint of a global formulation of Yang-Mills fields, a Lagrangian theory of non-Abelian classical Dirac monopoles is proposed. Dirac strings are used instead of coordinate patches; they are defined as purely geometric constructs. The formalism is free from pathologies such as "Dirac's veto". While the analysis focuses on the gauge group SU(N)(Z)(subN) allowing for only N - 1 nontrivial and topologically distinct types of monopoles, it applies in general to any compact Lie group.

1087. Ferrari E. Rome Univ., Nota Interna 681,1977.

FORMULATION OF ELECTRODYNAMICS WITH MAGNETIC MONOPOLES

1088. Frampton P.H. In: NEW PHENOMENA IN SUBNUCLEAR PHYSICS, Proceed. of Int. School of Subnuclear Physics held in Erice, Italy,1975. New York,1977, part A., pp.493-532.

RELATIONSHIP BETWEEN GAUGE THEORIES AND DUAL RESONANCE MODELS

1089. Frenkel A., Hrasko P. Ann. Phys. (USA) vol. 105, No 2,1977, pp.288-317.

INVARIANCE PROPERTIES OF THE DIRAC MONOPOLE

The quantum mechanical motion of a spinless electron in the external field of a magnetic monopole of magnetic charge is investigated. It is shown that Dirac's quantum condition $4\pi\mu\cdot e\,(hc)^{-1}=n$ for the string being unboservable ensures rotation invariance and correct space reflection properties for any integer value of n. The rotation and space reflection operators are found and their group theoretical properties are discussed. When n is odd, half-integer j representations of the SU(2) group emerge without the introduction of spin. A method of constructing conserved quantities in the case when the potential is not explicitly invariant under the symmetry operation is also presented and applied to the discussion of the angular momentum of the electron-monopole system.

1090. Frenkel A. Kozponti Fizikai Kutato Intezel, KFKI-77-95, Budapest, Hungary,1977.

REFORMULATION OF THE RELATIVISTIC THEORY OF DIRAC MONOPOLE

The theories of the magnetic monopoles proposed by Dirac (1931,1948) are revisited with main emphasis on the relativistic theory. The latter is reformulated with the

help of the method of canonical quantization of systems with degenerate Lagrangians. It is shown that Dirac's condition $2eg(\hbar c=n)$ (with n any integer) for the string(s) being unobservable remains the necessary and sufficient condition in the relativistic theory, too. The role of the famous veto of Dirac is also clarified. It is shown that it emerges only at the classical level. After quantization there is no need and there is no room for the veto. A system of a spinless charge and of a spinless monopole, possesses an intrinsic angular momentum $\hbar n/2$. A gedanken experiment in which this amgular momentum might be observed is describe

1091. Frenkel A., Hrasko P. Ann.Phys.,(N.Y.),1977, vol.105, pp.288-317.

INVARIANCE PROPERTIES OF THE DIRAC MONOPOLE

1092. Fustero X., Mas L., Lapiedra R. Phys.Rev.,1977,vol.D16, No 12, pp.3474-3482.

PREDICTIVE RELATIVISTIC MECHANICS OF MAGNETIC MONOPOLES AND ELECTRIC CHARGES

We explicitly construct the predictive interaction between a magnetic monopole and an electric charge up to second order in the coupling constant. The uniquely defined, energy-momentum four-vector and angular momentum are constructed as usual in predictive relativistic mechanics and their explicit form given up to first order in the coupling constant. Furthermore, a Hamiltonian formalism in the sense of Bel and Martin is given for this interaction.

1093. Garwin L.J., Garwin R.L. Amer.J.Phys.,1977, vol.45, No 2, pp.164-165.

ON THE STRNGTH OF THE DIRAC MONOPOLE

A magnetic pole of strength g_0 is placed initially midway between two electrons of charge e. Consideration of the torque required to move one electron in a semicircular arc into coincidence with the other leads to an

evaluation of the angular momentum thus added to the system as $2eg_o/c$. Since the eigenvalues of the angular momentum operator are space by h, g_o is clearly limited to $n(\hbar c/e^2)e/2$, the Dirac result.

1094. Gervias J.L. Proccedings of European Conference On Particle Physics, 1977, Budapest, 1977, vol.II,pp.1255-1275.

SOLITIONS AND INSTANTONS

1095. Gibbons G.W. Phys.Rev.,1977, vol.D15, No 12, pp.3530-3535.

BLACK-HOLE DYONS NEED NOT EXPLODE

During the final stage of black-hole evaporation particles of all kinds will be emitted, including exotic states not normally seen in the laboratory. Among them could be magnetic monopoles. This process is discussed. It is found that the presence of electric charge on the hole reduces the emission compared with that form a neutral hole. An interesting consequence of this is that a primordial black hole possessing both electric and magnetic charge (a black-hole dyon) need not explode but may end its life as an extreme Reissner-Nordström black-hole, with finite mass and zero temperature. The application of these results to other gauge theories is briefly discussed. An appendix treats the Dirac equation in curved space using Geroch, Held and Penrose and spin-weighted spherical-harmonic techniques.

1096. Goddard P., Nuyts J., Olive D. Nucl.Phys.,1977, vol.B125, No 1, pp.1-28.

GAUGE THEORIES AND MAGNETIC CHARGE

If the magnetic field for an exact gauge group H(assumed compact and connected) exhibits an inverse square law behaviour at large distances then the generalized magnetic charge, appearing as the coefficient, completely determines

the topological quantum number of the solution. When this magnetic charge operator is expressed as a linear combination of mutually commuting generators of H, the components are uniquely determined, up to the action of the Weyl group, and have to be weights of a new group $H^{\vee}$ which is explicitly constructed out of H. The relation between the "electric" group H and the "magnetic" group $H^{\vee}$ is symmetrical in the sense that $(H^{\vee})^{\vee} = H$. The results suggest that H monopoles are $H^{\vee}$ multiplets and vice versa and that the true symmetry group is $H \otimes H^{\vee}$. In this duality topological and Noether quantum numbers exchange roles rather as in Sine-Gordon theory. A physical possibility is that H and $H^{\vee}$ be the colour and weak electromagnetic gauge groups.

1097. Goldhaber A.S. Institute for Theoretical Physics, State University of New York, ITP-SB-77-29, Stony Brook, New York, 1977.

DIRAC PARTICLE IN A MAGNETIC FIELD: SYMMETRIES AND THEIR BREAKING BY MONOPOLE SINGULARITIES

1098. Goldhaber A.S. Phys.Rev., 1977, vol.D16, No 6, pp.1815-1827.

DIRAC PARTICLE IN A MAGNETIC FIELD: SYMMETRIES AND THEIR BREAKING BY MONOPOLE SINGULARITIES

Monopole singularities upset familiar results for motion of a charged Dirac particle, but P,C and T considerations restore the situation almost completely, although there may be a zero-energy bound state not heretofore suspected. Problems of second quantization with such a state are considered.

1099. Greub Werner H. In: DIFFERENTIAL GEOMETRICAL METHODS IN MATHEMATICAL PHYSICS, Proceed. of the Symposium held at the University of Bonn, 1975. Berlin-Heidelberg-New-York, 1977, pp. 350-354.

Lect.Notes Math.,1977, vol.570, pp.350-354.

COMPLEX LINE BUNDLES AND THE MAGNETIC FIELD OF A MONOPOLE

1100. Gribov V. Leningrad Nuclear Physics Institute, preprint No 367,Leningrad,1977.

QUANTIZATION OF NON-ABELIAN GAUGE THEORIES

1101. Gribov V. Lectures at the 12-th Winter School of the Leningrad Nuclear Physics Institute, Leningrad,1977, pp.147-162.

UNSTABILITY OF NON-ABELIAN GAUGE THEORIES AND IMPOSSIBILITY OF COULOMB GAUGE CHOICE

In the lecture it is shown that due to impossibility of introducing the Coulomb calibration for large fields and an increase of invariance charge at long distances the non-Abelian gauge theory cannot be formulated as a theory of massless particles interactions. This statement is a strong argument for the state spectrum in non-Abelian theories differs sufficiently from the state spectrum in a perturbation theory.

1102. Gu Chao-Hao, Yang Chen-Ning Sci.Sin.(China),1977, vol.20, No 2, pp.177-185.

SOME PROBLEMS ON THE GAUGE FIELD THEORIES III (In Chinese)

In the case of electromagnetic field with monopoles the concept of magnetic charges in the SU_2 gauge theory with the Higgs field and that in the global U_1 gauge theory are shown to be equivalent mathematically. The method of description of electromagnetic fields with magnetic charges in terms of U_1 gauge theory and the variational method for the derivation of the world lines of charged particles is considered.

1103. Gu Chao-Hao, Hu He-Sheng Acta Phys.Sinica,1977, vol.26, No 2, pp.155-168.

ON SPHERICALLY SYMMETRIC SU(2) GAUGE FIELDS AND MONOPOLES(In Chinese)

Some properties of spherically-symmetric SU(2) gauge fields are considered. It is shown that in a general case the spherically-symmetric fields can be divided into 3 classes: 1) strictly spherically-symmetric fields; 2)spherically-symmetric fields with accuracy up to gauge transformations; 3) spherically-symmetric SU(2)-gauge fields reduced to U(1)-gauge fields. These types of spherically-symmetric gauge fields are investigated and completely defined with Higgs fields. If one considers such a fields as an interacting electromagnetic field and as an electrically-charged vector boson, then the electromagnetic field may correspond to a magnetic monopole field with a multiple magnetic charge $0,\pm 1$.

1104. Hagstrom R. Phys.Rev.Lett.,1977, vol.38, No 13, pp.729-732.

HAVE WE SEEN A HEAVY ANTINUCLEUS?

The hypothesis of the first observed heavy antinucleus is proposed for the event of Price et al. This hypothesis demands depletion of the high-energy knock-on electrons which should be clearly evident in the nuclear emulsion. This hypothesis does not directly contradict any previous antimatter search; and conflict extrapolations from previous searches is of small statistical significance.

1105. Hirayoma M., Hsiung Chia Tze Stanford Linear Accelerator Center, SLAC-Pub-2001,Stanford,1977.

THE NAMBU MECHANICS OF NON-ABELIAN DYONS

1106. Hirayama M. Phys.Rev.,1977, vol.D16, No 2, pp.530-532.

REALIZATION OF NAMBU MECHANICS: A PARTICLE INTERACTING WITH AN SU(2) MONOPOLE

The paper points out that the equations of motion of a point particle of mass m possessing isospin degrees of freedom which interacts with an SU(2) magnetic monopole can be cast in the form of Nambu's mechanics.

1107. Hirayama M. Stanford Linear Accelerator Center, SLAC-Pub-1920, Stanford,1977.

REALIZATION OF NAMBU MECHANICS: A PARTICLE INTERACTING WITH AN SU(2) MONOPOLE

1108. t' Hooft G. 1977, Lectures given at the Banff Summer Institute.

EXTENDED OBJECTS IN GAUGE FIELD THEORY

1109. t' Hooft G. Autumn meeting,1977, Petten, Netherlands.

SOLITIONS AND INSTANTONS

1110. Hosada M., Kozakai H., Tokyo Metropolian Univ., preprint,1977.

CONVERSION OF ISOSPIN DEGREE OF FREEDOM INTO SPIN DEGREE OF FREEDOM

1111. Hosada M., Kozakai H. Progr.Theor.Phys.,1977, vol.58, No 6, pp.2008-2070.

ON THE FERMION - BOSON PUZZLE

1112. Horváth Z., Palla L. Phys.Lett.,1977, vol.B69, No 2, pp.197-201.

MONOPOLES AND GRAND UNIFICATION THEORIES

A method for constructing static extended monopole solutions in the grand unification theories is shortly described. SU(N)/S(U,(p) x U (q)) static finite energy monopole solutions are presented. The homotopy theory derivation of the charge quantization is given for these solutions.

1113. Horváth Z., Palla L., Cremmer E., Scherk J. Nucl.Phys., 1977, vol.B127, No 1, pp.57-65.

GRAND UNIFIED SCHEMES AND SPONTANEOUS COMPACTIFICATION

The mass spectrum of spontaneously compactified Einstein-Yang-Mills theories is computed using the Wu-Yang monopole harmonics functions. It is found that spontaneous compactification can be used to provide the correct mass scale generating the superstrong symmetry breaking which in grand unified theories, separates quarks from leptons.

1114. Horváth Z.,Palla L. Int.Cent.Theor.Phys.,IC/77/35, Trieste,1977.

EXTENDED MONOPOLES IN GAUGE FIELD THEORIES

We give a review of the 't Hooft monopole and briefly discuss the general topological considerations connected with monopoles. A method is presented for constructing explicit monopole solutions in any gauge theory. Some stability questions and time-dependent problems are also considered.

1115. Horváth Z.,Palla L. Acta Physica Austriaca,1977,vol.46, No 4, pp.297-314.

MONOPOLES,DYONS, AND OTHER TOPOLOGICALLY STABLE SOLUTIONS IN GAUGE THEORIES

An inductive discussion of 't Hooft's magnetic monopole solution is given illustrating how to construct such useful gauge invariants as the electromagnetic field strength.

It is described what kind of electrodynamical situation can result finite energy for a point-like magnetic monopole. Stable solutions in SU(3) gauge theories without scalars are presented. A detailed discussion of the SU(3) monopoles and dyons is carried out in the presence of Higgs sçalars. The radial oscillations of 't Hooft's monopole are discussed briefly.

1116. Hosoya A., Ishida J. Progr.Theor.Phys.,1977, vol.57, No 2, pp.608-619.

NON-ABELIAN MAGNETIC CHARGES

We have obtained exact solutions of the classical isotopic gauge field equations in the static case. Our solution has a nonlinear form in terms of the (pseudo-) scalar potential and its space derivative and shows to exhibit the isotopic analog of Dirac's monopoles. Our solution naturally leads to the integer-valued condition for the charge quantization.

1117. Hraskó P. Amer.J.Phys.,1977, vol.45, No 9, pp.838-840.

QUASICLASSICAL QUANTIZATION OF THE MAGNETIC CHARGE

Quasiclassical quantization of a spherical pendulum in which the moving point mass and the center have electric and magnetic charge, respectively, is discussed. It is shown that for this system quantum conditions do not simply select between classical orbits. The requirement of spherical symmetry leads to the quantization condition of Dirac for the product of the charges and the total angular momentum may be either an integer or a half-integer multiple of $\hbar$

1118. Hraskó P.,Balog J. Kozponti Fizikai Kutato Intezel, KFKI-77-26, Budapest, Hungary,1977.

ROTATIONAL SYMMETRY IN THE HAMILTONIAN DYNAMICS

1119. Hsu J.P.,Mac E. J.Math.Phys.,1977, vol.18, No 1., pp.100-103.

SYMMETRY AND EXACT DYON SOLUTIONS FOR CLASSICAL YANG-MILLS FIELD EQUATIONS

We show that the generalized electromagnetic field tensor $\bar{F}_{\mu\nu}$ and the magnetic and electric charges in non-Abelian gauge theories ahve little to do with the Higgs scalars and/or the dynamics of the Lagrangian. They are consequences of a symmetry in the theory. We present several exact static dyon solutions to the nonlinear classical field equations in both massless and massive Yang-Mills theories, which possess both electric and magnetic charges. The implications of $\bar{F}_{\mu\nu}$ are also discussed.

1120. Hsu J.P. Found.Phys.(USA),1977, vol.7, No 11-12, pp.801-812.

EXACT MONOPOLE SOLUTIONS IN YANG-MILLS AND UNIFIED GAUGE THEORIES

Magnetic monopoles are studied in non-Abelian gauge theories. The exact static, spherically symmetric solutions of the magnetic monopoles in both Yang-Mills and unified gauge theories are obtained. The energy of the static system is calculable and it is either zero or infinite. The existence of the magnetic monopole solution is a consequence of symmetry rather than dynamics. A new definition of the electromagnetic field tensor is proposed, which relates the static solution of gauge fields and the magnetic monopole solution. Experimental implications are discussed.

1121. Hsu J.P. The Center for Particle Theory, The Univ. of Texas at Austin,77-120, Austin,Texas,1977.

OBSERVABLE PHASE FACTORS AND SYMMETRY OF ELECTRIC AND MAGNETIC CHARGE

1122. Huang Kerson, Stump Daniel R. Phys.Rev.,1977, vol.D15, No 12, pp.3660-3667.

FLUX QUANTIZATION AND ANGULAR MOMENTUM IN

NON-ABELIAN GAUGE FIELD THEORIES

We study a Yang-Mills field, with gauge group generators L_a/a=1,...,n/ coupled to self-interacting source fields through a gauge coupling constant e. The following results are obtained: a) the total angular momentum, defined as Poincaré group generators, is the free-field angular momentum plus $(1/2\pi) Q_a \vec{\Phi}_a$ where Q_a is the total charge and Φ_a^k is the total flux of $\nabla \times \vec{A}_a$ in the x^k direction; b) there is a choice of $\{L_a\}$ such that the flux matrix $\vec{\Phi} = \vec{\Phi}_a L_a$ obeys the quantization condition $[(e/2\pi)\Phi^1, (e/2\pi)\Phi^2] = (ie/2\pi)\Phi^3$; c) $(e/2\pi)\vec{\Phi}$ generates gauge transformations that are equivalent to spatial rotations of asymptotic Higgs fields; d) for any solution in which $(e/2\pi)\vec{\Phi} \neq 0$ the gauge field is a monopole field with pole strength g=1/e.

1123. Ikeda M., Kawai T., Yoshida H. Lett. Nuovo Cimento, 1977, vol.20, No 7, ser.2, pp.227-231.

MAGNETIC MONOPOLE, VECTOR POTENTIAL AND GAUGE TRANSFORMATION

In rodinary electrodynamics where there is no magnetic monopole at all, the potential A'_μ, which is related to A_μ by a gauge transformation $A'_\mu = A_\mu + (\hbar c/e) \cdot \partial\chi(x)/\partial x^\mu$, describes exactly the same physical system as the A_μ does, and there is no experiment to descriminate between them. The authors discuss whether this is still true with a monopole in connection with the charge quantization condition. They study the magnetic field produced by a static magnetic monopole with strength $g\ (\neq 0)$ located at the origin.

1124. INFORMAL MEETING IN RECENT DEVELOPMENTS IN FIELD THEORY, 21-23 November, 1977, Trieste. Center for Theor. Phys., IC-77-152, Trieste, 1977.

1125. Ishikawa K. Progr. Theor. Phys., 1977, vol.58, No 4, pp.1283-1298.

COVARIANT QUANTIZATION OF SOLITION IN GAUGE THEORIES

A technique of relativistically covariant collective coordinates is applied to gauge theories in realistic space-time dimensions which have solutions of classical Euler-Lagrange equations. Masses and form factors of extended objects in such theories are calculated.

1126. Jackson J.D. European Organization for Nuclear Research, CERN-77-17, Geneva,1977.

THE NATURE OF INTRINSIC MAGNETIC DIPOLE MOMENTS

Although isolated magnetic poles have so far not been unambiguously observed, the notion recurs that they might exist in magnetically neutral groups, bound together to form magnetic dipoles. Perhaps the intrinsic magnetic moments of fundamental particles are just such dipoles. Using only basic ideas of electricity and magnetism and elementary quantum mechanics, a unified pedagogical discussion is given of the hyperfine structure of atomic s-states and the scattering of slow neutrons by magnetic media. All known intrinsic magnetic moments (of electron, muon,proton, neutron,nuclei) are shown to be caused, to a very high precision, by circulating electric currents and not by magnetic charges.

1127. Jacob M. University of California Riverside,UCR-77-15, California,1977.

HADRON PHYSICS IN THE 200-2000 GEV ENERGY RANGE

1128. Jang Pong Soo, Park Soo Yang, Wali K.C. Syracuse Univ., SU-4211-101, New York,1977.

CONCERNING AXIALARY SYMMETRIC MONOPOLE-TYPE SOLUTIONS

1129. Jehle H. In:CONTACTS BETWEEN HIGH ENERGY PHYSICS AND OTHER FIELDS OF PHYSICS,2 Feb.-5 March,1977, Schladming, Austria.

Acta Physica Austriaca,Suppl.,1977, No 18,pp.63-109.

TOPOLOGY OF MAGNETIC FIELDS IN PARTICLE PHYSICS. IMPLICATIONS ON THE QUARK MODEL

1130. Jehle H. Inst. voor Teoretsche Fysica, Univ. von Amsterdam, Amsterdam,1977.

FLUX QUANTIZATION IN PARTICLE PHYSICS

Quantization of magnetic flux was recognized by Fitzlandon as the basis on which superdonductivity may be understood. The many-body problems of superconductivity had later been cleared by the ingenious theories based on an understanding of solid state physics. London's early start has its special importance because the quantization of magnetic flux without the introduction magnetic monopole was a more conservative and, as it turned out, a most fruitfull basis for other developments in physics too.

1131. Jehle H. Phys.Rev.,1977, vol.D15, No 12, pp.3727-3759.

ELECTRON-MUON PUZZLE AND THE ELECTROMAGNETIC COUPLING CONSTANT

1132. Jersák J., Kiera M., Magg M. Nuovo Cimento,1977, vol.40A, ser.2, No 3, pp.269-283.

ON THE MONOPOLE-DYON SYSTEM IN NON-ABELIAN GAUGE THEORIES

The multipole forces in the monopole-dyon system with zero total magnetic charge in the Georgi-Glashow model are determined and their consequences for the spectrum of the model investigated. For the strong coupling, $e > \sqrt{8\pi}$,some long-live bound states are possible. The existence of stable localized states with ziro magnetic charge and half-integer spin is pointed out.

1133. Jersale J., Kiera M.,Magg M. Inst. für Theor.Phys. Rheinisch-Westfalische Tech.Hochschule, Aachen,Germany, 1977.

ON THE MONOPOLE-DYON SYSTEM IN NON-ABELIAN GAUGE THEORIES

1134. Jones L.W. Rev.Mod.Phys.,1977, vol.49, No 4, pp.717-752.

REVIEW OF QUARK SEARCH EXPERIMENTS

All of the experimental evidence for and against the existence of free, physical qaurks from cosmic rays, partic accelerators, and stable matter is reviewed. There is no evidence for the existence of free quarks of fractional charge save for one recent report of niobium pellets of third-integral residual charge. The related searches for quark of integral charge, for free magnetic monopoles, tachyons, dyons and other postulated, stable elementary objects are also reviewed. Although some puzzling observations are noted. There is no firm evidence for any of these particles.

1135. Kalb M. Massachusetts Institute of Technology,MIT-CTP-653, Cambridge,1977.

MAGNETIC MONOPOLES IN A GAUGE FIELD THEORY FROM VORTEX-STRING

1136. Kamat R.V. J.Phys.Educ.,(India),1977, vol.5, No 3., pp.11-15.

ELECTROMAGNETISM WITH MAGNETIC MONOPOLES

The correctness of certain equations regarding the magnetic monopole interactions as have been used earlier, has been investigated. It has been pointed out that these equations are incorrect when they are examined in the light of Maxwell's equation in the presence of magnetic monopoles. Using these, it is shown that the constant of proportiona -

lity in the Coulomb's law SUB(0) as given. Hitherto is incorrect and has to be replaced by SUB(0)/(4). Even in the case of monopole interactions, the $\mathcal{B}$ -field is fundamental and not the H -field.

1137. Kamata M. Inst. for Theor. Phys., Univ. of Tsukuba, Ibaraki, 1977.

VORTEX SOLUTIONS AND QUARK CONFINEMENT IN SU(3) GAUGE MODEL

1138. Kazama Y., Yang Chen Ning, Goldhaber A.S. Phys. Rev., 1977, vol. D15, No 8., pp. 2287-2299.

SCATTERING OF A DIRAC PARTICLE WITH CHARGE ZE BY A FIXED MAGNETIC MONOPOLE

The helicity-flip and helicity-nonflip scattering amplitudes of a Dirac particle with spin 1/2 and charge Ze by a fixed magnetic monopole field are calculated. To make the Hamiltonian meaningful an infinitesimal extra magnetic moment is added to the charged particle. The sign of this extra term has measurable consequences. The differential cross section, which is independent of the sign of Ze, is tabulated. The helicity-flip amplitude vanishes at all angles for incoming beam helicity = +1 if Zeg > 0, and for incoming beam helicity = -1 if Zeg < 0.

1139. Kazama Y. Ph.D. Thesis, State Univ. of New York, Stony Brook, USA, 1977. University microfilms order No 77-20,445.

INVESTIGATIONS IN THEORETICAL HIGH ENERGY PHYSICS

1140. Kazama Y. Univ. of Michigan, UM-HE-78-1, Ann Arbor, 1977.

DYNAMICS OF ELECTRON-MONOPOLE SYSTEM

1141. Kazama Y., Yang Chen Ning. Phys.Rev.,1977, vol.D15, No 8, pp.2300-2307.

EXISTENCE OF BOUND STATES FOR A CHARGED SPIN 1/2 PARTICLE WITH AN EXTRA MAGNETIC MOMENT IN THE FIELD OF A FIXED MAGNETIC MONOPOLE

Bound-state wave functions are found for a Dirac particle of spin 1/2 with an extra magnetic moment in the field of an infinitely heavy magnetic monopole.

1142. Kazama Y. Phys.Rev.,1977, vol.D16, No 10 ,pp.3078-3085.

ELECTRIC AND MAGNETIC DIPOLE MOMENTS OF THE BOUND SYSTEM OF A DIRAC PARTICLE AND A FIXED MAGNETIC MONOPOLE

The electric and the magnetic dipole moments are calculated for the bound states of a charged Dirac particle of spin 1/2 with an extra magnetic moment in the field of a fixed magnetic monopole. Unlike ordinary bound systems with P and /or T invariance, this system, lacking both, is found to possess a nonvanishing electric dipole moment. Its magnitude for the loosely bound states with the lowest possible angular momentum increases exponentially in the principal quantum number n. The magnetic moment of the system is found to be, in general,nonvanishing.

1143. Kazama Y. Fermi National Accelerator Laboratory, FERMILAB-Pub-77-59 THY,Batavia,1977.

ELECTRIC AND MAGNETIC DIPOLE MOMENTS OF THE BOUND SYSTEM OF A DIRAC PARTICLE AND A FIXED MAGNETIC MONOPOLE

1144. Keihn R.M., J.Math.Phys.,1977, vol.18, No 4, pp.614-624.

PERIODS ON MANIFOLDS QUANTIZATION AND GAUGE

It is suggested that the quantization of flux'charge

and angular momentum be interpreted as a set of independent natural concepts which physically exhibit certain topological properties of the fields on a space-time manifold. These quantum or topological properties may be described in terms of one-,two- and three- dimensional periods,respectively. In terms of this viewpoint, topological constraints between the one-,two-, and three-dimensional periods, can be put into correspondence with various gauge theories. If a dynamical system is to be nondissipative, in the sense that its one-, two-, and three-dimensional topological periods are reversible invariants of the motion than it is proved herein, that the dynamical field V must be a Hamiltonian vector field, the field currents must be proportional to V, and the Lagrangian difference between the elastic and inertial energy density must be twice the interaction energy density, respectively.

1145. Kerner R. Lett.Math.Phys.(Netherlands),1977, vol.2, No 1, pp.49-53.

ON THE UNICITY OF THE 'T HOOFT'S MAGNETIC MONOPOLE

Considers the most general rotationally invariance and stationary Yang-Mills potential generated by the SU(2)-gauge group. It is shown that the 't Hooft's substitution is unique up to a gauge if the finite energy conditions are imposed.

1146. Kiskis J. Phys.Rev.,1977, vol.D16, No 8, pp.2535-2539.

U(1) GAUGE THEORIES,FIBER BUNDLES,AND STEREOGRAPHIC PROJECTIONS IN TWO DIMENSIONS

1147. Kiskis J. Los Alamos Sci.Lab.,LA-UR-77-1373, Los Alamos,1977.

U(1) GAUGE THEORIES, FIBER BUNDLES,AND STEREOGRAPHIC PROJECTIONS IN TWO DIMENSIONS

Some general properties of U(1) gauge fields on R^2 and S^2 are investigated. In the absence of matter fields, configurations which are more general than fiber bundles are allowed on S^2. Fermion fields are not consistent with this more general structure on S^2. Stereographic projections are discussed.

1148. Kittel C., Manoliu A. Phys.Rev.,1977, vol.B15, No 1, pp.333-336.

INTERACTION OF A MAGNETIC MONOPOLE WITH A FERROMAGNETIC DOMAIN

We calculate the interaction energy of a magnetic monopole with a single ferromagnetic domain, taking into account the ferromagnetic exchange interaction in a linear approximation. In vacuum at 400 Å from the surface a monopole of strength 137e/2 is bound by 35 eV in magnitude, and for iron at 300 Å from the surface the binding energy is 50 eV. We expect the binding energy to increase at smaller distances. The attractive force on a slow monopole approaching the surface of a ferromagnet from the vacuum differs, at these large distances, only slightly from that computed by simple classical image methods treating the magnet as a medium with an isotropic and wavelength-independent permeability equal to the long-wavelength transverse permeability of the ferromagnetic material. We consider the apparent contradictions with energy and momentum conservation in the problem of a monopole in the field of an electron. The exclusion of s-wave scattering largely resolves the contradictions. The effective field on a monopole in a ferromagnetic is H and not B.

1149. Kobiske R.A., Parker L. Phys.Rev.,1977, vol.D16, No 12, pp.3355-3368.

MANY-BODY EQUILIBRIUM OF DUAL CHARGED SOURCES IN GENERAL RELATIVITY

Starting with the basic equations of Israel and Wilson ans Perjes, we give the explicit axially symmetric metric

for N dual charged sources in equilibrium under their mutual electromagnetic and gravitational forces. We give the conditions for the removal of all connecting strut singularities and for an asymptotically flat space-time. In the case of two sources, we show that the strut-free asymptotically flat solutions having given values of electric and magnetic charge cannot have a separation of the sources which exceeds a certain maximum value.

1150. Komarov L.I., Romanova T.S. Belorussk.Univ.,1977, ser.1, No 1, pp.86-88.

ON A VARIATIONA PRINCIPLE IN THE MAGNETIC CHARGE THEORY

The Lagrangian which is at the same time invariant with respect to Lorentz transformations and dual transformations of electromagnetic fields, is built in the magnetic charge electrodynamics by using the non-local potential.

1151. Konopel'chenko B.G. Sov.J.Nucl.Phys.(Engl.Transl),1977, vol.26, No 5, pp.598-599.

CLASSICAL SOLUTIONS OF THE FIELD EQUATIONS

Several solutions to the four-dimensional - Gordon equation are presented including that for 't Hooft-Polyakov monopole.

1152. Konopel'chenko B.G., Yadern.Fiz., 1977, vol.26, No 5, pp.1133-1134.

CLASSICAL SOLUTIONS OF THE FIELD EQUATIONS

1153. Kupiainen A., Byckling E. Phys.Lett.,1977, vol.67B, No 1, pp.80-83.

ON THE UNIQUENESS OF MONOPOLE SOLUTION

A previous (Cremmer et al.,ibid.,vol.65B, p.78,1976) uniqueness proof of 't Hooft's monopole solution is discussed and complemented.

1154. Kupiainen A., Byckling E. J.Phys. A, 1977, vol.10, No 3, pp.L49-L51.

ON THE UNITARY GAUGE

We give a rigoreus treatment of the unitary gauge in the SU(2) Yang-Mills-Higgs system. It is shown that the massive vector fields give a long-rouge contribution along the negative axis corresponding to the string in the electromagnetic field.

1155. Kurochkin Yu.A., Tolkachev E.A., Tomil'chik L.M. Doklady Akad.Nauk Belorussk.SSR,1977, vol.21, No 11, pp.988-990.

TWO CHARGE DISCRETE SYMMETRIES IN CLASSICAL ELECTRODYNAMICS

The operations of the space-time inversion and the variation of charge signs have been successively dtermined in the framework of a quarternion (spinor) formulation in classical electrodynamics. The properties of basic electrodynamic values have been investigated with respect to the transformations introduced.

1156. Kuvshinov V.I., Strazhev V.I. In: FROM A SCIENTIFIC HYPOTHESIS TO A PHYSICAL EVENT "Nauka i Tekhnika",Minsk, 1977, pp.53-82.

The history of prediction and discovery of fundamental elementary particles. On quarks, partons and monopoles in modern physics.

1157. Kyriakopoulos E. Phys.Rev.,1977, vol.D16, No 2, pp.517-519.

EQUATIONS OF A MASSIVE ELECTRODYNAMICS WITH MAGNETIC CHARGES

The paper presents some such equations which are a generalization of the dually-invariant form of Maxwell's equations with two vector potentials. These are expected to replace the familiar Maxwell's equations when there

exist isolated magnetic charges.

1158. Kyriakopoulos E. Physics Laboratory, National Technical Univ. of Athens, Athens, 1977.

EQUATIONS OF A MASSIVE ELECTRODYNAMICS WITH MAGNETIC CHARGES

Maxwell equations in the case where there exist isolated magnetic charges are generalized to become the equations of a massive electrodynamics with magnetic charges. The generalization is facilitated by using the manifestly duality-invariant form of Maxwell's equations with two vector potentials. The resulting equations are invariant under duality transformations.

1159. Lake T.W. J.Phys.,(GB),1977, vol. G3, No 4, pp.441-447.

THE CLASSIFICATION OF MONOPOLES IN SU(2) AND SU(3) GAUGE FIELD THEORIES

The author shows how to construct all the asymptotic solutions of the classical Yang-Mills equations in the spherically symmetric, static, magnetic case for SU(2) and SU(3) with Higgs fields present. The Higgs and Yang-Mills fields are asymptotically decoupled making a discussion of the topological properties quite straighforward.

1160. Lanyi G. Dept. of Phys., Syracuse Univ., New York, 1977.

RADAL YANG-MILLS FIELDS

Radial gauge field-strength solutions of the Yang-Mills equations for arbitrary gauge groups are exhibited. Coulomb type SU(2) solution of Ikeda and Miyachi and the monopole type SU(2) solution of Wu and Yang are recorded as subcases of radial gauge field-strength solutions.

1161. Lanyi G., Pappras R. Phys.Lett.,1977, vol.68B, No 5, pp.436-438.

NON -UNIQUENESS OF THE SOURCE FOR SINGULAR GAUGE

1162. Lanyi G., Pappas R. Syracuse Univ., preprint, New York, 1977.

NON-UNIQUENESS OF THE SOURCE FOR SINGULAR GAUGE

1163. Lebrun J.P. Univ. de l'Etat á Liége, 1977.

PROPERTIES OF THE ELECTROMAGNETIC SOLITION IN THE UNIFIED GAUGE THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS

The stationary solition solution given earlier by the author for the Salam-Weinberg Lagrangian is rederived from the gauge covariant homogenuity conditions on, the matter fields intervening in the theory. A complete interpretation is given fo the resulting electromagnetic field which is shown to correspond not to a magnetic monopole field in this case but to the field of a magnetic dipole placed in a conducting medium which undergoes a superconducting transition in the plane cutting the elementary dipole at the origin. An electric current vortex forming a transition region, surrounds the dipole. It is shown, that after spontaneous symmetry breaking, the interpretation given still holds. In appendix, a complete derivation of the elementary solition from the field equation is given.

1164. Li Hua-Zhong, Xian Ding-Chang, Guo Shuo-Hong. Acta Phys. Sin.(China), 1977, vol.25, No 6, pp.507-513.

ON THE PROBLEM OF THE DUAL CHARGE OF NON-ABELIAN GAUGE GROUPS. A DISCUSSION ON MAGNETIC MONOPOLES (In Chinese)

Starting from the integral definition of gauge fields, and using a formula a resembling the Gauss-Bonnet theorem (a theorem in differential geometry on compact manifolds), a general conjugate relationship between the gauge charge and the dual charge is derived. The relation between electronic charge and the magnetic monopole is an example of this conjugate relationship. For an SO(3) gauge group with a U(1) group as its invariant subgroup, the 't Hooft monopole

solution is obtained as a special solution without introducing anu concept of singular strings or any mechanism such as the spontaneous breaking of symmetries.

1165. Lahe M.A. Imperial Colledge, Dept. of Theor. Physics, ICTP-77-78-1, London, 1977.

MAGNETIC MONOPOLES AND BAEKLUNG TRANSFORMATIONS

1166. Lubkin E. Intern. J. Theor. Phys., 1977, vol. 16, No 7, pp. 551-554.

IS GRAVITATIONAL DUAL CHARGE PHYSICAL?

It has been shown that nonzero gravitational dual charg cannot be found in a spin-manifold space-time. Nevertheless, gravitational dual charge is not physically inconsistent with spin -1/2 because spinor modal regions should be excluded from the manifold. However, gravitational dual charge cannot be born by any object sufficiently localizable that it can be surrounded by an everwhere space-like two-sphere, hence is not readily visible in Canchy data.

1167. Lugo V.A. Phys. Lett., 1977, vol. 66B, No 5, pp. 459-460.

THE STRICT EQUIVALENCE OF THE ABELIAN MONOPOLE AND ITS NON-ABELIAN STRINGLESS COUNTERPART BY USE OF SECTIONS

In an SO(3) gauge theory the field of the Dirac monopole of charge $N=e_0g/\hbar c=0,\pm 1,\ldots$, in the z-isospin direction into a global, nonsingular (for $r\neq 0$) gauge field, thus showing the usefulness of the method of sections of Wu and Yang in avoiding the introduction of unphysical singularities. For N=1 we thus conclude that the basic 't Hooft-polyakov solution is strictly equivalent to the Abelian monopole.

1168. Luo Liao-Fu, Lu Tan Kexue Tongbao(China), 1977, vol. 22, No 9, pp. 396-397.

English translation in Kexue Tongbao (Scientia)(USA).

A POSSIBLE HIGH SPIN MESON BUILT FROM MAGNETIC MONOPOLE AND ANTIMONOPOLE

1169. Madore J. Gen.Relativ. and Gravitation(USA),1977, vol.8, No 8,pp.655-664.

ON AXIALLY SYMMETRIC SOLUTIONS TO THE HIGGS-KIBBLE-YANG-MILLS FIELD EQUATIONS

The field equations for axially symmetric generalizations of the 't Hooft-Polyakov magnetic monopole are written out in a preferred coordinate system. It is argued that no solition solutions exist when the product 2 eg of the electric charge e with the magnetic charge g is an event integer.

1170. Madore J. Commun.Math.Phys.(Germany),1977, vol.56, No 2, pp.115-123.

A CLASSIFICATION OF SU_3 MAGNETIC MONOPOLES

A classification scheme is proposed for SU_3 magnetic monopoles when the Higgs fields lie in the adjoint representation. The scheme is based on a study of the second homotopy groups of the orbit spaces.

1171. Mainland G.B., Takasugi E., Tanaka K. Phys.Rev.,1977, vol.D15, No 10, pp.3007-3010.

COMMON FEATURE OF NONLINEAR SOLVABLE MODELS

It is argued that the ansatz T = O(trace of the energy-momentum tensor order relevant space coordinates) may be useful in obtaining analytic solutions to nonlinear Lagrangian models. Previously known exact solutions to models with vortex lines, magnetic monopoles, or pseudoparticles can be obtained naturally from the equations of motion supplemented by this ansatz.

1172. Mainland G.B., Takasugi E., Tanaka K. Dept. of Phys. Ohio State Univ.,COO-1545-206, Columbus,USA ,1977.

COMMON FEATURE OF NON-LINEAR SOLVABLE MODELS

1173. Manton N.S. Nucl.Phys.,1977, vol.B126, No 3, pp.525-541.

THE FORCE BETWEEN 'T HOOFT-POLYAKOV MONOPOLES

A perturbative scheme for investigating the interaction of widely separated 't Hooft-Polyakov monopoles is developed. In the Prasad-Sommerfield limit, the force between oppositely charged monopoles is found to have an inverse square law behaviour, but the force between equally charged monopoles is zero.

1174. Manton N.S. Dept. of Applied Mathametics and Theoretical Physics Univ. of Cambridge, DAMTP 77-30, Cambridge,1977.

COMPLEX STRUCTURE OF MONOPOLES

1175. Manton N.S. Dept. of Applied Mathematics and Theoretical Physics, Univ. of Cambridge, Cambridge,DAMTP 77-8,1977.

THE FORCE BETWEEN 'T HOOFT-POLYAKOV MONOPOLES

1176. Maison D., Orfanidis S.J. Phys.Rev.,1977, vol.D15, No 12, pp.3608-3614.

SOME GEOMETRICAL ASPECTS OF MONOPOLE THEORIES

Some aspects of the relationship between Kaluza's generally covariant theory of electromagnetism and its non-Abelian generalizations and a geometrical formulation in terms of connection forms on principle fiber bundles are illustrated by the examples of the magnetic monopole (Abelian and non-Abelian) and the infinite solenoid.

1177. Marciano W., Pagels H., Parsa Z. Phys.Rev.,1977, vol.D15, No 4, pp.1044-1049.

MULTIPLY CHARGED MAGNETIC MONOPOLES, SU(3) PSEUDOPARTICLES, AND GRAVITATIONAL PSEUDOPARTICLES

We demonstrate how the finite-energy unit magnetic monopole of an SU(2) gauge theory generalizes to configurations with gauge theories. Masses and stability properties of these topologically distinct solutions are discussed, This same generalization is shown to hold for the pseudoparticle solution of Euclidean Yang-Mills theories. Finally, properties of the gravitational pseudo-particle solutions to the Einstein field equations are exhibited and discussed.

1178. Margolin A.E., Tomil'chik L.M. Izv. Akad.Nauk Belorussk. SSR, ser. fiz.-mat.,1977, No 3, pp.73-77.

CHARGE QUANTIZATION CONDITION IN GENERALIZED KEPPLER PROBLEM

A conclusion is made for the charge quantization condition in terms of a three-dimentional Euclidean group E_3 which serves as a group of dynamical symmetry of two dually-charged particle interaction (generalized Keppler problem). Distinctly from the existing approach, the group E_3 is considered not as an uncompact extension of the SO_3 group, but as a contraction of the SO_4 group according to Irenyu-Wagner method. It is shown that non-zero energy solution applies to $\mathcal{D}(\mu,\alpha)$ representation of the E_3group, where μ and α -are magnetic and electric interaction parameters, respectively.

1179. Mc Keon G. Phys.Rev.,1977, vol.D16, No 6, pp.1836-1839.

EXTENDED YANG-MILLS FORMALISM

In analogy with the extension of electromagnetism by the inclusion of the Dirac monopole, the possibility of extending the Ynag-Mills formalism to include two separate types of self-coupling for the vector field is examined. A local Lagrangian which lacks manifest rotational invariance is presented.

1180. Mecklenburg W., O'Brien D.P., Dublin Inst. Advanced Studies, DIAS-T -77-10, Dublin, 1977.

TIME-DEPENDENT PROPERTY OF THE PRASAD-SOMMERFIELD MONOPOLE

1181. Menihoff R., Sharp D.H., J.Mathematical Phys., 1977, vol.18, No 3, pp.471-482.

A GAUGE INVARIANT FORMULATION OF QUANTUM ELECTRODYNAMICS USING LOCAL CURRENTS

In this paper we formulate nonrelativistic quantum electrodynamics in a local and manifestly gauge invariant manner. This is eccomplished by using the electromagnetic field strengths, rather than potentials, to describe the electromagnetic field and local currents, rather than canonical fields to describe the matter. The exponentiated currents and field strengths form a group, whose representations can be studied using the Gel'fand-Vilenkin formalism. The currents and electromagnetic field strength can be represented on a physical Hilbert space having positive norm. (The necessity for an indefinite metric does not arise here). Furthermore, the classical equations of motion hold as operator equations on this Hilbert space. In this formulation the requirement of gauge invariance is essentially replaced by imposing the Maxwell initial value equations, which in turn lead to constraints on systems of Gel'fand-Vilenkin multipliers.

1182. Michel L., L.O.Raifeartaigh, K.C.Wali Phys.Rev., 1977, vol.D15, No 12, pp.3641-3655.

RADIALLY SEPARATED MONOPOLE SOLUTIONS IN NON-ABELIAN GAUGE MODELS

The 't Hooft-Polyakov model generalized to an arbitrary compact gauge group is considered. The conditions imposed on the fields by the requirement that the total energy be finite is discussed. Static finite-energy solutions are considered in which the fields can be expressed

as products of functions involving separately the radial coordinate and the polar angles, and the internal symmetry indices are associated with the angular functions. The angular equations are solved and it is shown that the gauge field angular part vanishes outside a fixed-SO(3) subalgebra of the original algebra, and that inside the subalgebra it reproduces the 't Hooft-Polyakov solution. The 't Hooft-Polyakov monopole is of the lowest possible mass.

1183. Michel L., O'Raifeartaigh L. Syracuse Univ., SU-4210-88, New York, 1977.

RADIALLY SEPARATED MONOPOLE SOLUTIONS IN NON-ABELIAN GAUGE MODELS

1184. Michel L., O'Raifeartaigh L., Wali C.K. Phys. Lett., 1977, vol. 67B, No 2, pp. 198-202.

STATIC-FINITE-ENERGY SOLUTION OF GAUGE FIELD WITH SEPARATED RADIAL VARIABLE

For arbitrary compact gauge group G and real representations of the Higgs fields, we seek static finite-energy solutions for which the radial dependence of the field is factorized. We find that the gauge fields vanish outside a fixed SO(3) subgroup of G, and that inside SO(3) they reduce to the 't Hooft-Polyakov solution with unit magnetic charge. The Higgs fields may belong to any integer representation of this SO(3).

1185. Micu M. Rev. Rou, Phys. (Romania), 1977, vol. 22, No 4, pp. 427-433.

GROUP THEORETICAL APPROACH TO MONOPOLE THEORIES

A group theoretical approach to the magnetic monopole theory is presented where the monopole appears through the requirement that the Hamiltonian operator be a scalar with respect to the orthogonal group whose generators are written in a form which is different from the well-known expression r x p. The vector potential of the monopole is

extracted from that part of the Hamiltonian which describes the minimal interaction with a vector field.

1186. Mignani R. Int.J.Theor.Phys.,1977, vol.16, No 6, pp.425-428.

A PATH-DEPENDENT APPROACH TO COLORED MAGNETIC MONOPOLES

The Abelian gauge theory of magnetic monopoles is extended to the non-Abelian case, by means of Mandelstam's path-dependent approach to Yang-Mills fields. In this frame-work, the SU(3) generalization of Dirac's relationship plays the role of a consistency condition for the theory.

1187. Mignani R. Instituto Nasionale Di Fisica Nucleare, INFN, L'Aquila Univ.,1977.

QUATERNIONS AND LORENTZ TRANSFORMATIONS

1188. Mignani R. Instituto Di Fisica G.Markoni, Universita di Roma, Roma,1977.

QUATERNIONS AND LORENTZ TRANSFORMATIONS

1189. Mignani R. Instituto di Fisica G.Marconi, Univ. di Roma, I.N.F.N. No 54, Roma,1977.

GRAVITATIONAL MONOPOLES

We discuss the possibility of introducing gravitational "magnetic" monopoles (i.e. sources of the dual Rieman tensor) into Einstein's equations, by means of Mandelstam's path dependent approach to the gravitational field. It is shown that, in this framework, gravitational monopoles aris straightforwardly from a consistency requirement for the theory. Moreover, their existence implies a local violation of energy-momentum conservation law. Possible relations with the steady-state cosmological model, strong black holes and unified theories of gravitational and strong

interactions are briefly considered.

1190. Montonen C., Olive D. Phys.Lett.,1977, vol.B72, No 1, pp.117-120.

MAGNETIC MONOPOLES AS GAUGE PARTICLES?

Evidence is presented for the following conjecture: when quantized, the magnetic monopole solition solutions constructed by 't Hooft(1974) and Polyakov(1974), as modified by Prasad, Sommerfield(1975) and Bogomolny(1976), form a gauge triplet with the photon, corresponding to a Lagrangian similar to the original Georgi -Glashow one, but with magnetic replacing electric charge.

1191. Montonen C., Olive D. European Organization for Nuclear Research, CERN-TH-2391, Geneva,1977.

MAGNETIC MONOPOLES AS GAUGE PARTICLES?

1192. Moshir M. Ph.D.Thesis, Princeton Univ.,USA,1977. Univ.microfilms order No 78--7,458.

INTERACTION OF LEPTONS AND MAGNETIC MONOPOLES

The interaction of solitions with other particles represented by extra field variables is studied. It is shown that the problem reduces to solving a Schrödinger equation for the auxiliary fields in a potential generated by the solition solution. The case where the solition is 't Hooft-Polyakov magnetic monopole is considered in detail and the resulting Schrödinger equation is solved for several models. It is shown that in a scattering of charged particles by the monopole it is possible for the charged particle to lose its charge and give it to the monopole. First a multiplet of charged scalar fields is used for auxiliary fields, then the case of a multiplet of spin A/R fields is considered. Finally the Georgi-Glashow model is used for the leptons and the corss section calculated for the neutrino turning into an electron and the monopole turning into a dyon. Assuming a mass of 50 GeV for the

W mesons the cross sections are evaluated for the scalar and Georgi-Glashow cases numerically. It is found that in the energy range of order 1 GeV the cross section for the process (neutrino $\rightarrow$ electron) is some order of magnitude larger than the neutrino-nucleon total cross section, and an energy of 10 GeV the ratio reaches 10D.

1193. Nambu Y. Caltech Rasadena,CALT-68-634, Calted,Rasadena, 1977.

SOME TOPOLOGICAL CONFIGURATIONS IN GAUGE THEORIES

1194. Nambu Y. Nucl.Phys.,1977, vol.B130, pp.505-516.

STRING-LIKE CONFIGURATIONS IN THE WEINBERG-SALAM THEORY

The Weinberg-Salam theory of electromagnetic and weak interactions admits classical configurations in which a pair of magnetic monopoles is bound by a flux string of the Z field. They give rise to Regge trajectories of excitations with a mass scale in the TeV range.

1195. Nambu Y. Ann.N.Y. Acad.Sci.,1977, vol.294, pp.74-79. International symposium on five decades of weak interactions, New York, N.Y.,1977.

MONOPOLES, STRINGS AND INSTANIONS

Some solutions of Yang-Mills field equations that have implications in elementary particle physics are discussed starting with the Landau-Ginzburg theory of superconductivity in which a complex field is introduced to represent the superfluid of condensed electrons (Cooper pairs). Monopoles string, and insantons are included as the treatment progresses.

1196. Nambu Y. Enrico Fermi Inst.,Chicago Univ.,EFI-77-59, Chicago,1977.

STRING-LIKE CONFIGURATIONS IN THE WEINBERG-SALAM THEORY

1197. Nambu Y. In: QUARKS AND HADRONIC STRUCTURE, Ed. Morpurgo G., New York-London, 1977, pp. 281-292.

DESCRIPTION OF HADRONIC STRUCTURE

1198. Norello M., Salim J.M. 29 Annual Meeting of the Brazilian Society for Advancement of Science, Braziliam Brazil, 1977.
Cienc. Cult. (Sao Paolo) Supl., 1977, vol. 29, No 7, p. 321.

1199. O'Raifeartaigh L., Rownsley J. Dublin Inst. Advanced Studies, DIAS-TP-77-28, Dublin, 1977.

MASS-SPECTRUM FOR MONOPOLES OF INTEGRAL ISOSPIN. BAG-MODEL AS THE HIGH ISOSPIN LIMIT

1200. O'Raifeartaigh L. Lett. Nuovo Cim., 1977, vol. 18, No 7, pp. 205-208.

GAUGE AND REPRESENTATION-INDEPENDENT PROOF OF THE GOTH-WEINBERG THEOREM

1201. Ozaki S. Preprint, 1977.

THE STRUCTURE OF HADRONS BASED ON COLOURED DYONS. II. AN INTERPRETATION OF THE NARROW RESONANCES (Revised paper)

1202. Ozaki S. Preprint, 1977.

QUANTUM FIELD THEORY OF MAGNETIC CHARGE I.

1203. Parkash O., Rajput B.S. Indian J. Phys., 1977, vol. 50, No 11, pp. 929-941.

STUDY OF FIELDS ASSOCIATED WITH SPIN-1 PARTICLES CARRYING ELECTRIC AND MAGNETIC CHARGES

It has been shown that electric and magnetic fields

due to spin-1 particles carrying electric and magnetic charges are symmetrical. In order to avoid the arbitrary string variables in the solution of field equations, two four-potentials are introduced and it has been shown that their components are proportional to electric and magnetic current source densities, respectively.

1204. Parse Z.J. Ph.D.Thesis, Polytechnic Inst. of New York, Brooklyn, USA,1977, University microfilms order No 77-21, 082.

SOME TOPOLOGICAL SOLITIONS:VORTICES,MAGNETIC MONOPOLES AND INSTANTONS

1205. Patkos A. Nucl.Phys.,1977, vol.B129, No 2, pp.339-353.

A NON-ABELIAN VORTEX-BOND MODEL OF HADRONS

It is argued for a general class of models by analyzing the internal holonomy group of the cylindrically symmetric solutions that the most general vortex-like configurations of minimal energy can always be transformed to Abelian form. The corresponding "magnetic" fluxes are defined gauge invariantly. In the case of the SU(3) local gauge group,Nambu's valency-model is recovered. The stability problem in the case of small-amplitude oscillations reduces to the analogue investigation for "truely" Abelian vortices.

1206. Patrascioiu A. Phys.Rev.,D15, No 10, pp.3051-3053.

CLASSICAL EUCLIDEAN SOLUTIONS

The magnetic monopole and the $\lambda\varphi^4$ kink are discussed as Euclidean solutions in field theory in 2+1 and 0+1 dimensions, respectively. A new type of pseudo-particle in 3+1 dimensions is proposed.

1207. Pavlovic P. Czech.J.Phys.,1977, vol.27, No 2,pp.172-175.

SEARCH FOR MAGNETIC MONOPOLES(In Slovack)

A brief survey of experimental methods of finding the

magnetic monopole. The basic ideas of the Dirac theory are listed, the basic experiments are rpincipally characterized and the results thereof are tabulated. The latest experiments carried out on the Serpukhov synchrotron are described.

1208. Perepelitsa V.F. Inst.Teor. i Eksp.Fiz., Preprint No 82, Moscow,1977.

A SEARCH FOR TACHYON MONOPOLES

The upper limits of production probability of the 0.25-9 MeV mass tachyon monopoles in e^+e^- annihilation are obtained in the present paper.

1209. Pradhan T. Inst.of Physics Bhubaneswar,IP-BBSR-77-16, Bhubaneswar,India,1977.

FABRICATION OF MAGNETIC CHARGE FROM EXCITED H-ATOM

1210. Prokhvatilov V., Franke V.A. Vestn.Leningr.Univ., Fiz.,1977,No 10, pp.139-141.

ON SOLUTIONS OF THE "FINITE STRINGS" TYPE IN CLASSICAL GAUGE FIELD THEORIES
(In Russian)

The model of non-Abelian gauge field which allows energetically stable solutions of the "finite strings" type has been considered.

1211. Protogenov A.P. Phys.Lett.,1977, vol.67B, No 1, pp.62-64.

EXACT CLASSICAL SOLUTIONS OF YANG-MILLS SOURCELESS EQUATIONS

Exact solutions of dual equations are found. They describe classical particle-like field formations possessing the zero energy and imaginary electric and magnetic charges. Possible interpretation of the solutions is associated with the hypothesis discussed on the existence

of two more vacuums, except for the trivial one, which are degenerated, complex-conjugated and characterized by the zero mean value of the charge and its negative rms value.

1212. Ramachandran R., Raval V.M. Pramana J.Phys.,1977, No 5, pp.507-514.

DUAL CHARGE SOLUTION IN CURVED SPACE-TIME

A classical SU(2) ⊠ U(1) -gauge theory with duplicate complex scalar fields which permits the symmetry spontaneous violation (the Weinberg-Salama model) is considered. The solution of the equations of motion is found, for which a scalar field is equal to a constant, and gauge fields are of Coulomb type. The gauge-invariant expression for a tensor of electromagnetic field strength is built(taking into account that the electromagnetic field is a mixture of a U(1)-field and a neutral component of SU(2)-fields). This expression makes it possible to establish that the obtained solution has electric and magnetic charges(a dually charged solution). The electric charge can be arbitrary and the magnetic charge g is equal to $g=\sin^2 Q/e$, where e is a charge of ordinary scalar and vector fields, and Q is the Weinberg angle. The magnetic charge quantization condition is valid only at $\sin^2 Q = 1/2$. The electric charge of the solution is e multiple. It is shown, that the system of bound Yang-Mills and Einstein equations has the same solution. The corresponding metric has the Reisner-Norstem form. The obtained solution has inifnite energy in the plane space. It is assumed, that this difficulty is eliminated by taking into account gravitational fields or quantum effects.

1213. Ramachndran R. In: QUARKS AND HADRONIC STRUCT, Ed. Morpurgo G., New York-London,1977,p.305.

MONOPOLE-ANTIMONOPOLE BOUND STATE

1214. Ramachandran R. Proceedings of the III High Energy Physics Symposium held at Bhubaneswar, India,1976. Ed. Sarma K.V.L., Bombay, Dept. of Atomic Energy,1977, vol.2, pp.209-234.

MAGNETIC MONOPOLE SOLUTIONS

Unusual features of the monopole solutions of some non-Abelian gauge theories obtained by classical and semi-classical approximations are discussed. Topological quantum numbers are introduced for the conservation of the magnetic charge. The features of 't Hooft-Polyakov model for monopole are described. Spin and isospin mixing, SU-3 groups in the monopole solutions are discussed. This may throw some light on the problem of the confinement of the quark-monopole and in finding a model for the hadron states arising from strong interactions.

1215. Ramachandran R. Phys.News,1977, vol.8, No 2, pp.66-70.

MAGNETIC MONOPOLE AND CLOSE RELATIVES

The general features of the classical magnetic monopole are described. The quantization of angular momentum of the charge-monopole system is discussed. Attempts to discover monopoles in high energy cosmic ray interactions and in accelerators and methods for detection are mentioned. The applications of monopole -like theories in subnuclear physics ,specially in strong interactions, is indicated.

1216. Ramsay N.F. In: WORKSHOP ON FUNDAMENTAL PHYSICS EXPERIMENTS WITH REACTOR NEUTRONS AND NEUTRINOS,Ed. Von Egidy T., Grenoble, France,1977, pp.61-69.

FUTURE EXPERIMENTS ON THE PROPERTIES OF FREE NEUTRONS

Eighteen properties of free neutrons:instability, mass,wave properties, spin, quantized properties, strong forces, electric charge, magnetic monopole, electric dipole moments, magnetic dipole moment, higher multipole moments, electric polarizability, diamagnetic succeptibility,neutron-electron interaction, internal distribution of electric

charge, internal distribution of magnetization, weak interaction with gravity, - are considered and comments made on the possibility of their measurements in the future.

1217. Rautian S.G., Safonov V.P., Smirnov G.I. Phys.Lett., 1977, vol. 70B, No 2, pp.278-280.

ON THE POSSIBILITY OF REGISTRATION OF DIRAC MONOPOLE BY NONLINEAR EFFECTS IN THE EMISSION OF INTERSTELLAR MASERS

A method for detection of magnetic Dirac monopoles by anomalies of maser radio emission of cosmic OH molecules is proposed.

1218. Rawnsley J.H., Tchrakian D.H. J.Phys.,1977, vol.10, No 5, pp.L87-L90.

COMMENT ON THE MAGNETIC CHARGE OF YANG-MILLS FIELDS WITH LARGE INTERNAL SYMMETRY GROUP

Working in the adjoint representation of the gauge group, we give a definition of magnetic charge in terms only of the Higgs field, for groups of 2n x 2n matrices (n -integer). We apply this recipe to two examples, SO(4) and SU(4).

1219. Rawnsley J.H., Tchrakian D.H. Dublin Inst.Advanced Studies - DIAS-TP-77-06, Dublin, Ireland,1977.

COMMENT ON THE MAGNETIC CHARGE OF YANG-MILLS FIELDS WITH LARGE INTERNAL SYMMETRY GROUP

1220. Rawnsley J.H. J.Phys.,1977, vol.10, No 8, pp.L139-L141.

SPHERICALLY SYMMETRIC MONOPOLES ARE SMOOTH

The spherically symmetric monopole solutions, whose existence was regorously demonstrated by Tyupkin,Fateev and Shwatz (see Math.Theor.Phys., vol.26, p.270,1976) are shown to be regular everywhere.

1221. Rawnsley J.H. Dublin Inst. Advanced Studies, DIAS-TP-77,15, Dublin,Ireland,1977.

SPERICALLY SYMMETRIC MONOPOLES ARE SMOOTH

1222. Recami E. In: THE UNCERTAINTY PRINCIPLE AND FOUNDATION OF QUANTUM MECHANICS, Ed. Price W.C. and Chisside S.S., London,1977.

A NEW THEORETICAL AND EXPERIMENTAL OUTLOOK ON MAGNETIC MONOPOLES

1223. Romanov V.N., Schwartz A.S, Tyupkin Yu.S. Nucl.Phys, 1977, vol.B130, No 2, pp.209-220.

ON SPHERICALLY SYMMETRIC FIELDS IN GAUGE THEORIES

Gauge fields admitting spherical symmetry are listed. Spherically symmetric solutions of Yang-Mills equations and spherically symmetric magnetic monopoles are studied. A simple exact solution of the Yang-Mills and Einstein equations is found.

1224. Rossi P. Phys.Lett.,1977, vol.71B, No 1, pp.145-148.

FERMION ZERO MODES AND "HIDDEN" SYMMETRY

1225. Rossi P. Pisa Scnola Norm.Sup.,Pisa,1977.

FERMION ZERO MODES AND "HIDDEN" SYMMETRY

1226. Rossi P. Nucl.Phys.,1977, vol.B127, No 3, pp.518-536.

SPIN-1/2 PARTICLES IN THE FIELD OF MONOPOLES

The equations of motion of a spin -1/2 particle in the field of a point-like (Abelian and non-Abelian) monopol are solved; helicity states and scattering solutions are constructed. The motion in an extended monopole and dyon source is disscued: charge-exchange scattering amplitudes are computed in the distorted-wave Born approximation. By

the introduction of suitable spinors, the separation of variables is accomplished for any value of isospin. The non-existence of fermion zero modes in the field of an SU(2) monopole when $T > 1$, $J > 1/2$ is shown.

1227. Rossi P. Pisa Scnola Norm.Sup.,Pisa,1977.

SPIN 1/2 PARTICLES IN THE FIELD OF MONOPOLES

1228. Roth R. Lawrence Berkeley Lab.,LBL-6473, Berkeley, 1977.

PROPAGATOR IN A THEORY WITH CONFINEMENT

1229. Rund H. J.Math.Phys.,1977, vol.18, No 1, pp.84-95.

CLEBSCH POTENTIALS IN THE THEORY OF ELECTROMAGNETIC FIELDS ADMITTING ELECTRIC AND MAGNETIC CHARGE DISTRI BUTIONS

Any skew-symmetric tensor field on a four-dimensional pseudo-Riemannian space V_4 admits a representation in terms of Clebsch potentials and their derivatives. Since the usual 4-potential representation of the electromagnetic field tensor of classical electrodynamics breaks down in the presence of magnetic charges, these Clebsch potentials are treated as the field variables of an invariant variational principle. The resulting Euler-Lagrange equations determine not only a useful representation of the electromagnetic field tensor (in the presence of magnetic charges), but also give rise to Maxwell-type field equations. The associated Lagrange density defines a unique energy-momentum tensor entirely on the basis of invariant consideration. A generalized variational principle is postulated, whose Euler-Lagrange equations specify the behaviour of both the electromagnetic field tensor and the metric tensor of V_4. These are generalized Einstein -Maxwell equations. For the case of a spherically symmetric line-element and a static electromagnetic field an explicit solution of these equation

is found which generalizes the well-known Reissner-Nordström metric. In the course of the construction of this solution the magnetic charge of the central mass appears naturally as a constant of integration of the associated differential equations for the Clebsch potentials. The equations of motion of a test particle in an external electromagnetic field are also deduced from a variational principle; subject to fairly weak restrictions, the expected generalization of the classical Lorentz force emerges from this analysis.

1230. Rund H. J.Math.Phys.,1977, vol.18, No 7, pp.1312-1315.

ENERGY-MOMENTUM TENSOR IN THE THEORY OF ELECTROMAGNETIC FIELDS ADMITTING ELECTRIC CHARGE DISTRIBUTIONS

When the field tensor of an electromagnetic field admitting both electric and magnetic charge distributions is expressed in terms of a Clebsch representation, the extended Maxwell equations in the presence of a given gravitational field are derivable from an invariant variational principle in which the Clebsch potentials play role usually assumed by the classical 4-potentials. The corresponding Lagrange density gives rise in a unique manner to a symmetric tensor density T^{hj}, which displays some of the properties normally associated with the energy-momentum tensor density of the electromagnetic field. However, this interpretation may be in conflict with the generally accepted expression for the modified Lorentz forc Accordingly an alternative energy-momentum tensor density O^{hj}, is derived which does not suffer from this drawback. However, when a generalized variational principle for the simultaneous determination of the behaviour of both the electromagnetic and the dynamical gravitational fields is introduced, the resulting Euler-Lagrange equations give ris to extended. Einstein-Maxwell equations which involve the density T^{hj}. On the other hand, the alternative Einstein-Maxwell equations, obtained by the replacement of T^{hj} by O^{hj} are not derivable from a variational principle. The

solutions of the two Einstein-Maxwell equations, for the case of a spherically symmetric metric and static electromagnetic field, predict distinctly different effects of the magnetic charges on the gravitational field.

1231. Sastry G.P., Parida B.K. Z.Naturforsch.,1977, vol.32, No 10, pp.1126-1128,

CHERENKOV LOSSES OF A RELATIVISTIC NEUTRON IN A CONDUCTING MEDIUM

Expressions are derived for the combined Cherenkov and ohmic losses of a relativistic magnetic dipole moving in a 1) strongly and 2) weakly conducting medium.

1232. Sawada T. Inst. of Physics, University of Tsukuba, UTHEP-16, Ibaraki, Japan,1977.

EVIDENCE FOR THE STRONG VAN DER WAALS INTERACTION IN THE LOW ENERGY PP SCATTERING

1233. Singh V. Tata Inst. of Fundamental Research, Bombay, 1977.

APPROACHES TO HIGH ENERGY PHYSICS

1234. Sinha A. Columbia Univ., Dept. of Phys.,CU-TP-100, New York, USA, 1977.

LORENTZ TRANSFORMATIONS FOR GAUGE THEORY MONOPOLE SOLUTIONS

The Poincare group transformations are discussed in the presence of monopole solutions in gauge theories, using the canonical formalism developed by Christ, Guth and Weinberg. It is shown that the infinitesimal transformations generated by the Dirac brackets with the generators defined, as usual, by the Belinfante tensor satisfy the Poincare group algebra, in the so-called axial gauge.

1235. Sinha A. Phys.Rev.,1977, vol.16, No 6, pp.1828-1835.

LORENTZ TRANSFORMATIONS FOR GAUGE THEORY MONOPOLE SOLUTIONS

1236. Sokolov V.V. J.Nucl.Phys.(Russ.), 1977, vol.26, No 10, pp.427-432.

ON THE THEORY OF DIRAC MAGNETIC POLES

It is discovered why the singularity lines arise in the theory of Dirac magnetic poles. This feature is shown to be caused by ambiguous dependence of the asimuthal angle upon the space point and therefore is of purely kinematic origin. A correct account of this ambiguity results in disappearance of the string contribution to calssical and quantum equation of motion and to the Poisson brackets. The validity of the Jacoby identity is explicitly demonstrated for the double Poisson brackets of the cartesian coordinates of the relative velocity.

1237. Sokolov V.V. Sov.J.Nucl.Phys.(English Translation), 1977, vol.26, No 2, pp.224-227.

THEORY OF DIRAC MAGNETIC POLES

1238. Sorkin R. J.Phys.A, 1977, vol.10, No 5, pp.718-725.

ON THE RELATION BETWEEN CHARGE AND TOPOLOGY

The generalization of Stokes' theorem to non-orientable manifolds shows that a suitable topology can appear to carry "net" electromagnetic charge. By treating this as the origin of electric charge in nature one explains the non-existence of magnetic monopoles.

1239. Stern A. Phys.Rev.,1977, vol.D15, No 12, pp.3672-3674.

RESONANCES IN SU(2) GAUGE THEORY

Classical periodic trajectories are shown to exist

for a test particle moving in an external SU(2) gauge field. The field is assumed to be static and of the form proposed by Wu and Yang. The energy of the system is positive, so the orbits are expected to give rise to a spectrum of metastable states. A Bohr-Sommerfield quantization scheme is proposed for finding the spectrum. The results are applied to the problem of a particle interacting with a Polyakov-'t Hooft monopole, via the explicit solution of Prasad and Sommerfield.

1240. Stern A, Syracuse Univ., SU-4210-90, New York, 1977.

RESONANCES IN SU(2) GAUGE THEORY

1241. Stora R. In: NEW DEVELOPMENT IN QUANTUM FIELD THEORY AND STATISTICAL MECHANICS, Proceedings of the 1976 Cargese Summer Inst. held at Cargese, France. New York,1977, pp.201-224.

CONTINUUM GAUGE THEORIES

1242. Tanikawa Y. Dept. of Phys., Kobe Univ., Kobe,1977.

REPORT ON FIFTH INTERNATIONAL WORKSHOP ON WEAK INTERACTIONS WITH VERY HIGH ENERGY BEAMS

1243. Teramoto Yoshiteru, Uchusen Kenkyu ,1977, vol.21, No 3, pp.314-325.

DETECTION OF DIRAC MONOPOLE WITH THE COMBINATION OF MUON BURST DETECTOR,NEUTRINO DETECTOR AND CORE DETECTOR(In Japanese)

(Study meeting on 100 TEV muon and high energy neutrino, Tanashi, Tokyo, Japan,3-4 Feb.,1977).

Dirac monopole has been searched in accelerator experiments, cosmic ray as experiments and meteorite analysis. The upper limit on the monopole flux has been obtained from these experiments. In order to detect magnetic monopole

in cosmic ray, the detector must have the sensitivity of being able to observe at least the flux of 10 KAC CM K BS K ASR K A. The identification of magnetic monopole is made by using that the ionization loss is 5000 times as large as singly charged particles. If the existing muon burst detector, neutrino detector and core detector are used for the monopole search, the detection sensitivity can be increased by 10-10 G times as much as the present stage.

1244. Tereshenkov V.I., Tomilchik L.M. Vestsi Akad.Nauk Belorussk.SSR, ser. fiz.-mat., 1977, No 5, pp.112-116.

DIRAC POTNETIAL AS A SOLUTION OF THE POISSON EQUATION

By using the method of generalized functions it has been shown that the Dirac potential for a stationary monopole is a solution of the Poisson equation, where the right-side singularity part is obtained from the expression for current density of a semi-infinite thin solenoid in vanishing to zero its transversal dimensions.

1245. Tomilchik L.M. VINITI(Russ.), No 1656,1977.

LAGRANGIAN FORM-INVARIANCE OF FREE ELECTROMAGNETIC FIELD AND PRESERVING DUAL CURRENT

1246. Tomilchik L.M. Inst.of Phys., Akad.of Sci. Belorussk. SSR, Preprint No 131, 1977.

LIENAR-WICHERT-TYPE POTENTIALS FOR DIRAC MONOPOLE

The relativistically covariant expression for Dirac monopolw potential depending on a constant isotropic four-vector is found. The electromagnetic field of the arbitrarily moving monopole is calculated. Outside the singularity line this field coincides with the field of pointlike magnetic charge.

1247. Toussaint D., Wilczele F. Princeton Univ.,preprint, 1977.

'T HOOFT MONOPOLES IN CARGER GAUGE GROUPS

1248. Trautman A. Int.J.Theor.Phys.,1977, vol.16, No 8, pp.561-565.

SOLUTIONS OF THE MAXWELL AND YANG-MILLS EQUATIONS ASSOCIATED WITH HOPF FIBRINGS

It is shown that the magnetic pole of ,owest strength and the pseudoparticle solution of the Yang-Mills equations corresponding to natural connections defined on the principal bundles $U(2)/U(1)=S_3 \rightarrow S_2$ and $Sp(2)/Sp(1)=S_7 \rightarrow S_4$, respectively. This observation leads to a general method of constructing new, topologically nontrivial solutions of the Maxwell and Yang-Mills equations. Among them is an "electromagnetic instanton" defined over the two-dimensiona complex projective space endowed with the Fubini-Study metric.

1249. Trippe Thomas G., Barbaro-Galtieri A., Horne C.P.,Kelly R.L. Phys.Lett.,1977, vol.B68, No 1, pp.1-30.

NEW PARTICLE SEARCHES AND DISCOVERIES

A supplement to the 1976 edition of "Review of particl properties".

This supplement to the 1976 edition of "Review of particle properties",Particle Data Group (Rev.Mod.Phys.,48, No 2, Part II,1976), contains tabulations of experimental data bearing on the "new particles" and related topics; cat gories covered include charmed particles, ψ's and their decay products, and heavy leptons. Errata to the previous edition are also given.

1250. Vergeles S.N., Khokhlachev S.B. Yad.Fiz.,1977, vol.26, No 4, pp.883-891.

QUANTUM THEORY OF POLYAKOV-'T HOOFT MONOPOLE
(In Russian)

A perturbation theory for the wave functions of the monopole and dyons is developed in the gauge theory with a gauge SU(2) group and Higg's triplet of particles. Small as well as high dyon charges are treated. Excited states of the monopole with non-zero spin are found.

1251. Vergeles S.N., Khokhlachev S.B. Sov.J. Nucl.Phys. (English Transl),1977, vol.26, No 4, pp.463-467.

QUANTUM THEORY OF POLYAKOV-'T HOOFT MONOPOLE

1252. Villervel D. In: GROUP THEORETICAL METHODS IN PHYSICS, V-th International Colloquium in Group Theoretical Methods in Physics, Montreal, Canada,1976. Eds. Sharp R., Kolman B. New York,1977, pp.507-514.

POINCARE GROUP AND MAGNETIC CHARGE

In attempt is made to give a canonical Hamiltonian formulation for a system of classical electric and magnetic charges without the introduction of potentials.

1253. Vinciarelli P. Phys.Rev.Lett.,1977, vol.38, No 21, pp.1179-1182.

COLLAPSE OF FLUX LINES - THE INVISIBLE STRING

Flux bundles with non-zero transverse winding numbers, in spontaneously broken non-Abelian gauge models or electromagnetics with anomalous magnetic moment interactions, collapse to string of vanishing transverse size and vanishi classical energy per unit length. This self-focusing phenomenon, which occurs independently of the strength of coupling constants and other Lagrangian parameters, yields the first example of solition solutions as distributions extended only witnin a manifold of lower dimensionality tha space-time.

1254. Vinciarelli P. Princeton Inst. Adv.Study, Princeton, New Jersey, 1977.

COLLAPSE OF FLUX LINES -THE INVISIBLE STRING

1255. Wadia S.R. Phys.Rev.,1977, vol.15, No 12, pp.3615-3628.

HAMILTONIAN FORMULATION OF NON-ABELIAN GAUGE THEORY WITH SURFACE TERMS: APPLICATIONS TO THE DYON SOLUTION

A Hamiltonian formulation is presented to include long-ranged, topologically nontrivial asymptotic structure, such as the dyon. The variational principle and its implica tions are discussed;a dynamical treatment of boundary condi tions requires the extension of the usual phase space of th non-Abelian gauge theory to include gauge parameters at spatial infinity. A detailed discussion of internal charge rotations is presented; various gauges are discussed. In terms of the well-defined action of surface integrals on canonical variables we formulate a criterion for the admis-sibility of gauge conditions within the Hamiltonian formula tion. A detailed discussion and existence of the Coulomb gauge is presented. The Poincaré invariance of the theory is established.

1256. Wilczek F. In :QUARK CONFINEMENT AND FIELD THEORY, Symposium on Quark Binding,Rochester,1976. Eds.Stump D.R., Weingartee D.H., New York,1977, pp.211-219.

GEOMETRY AND INTERACTIONS OF INSTANTONS

Some work on classical gauge fields is summarized. First it is shown how Rienmannian geometry structures lead to SO(4) gauge structures, and give some applications of this idea. Second, it is shown how the existence of in-equivalent embeddings of SU(2) in larger groups has some remarkable implications for the interactions of instantons (and monopoles).

1257. Wilkinson D., Goldhaber A.S. Phys.Rev.,1977, vol.D16. No 4, pp.1221-1231.

SPHERICALLY SYMMETRIC MONOPOLES

A universal prescription is given for the construction of spherically symmetric monopole solutions for arbitrary groups, and for SU(N) a practical scheme for obtaining minimum-energy solutions is proposed.

1258. Wilkinson D. State Univ. of New York, Stony Brook,1977.

MONOPOLE BOUND STATES: AN SU(4) EXAMPLE

1259. Wilkinson D. Nucl.Phys.,1977, vol.B125, No 3-4, pp.423-444.

MONOPOLE BOUND STATES.AN SU(4) EXAMPLE

Finite energy monopole solutions are studied in SU(4) spontaneously broken to SU(2) XSU(2) XU(1) by a single Higgs field in the adjoint representation. Both the smallest and double strength monopoles which couple only to the U(1) charge are written in a spherically symmetric form, thus allowing the corresponding energies to be coupled numerically. It is found that the mass of the double pole is always more than twice that of the single pole, except in the limit of vanishing scalar self-couplings when it is exactly twice. Analytic solutions are obtained in this limit. The question of the existence of finite energy solutions corresponding to a given spherically symmetric point monopole is discussed.

1260. Wu T,T. and Yang C.N. Phys.Rev.,1977, vol. D16, No 4, pp.1018-1021.

SOME PROPERTIES OF MONOPOLE HARMONICS

Standard properties, including an addition theorem, are proved for monopole harmonics.

1261. Wu Yomg-Shi, Kuo Han-Ying. Scientia Sinica, 1977, vol.20, No 2, pp.186-196.

THE STRUCTURE OF PRINCIPLE BUNDLES FOR DUAL CHARGES IN GAUGE THEORIES

Properties of electromagnetic fields near a magnetic monopole with charge g are considered in terms of the structure of the main nontrivial $Pg(S^2, U_1)$ differentiation over S^2 with a structure group U_1. A topological structure of the $Pg(S^2, U_1)$ main nontrivial differentiation is studied. It is shown that for the $g=1$ minimum magnetic monopole (in 1/2e units) which satisfy the Dirac quantization condition, the main $P_1(S^2,U_1)$ differentiation is isomorphous to the Hopff differentiation S^3 over the S^2 base with a U_1 structure group. At a suitable introduction of a matrix on a group set the main differentiation $P_1(S^2,U_1)$ for a static monopole is a S^3 sphere. For a general case $g=D$ the $P_1(S^2, U_1)$ main differentiation is isomorphous to the $S^3/2_D$ differentiation over the S^2 base with a standard beam U_1^D/Z_D where Z_D is a cyclic subgroup U_1 of the D order. At a suitable introduction of the matrix, the S^2/Z_D is the main differentiation of $P_D(S^2,U_1)$. for a static monopole. The problem of introducing dual charges into the non-Abelian gauge theory is being investigated. By means of a homotopical classification of differentiations over the spheres it is shown that in a SU(2), invariant theory with S^4 E^4, the equivalence classes are characterized by dual charges which correspond to the second Chern class. It is shown that the differentiation is isomorphous to the S^7 Hoppff differentiation. The corresponding gauge potential is a O(S) potential of the SU(2) invariant monopoles or an instantaneous solution in the Yang-Mills theory.

1262. Wu Yong-Shi, Chen Shin, Tu Tung-Sheng, Kuo Han-Ying. Phys.Energ.Fort.Phys.Nucl.,1977, vol.1, pp.52-64.

DUAL CHARGES OF A SUBGROUP IN GAUGE THEORIES-MAGNETIC MONOPOLES OF SU(2) AND SO(3) GAUGE FIELD(In Chinese)

1263. Yang C.N. Ann.N.Y.Acad.Sci.,1977, vol.294, pp.86-97. International Symposium on Five Decades of Weak Interactions, New York,N.Y.,1977.

MAGNETIC MONOPOLES, FIBER BUNDLES, AND GAUGE FIELDS

It is shown that the theory of fiber bundles is not unrelated to the structure of physical world. Starting with a demonstration that electromagnetism and quantum mechanisc together lead naturally to nontrivial fiber bundles, the proof progresses to a trace of the early history of the gauge field concept and its generalization emphasizing three related but different conceptual motivations each of which leads to a general formulation of gauge fields. Also included are magnetic monopoles and their harmonics, and the Hilbert space.

1264. Yang C.N. New York State University, Stony Brook, ITP-SB-77-20, Stony Brook,1977.

GENERALIZATION OF DIRAC'S MONOPOLE TO SU(2) GAUGE FIELDS

1265. Yang C.N. New York State University, Stony Brook, 1977.

MAGNETIC MONOPOLES,GAUGE FIELDS AND FIBER BUNDLES

(talk)

1266. Yonyea T. J.Math.Phys.,1977, vol.18, No 9, pp.1759-1762.

TOPOLOGY OF EUCLIDEAN YANG-MILLS FIELDS: INSTANTONS AND MONOPOLES

1267. Yonyea T. New York City College, CCNY-HEP-77-1, New York,1977.

TOPOLOGY OF EUCLIDEAN UANG-MILLS FIELDS:

INSTANTONS AND MONOPOLES

Heneralizes the topology of instantons and monopoles to higher dimensional space. Some of the work paralles R75.Y.

1268. Yonyea T. New York City College,CCNY-HEP-6,New York, 1977.

STABILITY AND INSTABILITY OF THE WU-YANG SOLUTION OF YANG-MILLS FIELD EQUATIONS

1269. Yock P.C.M. Proceedings of the 18-th International Conference on High Energy Physics, Joint Inst. for Nucl. Research, Dubna,JINR-D1,2-10400, 1977, vol.2, pp.N26-N27.

A POSSIBLE,CONSISTENT IDENTIFICATION OF THE MONOPOLE CANDIDATE OF PRICE ET AL. A HIGHLY ELECTRICALLY CHARGED "QUARK"

Price et al. have recently detected highly ionizing particle in cosmic radiation with unusual characteristics. Three possible identifications have been published for this particle: a magnetic monopole, a fragmenting nucleus, a highly electrically charged "quark". The probabilities for each of the above three possible identifications are considered. According to combinations of mass,electric charg and speed stated by Price($\gtrsim$ 2900 mp,54e,p.48c)($\gtrsim$ 1400 mp,67e, 0.60 c; $\gtrsim$ 3700 mp,50e,0.45 c) the particle would appear to be a good candidate for a highly electrically-charged

"quark". However, until the speed measurement is completely calibrated, no firm conclusion regarding the identity of this particle can be reached.

1270. Yanaya T. Phys.Rev., 1977, vol.D16, No 8, pp.2567-2576.

STABILITY AND INSTABILITY OF WU-YANG SOLUTION OF THE YANG-MILLS FIELD EQUATION

We investigate small perturbations about the spherically symmetric Wu-Yang solution of the Yang-Mills field equation. We show that small nonspherical perturbations are stable. Because of the singularity of the Wu-Yang solution at the origin, S-wave perturbations are not stable. In the case of the Prasad-Sommerfield monopole, we explicitly show that the S-wave perturbations of both natural and unnatural parity are stable.

1271. Zrelov V.P. Joint Institute for Nuclear Research, P13-10876,1977, Dubna.

ON POSSIBLE IMPROVEMENT OF PHOTOGRAPHIC DETECTOR TO SEARCH FOR DIRAC MONOPOLE BY VAVILOV-CHERENKOV RADIATION(In Russian)

Disadvantages of a photographic Cherenkov detector applied for investigation of a composition of cosmic radiation by Z are considered. It is shown that the use of a lens-raster radiator allows to low considerably requirements for a photolayer sensitivity, simplifies the determination of velocity and direction of relativistic nuclei, and makes it possible to search for Dirac's monopole with more reliability.

1978

1272. Ahlen S.P. Phys.Rev.,1978, vol.D17, No 1, pp.229-233.

STOPPING-POWER FORMULA FOR MAGNETIC MONOPOLES

The semiclassical approach of Landau(1960) is used to treat the distant collisions of magnetic monopoles. The energy-loss formula for magnetic monopoles with charge g=137e/2 and 13e which includes the effects of both close and distant collisions is derived. The accuracy of this formula is discussed.

1273. Anandan J. Dept. of Phys. and Astronomy Univ.of Pittsburg, Pittsburg, Pensylvania,1978.

QUANTUM INTEREFERENCE AND THE CLASSICAL LIMIT
(Revised version)

1274. Arcidiacono G. In:TACHYONS,MONOPOLES AND RELATED TOPICS, Procced. of the first session of the interdisciplinary seminars on "Tachyons and Related Topics" held in Erice, Italy, 1-15 sept.,1976. Recami E. Ed., Amsterdam,1978, pp.115-124.

TACHYONS AND MAGNETIC MONOPOLES IN THE
DE SITTER UNIVERSE

The author examines the place of tachyons and magnetic monopoles in the "projective relativity" theory, which is based on the De Sitter universe and which has special relativity as a limiting case. A link with a generalized form of Maxwell's equations is examined in detail, the connection being through the rotation group RU.

1275. Ardalan F. Phys.Rev.,1978, vol.D17, No 4, pp.1131-1135.

CLASSICAL SOLUTIONS OF SO(3,1) GAUGE THEORY

Classical solutions of the Yang-Mills-Higgs field

theory with SO(3,1) gauge group are considered. Two types of electromagnetic field tensors are constructed, one with pure magnetic charge, the other with electric charge. The solutions have zero energy.

1276. Argyres E.N.,Lam C.S. Phys.Rev.,1978, vol.18, No 6, pp.2100-2104.

PHYSICAL MECHANISM FOR QUARK CONFINEMENT VIA PSEUDOPARTICLES

We investigate in detail the physical mechanism whereby confinement is achieved in the (2+1)-dimensional Georgi-Glashow model through a medium of pseudoparticles. The arguments are semiclassical and avoid using the path-integr formalism. We show that vacuum fluctuation produces circula vortex-like electric field lines, which change the classica electric field between two fixed charges into a stringlike confinement field. We also show that when the magnitude of the fixed charges is sufficiently large the string splits longitudinally into two halves, which are more away from each other. Finally, we comment on how confinement may be achieved in Yang-Mills theory in 3+1 dimensions.

1277. Baaklini N.S. Nucl.Phys.,1978, vol.142B, No 4,pp.510-524.

QUANTIZATION OF SUPERPARAMETRIZED MONOPOLES

Classical finite-energy solutions of the SU(2) Yang-Mills-Higgs system in four-dimensional space-time are embedded in the supersymmetric extension of the theory. Finite supertranslations are constructed and are used to obtain a family of solutions to the supersymmetric field equations, parametrized by fermionic Majorana spinor parameters. The quantum theory around arbitrary classical solutions, parametrized by arbitrary bosonic (global and local) as well as fermionic (global) parameter, is constructed and discussed.

1278. Bacry H., Nuytz J. Centre National de la Recherche Scientifique, Centre de Physique Theorique, CNRS-78/p.1027, Marseille,1978.

PURE CLASSICAL SU(2) YANG-MILLS THEORY WITH POTENTIALS INVARIANT UNDER A U(1) GAUGE SUBGROUP

1279. Bais F.A., Weldon H.A. Phys.Rev.Lett.,1978, vol.41, No 9, pp.601-604.

EXACT MONOPOLE SOLUTIONS IN SU(n) GAUGE THEORY

We construct exact monopole and dyon solutions in a renormalizable SU(N+1) gauge theory broken down to SU(N) $\otimes$ U(1) by one Higgs multiplet in the adjoint representation. The solutions saturate the Bogomolny lower bound and are spherically symmetric with respect to the angular momentum operator $\vec{J}=-i\vec{r} \times \nabla + \vec{T}$, where $\vec{T}$ spans the maximal SO(3) subalgebra of SU(N+1). The solutions are obtained after a remarkable factorization of the relevant coupled "nonlinear" second-order radial equations into a product of coupled "linear" first-order equations.

1280. Bais F.A. Phys.Rev.,1978, vol.D18, No 4, pp.1206-1210.

CHARGE-MONOPOLE DUALITY IN SPONTANEOUSLY BROKEN GAUGE THEORIES

The conjecture of Montonen and Olive concerning an electric-magnetic dual symmetry in the O(3) Georgi-Glashow model is generalized to theories with an arbitrary compact gauge group.

1281. Bais F.A. Department of Physics University of Pensylvania PA 19104, Philadelphia, USA,1978.

CHARGE-MONOPOLE DUALITY IN SPONTANEOUSLY BROKEN GAUGE THEORIES

1282. Bais F.A., Weldon H.A. Dept. of Phys.,Univ. of Pensylvania, Philadelphia ,USA,1978.

EXACT MONOPOLE SOLUTION IN SU(N) GAUGE THEORY

1283. Bais F.A. Fermi National Accelerator Laboratory,FERMILAB-Pub-78-77-THY,Batavia,1978.

EXACT SU(N) MONOPOLE SOLUTIONS WITH SPHERICAL SYMMETRY

1284. Balachandran A.P., Borchardt S., Cang S.S., Stern A., Cahalan R., Ramachandran R., Rupertsberger Phys.Rev., 1978, vol. D17, No 4, pp.1136-1149.

ROTATIONALLY INVARIANT APPROXIMATION TO CHARGE-MONOPOLE SCATTERING

A semicalssical approximation derived directly from the Feynman path integral is employed in the study of electric-charge-magnetic-monopole scattering. We show that this approximation, unlike perturbation theory, is consistent with rotational invariance. The semiclassical cross section is explicitly evaluated. It differs from the classical differential cross section for sufficiently large scattering angles due to the interference between the several classical trajectories contributing to the scattering at such angles. It is found that when the scattering angle is not too near the backward direction the semiclassical cross section approaches the classical limit rather slowly as the Dirac quantization number becomes large, or equally as $\hbar \to 0$ with the product of electric and magnetic charges held fixed.

1285. Balachandran A.P., Borchardt S., Stern A., Phys.Rev., 1978, vol.D17, No 12, pp.3247-3256.

LAGRANGIAN AND HAMILTONIAN DESCRIPTIONS OF YANG-MILLS PARTICLES

A new Lagrangian L is proposed for the description of a particle with a non-Abelian charge in interaction with a

Yang-Mills field. The canonical quantization of L is discussed At the quantum level L leads to both irreducible and reducible multiplets of the particle depending upon which of the parameters in L are regarded as dynamical. The case which leads to the irreducible multiplets is the minimal non-Abelian generalization of the usual Lagrangian for a charged point particle in an electromagnetic field. Some of the Lagrangians proposed before such systems are either cases of ours or can be obtained from ours by simple modifications. Our Formulation hears some resemblance to Dirac's theory of magnetic monopoles in the following respects:
1) Quantization is possible only if the values of certain parameters in L are restricted to a certain discrete set, this is analogous to the Dirac quantization condition;
2) In certain cases, L depends on external (nondynamical) directions in the internal-symmetry space. This is analogous to the dependence of the magnetic monopole Lagrangian on the direction of the Dirac string.

1286. Balachandran A.P., Borchardt S., Chang S.S., Stern A., Cahalan R., Ramachandran R., Rupertsberger
Phys.Rev., 1978, vol. D17, No 4., pp.1150-1154.

ANALYTICITY OF THE CHARGE-MONOPOLE SCATTERING AMPLITUDE

We study the analyticity in $\cos\theta$ of the exact quantum mechanical electric-charge-magnetic-monopole scattering amplitude by ascribing meaning to its formally divergent partial-wave expansion as the boundary value of an analytic function. This permits us to find an integral representation for the amplitde which displays its analytic structure. On the physical sheet we find only a branch-point singularity in the forward direction, while on each of the infinitely many unphysical sheets we find a logarithmic branch-point singularity in the backward direction as well as the same forward structure.

1287. Balog J. and Hrasko P. Phys.Rev.,1978, vol.D18, No 12, pp.4802-4805.

EXISTENCE OF MAGNETIC MONOPOLES IN THE UNIFIED FIELD THEORY

It has been stated that a unified field theory proposed recently forbids the existence of magnetic monopoles. We show that this result is the consequence of an unnecessarily stringent condition imposed on the magnetic-monopole solution.

1288. Banks T., Spiegelglas M. Tel Aviv Univ., Dept of Physics, TAUP-717-78, Pamat Aviv,1978.

SPIN DEPENDENT FORCES IN SEMICLASSICAL MODEL OF CONFINEMENT

1289. Bardakci K., Samuel S. Calif. Univ., Dept.of Physics, Berkeley, California,1978.

LOCAL FIELD THEORY FOR SOLITIONS

1290. Bardakci K., Samuel S. Phys.Rev.,1978, vol.D18, No 8, pp.2849-2860.

LOCAL FIELD THEORY FOR SOLITIONS

A method is developed for constructing the Lagrangian that describes the interaction of classical solition solutions. We apply it to the Abelian -Higgs model in 2+1 dimensions and the Georgi-Glashow model in 3+1 dimensions and various features of the relevant Lagrangians are investigated.

1291. Barrcelli N.A. Oslo Univ.,preprint No 5, Oslo,Norway, 1978.

SHORT-RANGE FIELD PROBLEMS CONNECTED WITH MAGNETIC MONOPOLES

It is shown that the main difficulty which has hither-

to prevented the calculation of the energy levels in a system of two magnetic charges is related to the implicit assumption generally applied in the calculation of energy levels, that magnetic monopoles behave as Coulombian point charges. If this assumption is removed, for example, by considering each magnetic monopole an an object whose magnetic charge is distributed in a spherically symmetric fashion within a certain volume with a standard radius comparable to the classical radius, one would have to ascribe to it if one wants to interpret its mass as magnetostatic energy, the problem of calculating the energy levels can be solved. A few examples of coulombian field approximations consistent with this interpretation of magnetic charge distribution are presented, and some of the lowest energy levels of particles formed by the association of two magnetic monopoles are calculated for circular orbits by the Bohr and Sommerfield procedure. Such associations of magnetic monopoles obtain particulary appealing properties for the interpretation of elementary particles if we use the simple assumptions that all magnetic monopoles have the same standard radius and that their masses can be interpreted as magnetic energy,

1292. Barricelli N.A. Oslo Univ., Prerpint No 6, Oslo, Norway, 1978.

MAGNETIC QUARK MODELS FOR THE INTERPRETATION OF THE MASSES OF ELEMENTARY PARTICLES

The energy levels in a system of two magnetic monopoles are applied to the calculation of the masses of elementary particles, on the assumption that the quarks and other partons involved are magnetic monopoles. The calculated masses differ from the correct ones by errors which with few exceptions, are lower than 1%. The models adopted are modified version of a suggestion ascribing to the quarks both electric and magnetic charges. The masses of the magnetic monopoles used are ascribed to their magnetostatic and electrostatic energy. Methods for obtaining approximate mass estimates also for systmes formed by more than two magnetic monopoles are introduced. The assumption

that the quarks could absorb and accasionally interchange a boson of spin=0 and magnetic charge of opposite sign and three times greater than that of a single quark proved useful in the interpretation of meson masses. For the interpretation of barion masses the assumption had to be modified to the effect that the boson was present in each baryon but was not abosrbed by the quarks. An other boson, designated a light boson of spin =0 and magnetic charge 1, was introduced for the interpretation of stangenes. Together with the U-quark of spin 1/2 and magnetic charge 1, this presents a group of three basic monopoles which are used as a basis for the interpretation of elementary particle decay. The magnetic and the electric potential distribution of magnetic monopoles which gives the best fit for the masses of elementary particles is found to be dependent on a parameter, whose optimaé value is the ratio between the Dirac monopole and the product ch, a coincidence which seems rather unlikely to be accidental.

1293. Barker W.A. and Graziani F. Phys.Rev.,1978, vol.D18, No 10, pp.3849-3857.

QUANTUM-MECHANIC FORMULATION OF THE ELECTRON-MONOPOLE INTERACTION WITHOUT DIRAC'S STRINGS

A relativistic wave equation is used to describe the interaction of an electron with a magnetic monopole at rest. A quasipotential, defined in terms of an integral involving the pseudoscalar potential $\varphi_m = \frac{g}{r}$ is used in this Dirac string-free formalism. This equation, written in non-relativistic form, is used in conjunction with the appropriate angular-momentum operators to obtain the Dirac quantization condition. An argument using gauge invariance shows that this condition is not modified by a relativistic treatment. A detailed comparison is made with conventional string theory, which is also formulated relativistically.

1294. Barker W.A., Graziani F. Amer.J.Phys.,1978, vol.46, No 11, pp.1111-1115.

A HEURISTIC POTENTIAL THEORY OF ELECTRIC AND MAGNETIC MONOPOLES

A simple spherical distribution and/or magnetic charge moves with a constant velocity with respect to an observer in the laboratory frame. The electric and magnetic potentials are written in the rest frame of the two types of charge, and in the laboratory frame by means of the Lorentz transformation. The E and H fields are evaluated and are shown to be consistent with Maxwell's equations, generalized to include magnetic charge. In this development a "scalar" rather than a "vector" potential is used to describe the magnetic monopole at rest, thus avoiding "string theory". This approach leads to a more complicated, but still useful form for the classical Lagrnagian.

1295. Bartels J., Buras A.J., Cabibbo N.,Close F.E.,Combridge B.L., De Rujula A., Ellis J.,Florados E.G.,Gaemers K.J.F., Geillard M.K.,Jarlskog C., Kessler P., Kripfganz J., Llewellyn S.C.H., Moshe M., Parisi J., Reignier J., Ross D., A.Sachrajda C.T., Schrempp B., Schrempp F. In: CHEEP-AN P-P FACILITY IN TH SPS, CERN-78-02,pp.39-40, Geneva,1978.

THEORETICAL REMARKS ABOUT E-P COLLISION

1296. Bartlett D.F., Soo D., White M.G. Phys.Rev.,1978, vol.D18, No 7, pp.2253-2261.

SEARCH FOR TACHYON MONOPOLES IN COSMIC RAYS

We have searched for a particle which combines the properties of a tachyon with those a magnetic monopole. The tachyon monopole is assumed to exist in cosmic ray striking the earth and to be influenced by the extensive magnetic fringing field of Fermilab's 15-ft bubble chamber. By hypothesizing that the tachyon monopoles will either emit Cherenkov radiation in air or ionize lexan plastic we set an upper limit of 5×10^{-12} $cm^{-2}s^{-1}$ on their flux.

1297. Barut A.O. J.Phys.A(London),1978, vol.11, No 10, pp.2073-2081.

COVARIANT FIELD EQUATIONS FOR AN ELECTROMAGNETIC STRING WITH MASS POINTS AT THE ENDS

A new set of covariant field equations for the interacting charge-monopole system have been obtained which treats the string singularities of the electromagnetic potentials dynamically. The nonrelativistic monopole potentials are derived from the covariant theory.

1298. Barut A.O. In:TACHYONS,MONOPOLES AND RELATED TOPICS Proc. of the first session of the interdisciplinary seminars on "Tachyons and related topics" held in Erice,Italy, 1-15 Sept.,1976. Ed. Recami E., Amsterdam,1978, pp.227-231.

ELECTRODYNAMICS WITH STRING AND MONOPOLES

The author reviews some newer results in the theory of interacting electric and magnetic charges. The significance of the singularities of the electromagnetic potential is particularly emphasized both in the formulation of a consistent field theory based on Dirac's action principle and in the many other topological and quantum properties of charge-monopole or dyonium systems.

1299. Barut A.O. Lect. Notes Math.,1978, vol.676, pp.179-187.

ELECTROMAGNETIC FIELDS ON MANIFOLDS BETTI NUMBERS, MONOPOLES AND STRINGS,MINIMAL COUPLING

1300. Bazhanov V.V., Borodulin V.I., Pron'ko G.P.,Soloviev L.D. Serpukhov Inst., High Energy Phys.,IHEP-78-135, Serpukhov, 1978.

SMALL ANGLE ELECTRON-MONOPOLE SCATTERING IN QUANTUM THEORY OF DIRAC-SCHWINGER MONOPOLE

(In Russian)

An amplitude for small angle electron-monopole scattering has been obtained in the framework of the quantum theory of Dirac-Schwinger magnetic monopole. The amplitude obtained satisfies the requirement of relativistic invariance.

1301. Bender C.M., Eguchi T., Pagels H. Phys.Rev.,1978, vol.D17, No 4, pp.1086-1096.

GUAGE-FIXING DEGENERACIES AND CONFINEMENT IN NON-ABELIAN GAUGE THEORIES

Following several suggestion of Gribov we have examined the problem of gauge-fixing degeneracies in non-Abelian gauge theories, First we modify the usual Fadeev-Popov prescription to take gauge-fixing degeneracies into account. We obtain a formal expression for the generating functional which is invariant under finite gauge transformations and which consists gauge-equivalent orbits only once. Next we examine the instantaneous Coulomb interaction in the canonical formalism with the Coulomb-gauge condition. We find that the quantum of the Coulomb Green's function in an external monopole-like field configuration has an accumulation of negative-energy bound states at E=0. Using semi-classical methods we show that this accumulation phenomenon which is closely linked with gauge-fixing degeneracies, modifies the usual Coulomb propagator from $|\vec{k}|^{-2}$ to $|\vec{k}|^{-4}$ for small $|\vec{k}|$. This confinement behaviour depends only on the long-range behaviour of the field configuration. we thereby demonstrate the confinement property of non-Abelian gauge theories in Coulomb gauge.

1302. Blagojevič M., Nešič D., Senjanovič P., Šijački D., Živanovič D. Phys.Lett.,1978, vol.79B, No 1/2,pp.75-78.

A NEW APPROACH TO THE QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

We propose a formulation of quantum field theory of electric and magnetic charge closely patterned after Dirac' quantum-mehcanical theory. This formulation possesses an

extremely transparent canonical structure and picture of the physical photon degrees of freedom.

1303. Bollini C.C. and Ferreira Leal P. Nucl.Phys.,1978, vol. B137, No 3, pp.351-358.

ON THE MOTION OF A CHARGED PARTICLE IN THE FIELD OF A MAGNETIC MONOPOLE

A quantum-mechanical treatment of the motion of a charged particle in the field of a fixed magnetic monopole is given, based on a representation of the corresponding vector potential by means of a distribution. The results are closely similar to those obtained in the work of Wu and Yang, which stems from ideas borrowed from mathematical fiber bundle theory. We believe that our method follows more closely the usual quantum mechanical procedures and provides an alternative approach to that of Wu and Yang. Although the present paper deals with the non-relativistic problem, it is clear that the extension to the case of a Pauli or Dirac particle can be easily done using spinor monopole harmonics.

1304. Bona C., Fustero X., Mas L. Phys.Rev.,1978, vol.D18, No 12, pp.4770-4779.

DYON-DYON INTERACTION IN PREDICTIVE RELATIVISTIC MECHANICS

We present systematic study of the dyon-dyon classical interaction in the framework of predictive relativistic mechanics. A uniquely defined expression for the accelerations of the system is obtained up to first order in the coupling constants. We analyze the symmetry properties of the system under discrete symmetries and obtain explicit expressions for P^{μ} and $J^{\lambda\mu}$ of this order. Furthermore, we find a family of bound states with circular orbits that seems to be a generalization of the well-known exact solution of Schild. The scattering problem is also treated and second-order expression for the cross sections are given which agree, by taking the appropriate limits, with the one previously found by Barut and Beker and also with

the one obtained by Bel in the framework of a quantized version of predictive relativistic mechanics for spinless particles.

1305. Boultaleb J.H., Chakrabarti A. Centre de Physique Theoretique Ecole Polytechnique, C.N.R.S.-A 292.0378, Palaisean Cedex,France,1978.

KERR-SCHILD GEOMETRY SPINORS,AND INSTANTONS

1306. Boya L.J., Corinena J.F., Mateos J. Fortschr. Physik, 1978, vol.26, pp.175-214.

HOMOTOPY AND SOLITIONS

1307. Brachet M.E., Tipapegui E. Instituut voor Theoretische Fysick Univ. Leuven, KUL-TF-78-011, Leuven, Belguim,1978.

ON THE INTERACTION OF CLASSICAL FIELDS AND PARTICLES

1308. Brachet M.E., Tipapegui E. Nuovo Cim.,1978, vol.47A, No 2, pp.210-230.

ON THE INTERACTION OF CLASSICAL FIELDS AND PARTICLES

The interaction of a classical field with general tensorial character with a particle described by its trajectory is shown to lead in general to a Lorentz-Dirac-typé equation, independently of the details of the interaction. The divergences of the theory are carefully analyzed by a method we have proposed before, which is shown to be equivalent to other regularization schemes that have been used previously. We apply our results to several well-known interactions including lineaorized gravitation and symmetric electrodynamics with monopoles.

1309. Brandt R.A., Neri F., Zwanziger D. Phys.Rev.Lett.,1978, vol.40, No 3, pp.147-150.

LORENTZ INVARIANCE OF THE QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

A gauge-invariant Green's function approach is used to indicate the Lorentz invariance of electric and magnetic charges, in local quantum field theory.

1310. Brandt R.A., Neri F. New York Univ., NYU-TR4-78, New York,1978.

NON-ABELIAN GAUGE INVARIANT CLASSICAL LAGRANGIAN FORMALISM FOR POINT ELECTRIC AND MAGNETIC CHARGES

1311. Brandt R.A., Neri F., Zwanziger D. New York Univ., NYU-TR7-78, New York,1978.

LORENTZ INVARIANCE FROM CLASSICAL PARTICLE PATHS IN QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

1312. Brandt R.A., Young K. London Univ., Queen Mary Coll., preprint,1978.

ELECTRIC-MAGNETIC DUALITY AS A SECONDARY SYMMETRY

1313. Brandt R.A., Neri F. Phys.Rev.,1978, vol.D18, No 6, pp.2080-2090.

REMARKS ON ZWANZIGER'S LOCAL QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

1314. Brandt R.A., Neri F. Nucl.Phys.,1978, vol. B145,No 1, pp.221-253.

NON-ABELIAN GAUGE INVARIANT CLASSICAL LAGRANGIAN FORMALISM FOR POINT ELECTRIC AND MAGNETIC CHARGE

1315. Brandt R.A. and Primack J.R. New York University Conference on Monopoles,1978. Int.J.Theor.Phys.,1978, vol.17, No 4, pp.267-273.

THE SPIN STATISTICS CONNECTION FOR DYON

Goldhaber's spin-statistics connection for electric-pole-magnetic-pole composite "dyons" is deduced in a gauge-invariant way by connecting the spatial interchange operator wit a rotation.

1316. Bruce D.J. Nucl.Phys.,1978, vol.B142, No 3, pp.253-257.

BÄCKLUNG TRANSFORMATIONS AND MAGNETIC MONOPOLES

We show that a recent solution of an SU(2) gauge theory, claimed to be a 3-monopole solution, is in fact an infinite-energy solution.

1317. Callan C.G., Dashen R., Gross D. Princeton Inst.Adv. Study, Princeton,1978.

PHASE TRANSITIONS IN QCD AS TUNNELING THROUGH SINGUALR BARRIERS

1318. Callan C.G., Dashen R., Gross D. Phys.Lett.,1978, vol. B77, No 3, pp.270-274.

PHASE TRANSITIONS IN QCD AS TUNNELING THROUGH SINGULAR BARRIERS

We show that the phase transition of QCD, chiral symmetry breaking and confinement, can be interpreted physically as tunneling through (infrared) singular barriers. The appearance of monopoles in QCD and the properties of massless fermions in a meson field are discussed in the context of this interpretation.

1319. Callias C. Commun.Math.Phys., 1978, vol.62, No 3, pp.213-234.

AXIAL ANOMALIES AND INDEX THEOREMS ON OPEN SPACES

Using an approach isospired by the theory of the anomalous divergence of the axial vector current, we derive trace formulas for the resolvents of Dirac operators on open spaces of add dimension. These formulas readily yield index theorems for these operators. As applications we determine the index of the Dirac operator for a particle of arbitrary isospin in the background of a static system of SU(2) monopoles; and we find formulas in essentially closed form for certain determinants involving these operators.

1320. Carmeli M., Charac C., Kaye M. Nuovo Cim.,1978, vol.45B, No 2, pp.310-334.

NULL-TETRAD FORMULATION OF THE YANG-MILLS FIELD EQUATIONS

The Ynag-Mills dynamical variables in the presence of gravitation are presented in terms of new variables by means of a null-tetrad and spin coefficient method. The Yang-Mills equations in curved space are consequently written in the null-tetrad method. The resulting equations then resemble the Newman-Penrose version of Maxwell's equations extended to a non-Abelian gauge group. A special consideration is then given to the flat-space case, thus recovering the usual Yang-Mills theory, but now written in the null-tetrad method. The advantages of the new approach to the Yang-Mills equations are illustrated by considering the problem of exact solutions of these equations both in the presence and in the absence of gravitation.

1321. Carrigan R.A.,Jr., Strauss B.P., Giacomelli G. Phys.Rev.,1978, vol. D17, No 7, pp.1754-1757.

SEARCH FOR MAGNETIC MONOPOLES AT THE CERN INVESTIGATING STORAGE RINGS

In a search for magnetic monopoles produced in high-energy PP collisions, a series of metallic collectors was exposed at an intersection region of the CERN Intersecting Storage Rings to an integrated luminosity Lt $\simeq 7.2 \times 10^{37}$ cm^{-2}. The search was sensitive to poles with a mass $m_g \leq$

30 GeV. For $m_g < 20$ GeV, the search yielded an upper-limit cross section of $\sigma < 1.3 \times 10^{-37} cm^2$ (95% confidence level) for $0.2 \leq g \leq 1.2$ Dirac magnetic charges; for $1.2 < g < 24$ the limit is $\sigma \lesssim 4 \times 10^{-37}$ cm^2.

1322. Chakrabarti A. Centre de Physique Theoretique Ecole Polytechnique, C.N.R.S.-Palaisean Cedex,France,1978.

INTRODUCTION TO CLASSICAL SOLUTIONS OF YANG-MILLS FIELD EQUATIONS

1323. Cheng Kuo-Shung Phys.Rev.,1978, vol.D18, No 2, pp.549-551.

CLASSICAL LAGRNAGIAN THEORY WITH RADIATIVE REACTION: EXTENSION OF THE ROHRLICH TWO-FIELD FORMALISM TO INCLUDE MONOPOLES

We give an action integral $L(x, X, A_\mu, a_\mu)$. The stability of L agianst the variations $\delta A_\mu(\xi), \delta a_\mu(\xi), \delta x_\mu(\theta), \delta X_\mu(\tau)$ give us the coupled maxwell euqations and the Lorentz-Dirac equation for the positron and monopole.

1324. Chernavskii D.S. and Kerner R. J.Math.Phys.,1978, vol.19, No 1, pp.287-291.

REMARKS ON THE ASYMPTOTIC BEHAVIOUR OF THE 'T HOOFT'S MAGNETIC MONOPOLE

We investigate the asymptotic behaviour of the 't Hooft's solution at $r \to 0$ and $r \to \infty$. Using the methods of the qualitative theory of ordinary differential systems, we are able to derive the asymptotic form of the solution up to a higher approximation than in 't Hooft's original paper G.'t Hooft, Nucl.Phys.,B79, 276(1974)), as well as show that the Prasad-Sommerfield's exact solution can be considered as an analytical limit of the 't Hooft's solution for $\mu^2 \to 0, \lambda \to 0$. Some remarks on the stability of the monopole close the paper.

1325. Cox P.H., Yildiz A. Phys.Rev.,1978, vol. D18, No 4, pp.1212- 1215.

BOUND STATES WITH A GAUGE MONOPOLE

Relativistically exact bound states of a Dirac spinor and of a scalar with an SU(2) gauge monopole are determined asymptotically for arbitrary (integer or half-integer)isospin. Independently, zero-energy bound states of the Dirac spinor are proved to exist for each value of total angular momentum J less than the isospin T. The spin of the system is shown to be the sum of the original spin and isospin of the bound particle.

1326. D'Adda A., Horsley R., Di Vecchia P. Phys.Lett., 1978, vol.B76, No 3, pp.298-302.

SUPERSYMMETRIC MAGNETIC MONOPOLES AND DYONS

The authors construct the supersymmetric generalization of the 't Hooft-Polyakov magnetic monopole and of the Julia-Zee dyon. It is shown that the quantum corrections to the monopole mass are vanishing as a consequence of the supersymmetry of the theory.

1327. D'Adda A., Horsley R., Di Vecchia P. Niels Bohr Institutet, Copenhagen Univ., NBI-HE-78-8, Copenhagen,Denmark, 1978.

SUPERSYMMETRIC MAGNETIC MONOPOLES AND DYONS

1328. Dai Xion-Xi, Guan-Jiong Ni Phys.Energ. Fort.Phys.Nucl., 1978, vol.2, pp.225-235.

ON THE ELIMINATION OF PHASE ANGLE UNCERTAINTY IN SOME PROBLEMS OF RELATIVISTIC QUANTUM MECHANICS
(In Chinese)

1329. Dai Xion-Xi, Phys.Energ.Fort.Phys.Nucl.,1978,vol.2, No 4, pp.305-310.

ON THE ENERGY LEVELS AND THE STATIONARY STATES OF

1330. Dattoli G. and Mignani R. Lett.Nuovo Cim.,1978,vol.22, No 2, pp.65-68.

FORMULATION OF ELECTROMAGNETISM IN A SIX DIMENSIONAL SPACE-TIME

A preliminary formulation of electromagnetism in a six dimensional space-time with three time-coordinates is given. It is shown that such a formalism provides a further support to the hypothesis by Mignani and Recami that charged techyons in an E.M. field behave as magnetic monopoles.

1331. Dattoli G. and Mignani R. L'Aquilla Univ.,INFN,LNF-77-58, Italy, 1978.

FORMULATION OF ELECTROMAGNETISM IN A SIX DIMENSIONAL SPACE-TIME

1332. DeVega H.J. Phys.Rev.,1978, vol.D18, No 8, pp.2932-2944.

FERMIONS AND VORTEX SOLUTIONS IN ABELIAN AND NON-ABELIAN GAUGE THEORIES

The interaction of fermions with an extended vortex solution of the Higgs model is investigated. It is found that this interaction has a long-range inverse-square tail. It is caused by the coupling of the fermion angular momentum with the vortex gauge field itself. The fermion-vortex bound states present at the threshold and the fermion-vortex scattering are studied. The scattering phase shifts and the lost functions are obtained for large and small fermion momenta as well as the low-energy cross section which diverges at zero momentum. The quantum field theory in the one-vortex sectors is developed. It is found that in the presence of fermions, a vortex with an even (odd) number of flux quanta has a half-integer(integer) formionic number. It follows that a two-quantum vortex is stable.

Finally, the stable vortex solution of an SU(2) Higgs model is investigated. The appropriate ansatz for the field is given and radial equations are discussed. It is shown that the interaction of a vortex with any nonsinglets particle has a long-range inverse-square total.

1333. Dirac P.A.M. Int.J.Theor.Phys., 1978, vol.17, No 4, pp.235-247.

THE MONOPOLE CONCEPT

1334. Dirac P.A.M. In: DIRECTIONS IN PHYSICS, Lectures delivered during a visit to Australia and New Zealand, August-September 1975. Ed. Hora H. and Shepanski J.R., New York, 1978, pp.39-54.

MAGNETIC MONOPOLES

A firsthand account is given of fundamental developments for which Dirac presents his views on basic physical concepts, providing historical insight on their generation and consequences. Basic, remarks are made on quantum mechanics and quantum electrodynamics with insight into cosmological theories and the development of the magnetic monopole.

1335. Deons W. Glashow Univ., Preprint 1978.

STRINGS IN GAUGE THEORIES

1336. Dobson P.N., Jr., and Tuan S.F. Phys.Rev., 1978, vol.18, No 1, pp.296-302.

SCHWINGER'S PHENOMENOLOGICAL AND DYON DESCRIPTIONS FOR THE NEW PARTICLES

A phenomenological description proposed by Schwinger to avoid $\Delta Y=1$ neutral currents predicted particles much akin to the J/ψ variety prior to their experimental

recognition. When supplemented with a hypothetical magnetic-dyon model of matter, a natural setting is provided for the newly discovered ψ particles. We extend Schwinger's earlier suggestions to cover more recently discovered states (D,D*, F,F*, γ) and their baryon analogs, using the magnetic-U-spin approach. A key test which differentiates the present description from charm theory is the existence of a relatively narrow I=1, $J^{PC}=1^{--}$ ψ " nearly mass degenerate with the established ψ' (3,684). Could it be the recently discovered state ψ''(3.772)?

1337. Duff M.J., Madore J. Phys.Rev.,1978, vol.18, No 8,pp.2788-2797.

EINSTEIN-YANG -MILLS PSEUDOPARTICLES AND ELECTRIC CHARGE QUANTIZATION

Solutions of the euclidean-space Einstein-Yang-Mills equations are presented which describe a dyon black hole of mass M , angular momentum J, electric charge Q_e, and magnetic charge Q_m. In addition to the usual magnetic-charge quantization rule $e\Theta_m = m$ (m =integer), the space-time topology of the euclidean black hole, in particular the periodicity in the time coordinate, leads to a new electric-charge quantization $e\Theta_e = n(1-r_c/r_+)$,where n integer regarded as a (non-self-dual) Einstein-Yang-Mills pseudoparticle, the solution has finite action, a gravitational Euler number χ =2, and SU(2) number P =2mn.

1338. Durgaprasad N., Rev M.V.S. Pramana,1978, vol.10, No 2, pp.131-141.

A NEW INTERPRETATION OF AN EVENT ATTRIBUTE TO A MAGNETIC MONOPOLE

An alternate and a new interpretation is given for the event attribute to a magnetic monopole by Price and co-workers found in an emulsion plastic sandwich stack flown from Siouz city, Iowa, USA, on 18 sept.1973. The electron πK^- and stripping cross-sections of nuclei of Z approximately 70-80 and v approximately 0.6 ÷ 0.7c in lexan

polycarbonde are evaluated using the formula given by Nikolaev. It is shown that the corresponding mean free paths are of the order of thickness approximately 250) of lexan plastic sheets used by them. In such a case a snapshot of these processes is believed to have been observed in plastic sheets. Monte-carlo simulations of the events have been made for three values of charges at the top of the main lexan stack, namely Z=83,78 and 70 respectively. The event is thus interpreted as a cosmic ray nucleus of Z=70÷ 83 and ϑ =0.6 ÷ 0.7c losing and capturing electrons (mainly the latter) as it passes through the stack. The probability of the occurrence of such an event is estimated by several methods.

1339. Einhorn M.B. and Savit R. Phys.Lett.,1978, vol.B77, No 3, pp.295-298.

FLUX LOOPS: MORE NEW HEAVY PARTICLES IN THE WEINBERG-SALAM MODEL

A lattice version of the Abelian -Higgs model is studied in arbitrary Euclidean dimension. Using an exact duality transformation, the theory is rewritten in terms of its topological excitations. The dual form of the theory specifies in a simple way all the allowed topological excitations as well as their interactions. The combination of th scalar Higgs field and the Abelian gauge field produces excitations found neither in the pure gauge theory nor in the pure scalar theory (XY model). In three dimensions, for example, we find finite vortex strings terminating on monopoles, as well as closed vortex loops. Implications of these singularities for the critical behaviour of the theory are briefly discussed.

1340. Einhorn M.B., Savit R. Phys.Rev.,1978, vol.D17, No 10, pp.2583-2594.

TOPOLOGICAL EXCITATIONS IN THE ABELIAN -HIGGS MODEL

Extending Nambu's suggestion that there are stringlike classical solutions in the Weinberg-Salam model, we argue that flux includes closed tori of weak neutral (Z^o)flux.

1341. Ellis J. In: WEAK INTERACTIONS-PRESENT AND FUTURE, Stanford,1978, pp.108-111.,SLAC-Pub-2177,1978.

1342. Englert F., Windey P. Nucl.Phys.,1978, vol.135, No 3, pp.529-545.

ELECTRIC CONFINEMENT AND MAGNETIC SUPERCONDUCTORS

Reinterpretation of the pioneering work of Nielsen and Olesen and others on magnetic confinement in (electric) superconductors leads to simple models which exhibit electric confinement of the type hoped for in quantum chromodynamics. "Electric", flux tubes joining "qaurks" arise at a semi-classical level as a result of the existence of (pseudo) particles. The theory can be described in terms of a classical action principle only upon suitable modification of the action; this modification has profound topological significance as it is intimately related to the quantization condition for (pseudo)particles.

1343. Englert F. and Winley P. Université Libre de Brouxelles, Bruxelles, Belgium,1978.

DYNAMICAL AND TOPOLOGICAL CONSIDERATIONS ON QUARK CONFINEMENT

1345. Ezawa Z.F. Muenchen Max-Planck-Inst. für Phys.,and Astrophys., MPI-PAE-PTH 23-78, Muenchen,1978.

QUANTUM SOLITION OPERATORS FOR MONOPOLES AND A FERMION-BOSON PUZZLE

1346. Ezawa Z.F. Phys.Rev.,1978, vol.D18, No 6, pp.2091-2099.

QUANTUM SOLITION OPERATORS FOR VORTICES AND SUPERSELECTION RULES

We propose a quantum field theory of vortex solitions in the canonical formalism. Using the fact that the topolo-

gical charge, regarded as an operator, commutes with all local operators, we obtain a superselection rule structure of Abelian and non-Abelian -Higgs models in 2+1 dimensions. Lorentz-invariant vortex sectors are constructed as non-vacuum representations of the canonical commutation relations The intertwining operator between the vortex sector and the vacuum sector is indentified to be a quantum vortex operators

1347. Falik D., Opher R. Phys.Rev.,1978, vol.D18, No 7, pp.2694-2697.

POSSIBLE EXISTENCE OF FRACTIONAL CHARGES AND MAGNETIC MONOPOLES IN MATTER

A model is suggested which explains the discovery of fractional electric charges, in spite of the former failures to find quarks and quark-confinement theories; the model does not need many new assupmtions about the fractionally charged particles. According to this model, the fractionally charged particles came from the decomposition of naturally occurring bound pairs of oppositely charged magnetic monopoles. Such bound pairs were suggested by the authors in a recent article in this journal to explain other phenomena.

1348. Falik D., Opher R. Phys.Rev.,1978, vol.D17, No 3, pp.923-926.

COMMENT ON THE PRODUCTION OF HIGH-MASS LOW-VELOCITY MAGNETIC MONOPOLES IN THE ATMOSPHERE

It is pointed out that the monopole candidate event of Price et al.(1975) is not inconsistent with production by collision of a bound pair of monopoles with an atmospheric nucleus-one with mass of thousands of GeV, the other mass of several GeV.

1349. Ferrari E. In: TACHYONS,MONOPOLES AND RELATED TOPICS, Proceed. of the first session of interdisciplinary seminar on "Tachyons and related topics", held in Erice,Italy, 1-15 sept.1976. Ed. Recami E., Amsterdam,1978, pp.203-225.

FORMULATION OF ELECTRODYNAMICS WITH MAGNETIC MONOPOLES

The term "magnetic monopole" is used in different instences, in order to describe physical objects that have a common propoerty (they bear what can be called a "magnetic charge") but are different things. The most popular objects is still the traditional monopole, postulated by Dirac on the basis of a straightforward extension of the Maxwell's equations one can use the name "Maxwell-Dirac monopole" for it. The author restricts his discussion to these traditional Maxwell-Dirac monopoles, which alone provide a rich possibility to study and discussion.Furthermore, it is just this type of monopole that experimentalist have been trying to detect (so far, without success).A survay of the various formulations of the monopole theory is presented.

1350. Fradkin E., Susskin L. Phys.Rev.,1978, vol.D17, No 10, pp.2637-2658.

ORDER AND DISORDER IN GAUGE SYSTEMS AND MAGNETS.

We show how phase transitions in Abelian two-dimensional spin and four-dimensional gauge systems can be understood in terms of condensation of topological objects. In the spin systems these objects are links and in the gauge systems either magnetic monopoles or fluxoids (quantized lines of magnetic flux). Four models are studied: two-dimensional I_{sing} and XY models and four- dimensional Z_2 and U(1) gauge systems.

1351. Fradkin E., Susskin L. Stanford Linear Accelerator Center, SLAC-Pub-2069, Stanford,1978.

ORDER AND DISORDER IN GAUGE SYSTEMS AND MAGNETS

1352. Finkelstein D. New York Univ. Conference on Monopoles, 1978. Int.J.Theor.Phys., 1978, vol.17, No 4, pp.293-299.

HOLISTIC METHODS

1353. Frank I.M. Joint Inst. for Nucl.Research,JINR,Dubna, 1978. P4-11777.

TRANSITION RADIATION OF THE MAGNETIC CHARGE
(In Russian)

Theoretical investigation of the transition radiation of a magnetic charge is carried out similarly to that of an electric charge. Formulas obtained for the spectral intensity and polarization were analysed for the two cases: perpendicular and inclined incidence of a magnetic charge on the boundary surface.

1354. Freund P.G.O. New York University Conference on Monopoles,1978, Int.J. Theor.Phys.,1978, vol.17, No 4, pp.301-308.

MONOPOLES,TOPOLOGY, SYMMETRY

1355. Freund P.G.O. Chicago Univ.,EFI-78-01, Chicago,1978.

MONOPOLES,TOPOLOGY,SYMMETRY

1356. Friedman J.L., Mayer S., Parker L. Phys.Rev.,1978, vol.D17, No 8, pp.1957-1964.

ANGULAR MOMENTUM AND DIRAC CHARGE QUANTIZATION
IN CURVED SPACETIME

We consider the angular momentum of two dual charged particles in an axisymmetric spacetime and of a single dual charged test particle in a charged axisymmetric background. In each instance we find the component of angular momentum along the symmetry axis has the same value EQGR-ERGQ that it takes in flat spacetime.

1357. Giacomelli G. IFUB-78-16, Bologna,Italy,1978.

SEARCHES FOR MASSING PARTICLES

1358. Galitsky V. Veda Tech.SSSR,1978, vol.6, No 2,pp.93-96.

DISCOVERY OF THE MONOPOLE
(In Czech)

An experiment is described conducted in Berkeley in which the magnetic monopole was first detected. The objections are reported of prof.Fowler and prof.Alvarez, permitting a different interpretation of experimental data.

1359. Gliozzi F. Nucl.Phys.,1978, vol.141, No 4, pp.379-390.

STRING-LIKE TOPOLOGICAL EXCITATIONS OF THE ELECTROMAGNETIC FIELD

In order to analyze the topological properties of an arbitrary configuration of the electromagnetic field, its strength $F^{\lambda}_{\mu\nu}$ is expressed in terms of new auxiliary fields which replace the gauge potential A_μ .These new fields have only physical singularities even in the presence of monopoles (no Dirac strings) and exhibit a new local O(1,1) symmetry which replaces the gauge invariance, Boundary conditions on these fields may induce localized string-like singularities or topological defects which act as sources of magnetic field. A typical defect which emerges is a sort of tadpole formed by a nonquantized monopole attached to one or more magnetic strings of finite length For topological reasons the total magnetic charge is quantized.

1360. Goddard P., Olive D.I. Rep.Progr.Phys.,1978, vol.41, No 9, pp.1357-1437.

MAGNETIC MONOPOLE IN GAUGE FIELD THEORIES

An account is given of the new insight into the theory of magnetic monopoles originated from the work of 't Hooft (Nucl. Phys.,1974, vol.B79, p.276) and Polyakov (JETP Lett.,

1974, vol.20,p.194). Their magnetic monopoles, associated with the conventional electromagnetic gauge group U(1) occur as a finite-energy smooth solition solution to an SU(2) gauge theory. A precise picture of its internal structure, the values of its magnetic charge and its mass are obtained. These new developments bring together previously unrelated fields of study, namely, the Dirac monopole with point structure and the Sine-Gordon solition in two-dimensional space-time. Properties of more general monopoles, associated with large gauge groups now thought to be relevant in physics, are discussed. Particular attention is paid to topological properties. Based on this new viewpoint, conjuctures can be made about a future quantum theory of monopoles.

1361. Goddard P., Olive D.I. European Organization for Nuclear Research, CERN-TH-2445, Geneva,1978.

NEW DEVELOPMENTS IN THE THEORY OF MAGNETIC MONOPOLES

1362. Goddard P. In:TOPICS IN QUANTUM FIELD THEORY AND GAUGE THEORIES, Proceed. of the VIII International Seminar on Theoretical Physics, held by GIFT in Salamanca,1977, Ed. de Azcarraga J.A., Berlin,1978, pp.1-38.Lecture notes in Physics, vol.77.

MAGNETIC MONOPOLE AND RELATED OBJECTS

1363. Hegedues S. Seminar of theoretical physics, University of Timisoara ,1977. Timisoara,1978, pp.95-144.

CLASSICAL ELECTRODYNAMICS WITH TWO KINDS OF CHARGES

1364. Hart F.X.,Massey J.S. Am.J.Phys.,1978, vol.46, No 5, pp.587-588.

MAGNETIC MONOPOLE MOBILITY SPECTROMETER

1365. Goldberg J.N., Jang Pong Soo , Park Soo Yong, Wali K.C. Phys.Rev.,1978, vol.D18, No 2, pp.542-548.

INTERACTION BETWEEN 'T HOOFT-POLYAKOV MONOPOLES

We use the stress-energy tensor and the associated energy-momentum conservation to study the interactions between two widely separated monopoles (or monopole and antimonopole). By defining a set of minimal conditions to represent the above systems we show how the problem reduced mathematically to a known electrostatic problem. The force between the monopoles (or monopole and antimonopole) is then, in the leaning order, the expected repulsive(attractive Coulomb force. We also discuss how the Prasad-Sommerfield limit alters the problem, leading to twice the Coulomb force between a monopole and antimonopole and zero force between two monopoles.

1366. Hirata K. Tsukuba Univ., UTHEP-38, Tsukubo,1978.

CLASSICAL LAGRANGIAN THEORY OF DIRAC'S MONOPOLE AVOIDING DIRAC'S VETO

Defenition of Dirac's action for a charge-monopole system as a certain limit of Wu-Yang's action solves Dirac's veto problem. The string variable $Y^{\mu}(\tau,\sigma)$ plays an essential role in the variation principle.

1367. Hirayama M., Hsiung Chia Tze Phys.Rev.,1978, vol.D17, No 2, pp.546-556.

NAMBU MECHANICS OF NON-ABELIAN DYONS

Nambu's generalized mechanics is appropriate for the description of non-Abelian dyons-solutions are given for the gauge groups U(1),SU(2), and SU(3) to illustrate.

1368. Hasenfratz P., Ross D.A. Phys.Lett.,1978, vol.74B, No 4-5, p.432.Erratum.

ARE QUARKS SHORT RANGE SOLITONS?

1369. Hoffmann H. Lett.Nuovo Cim.,1978, vol.23, No 10, pp.357-360.

A NEW SEARCH FOR MAGNETIC MONOPOLES AT THE CERN-ISR WITH PLASTIC DETECTORS

1370. Honda M. Dept. of Phys., Tohoku Univ., TU-78-185, Sendari, Japan,1978.

FIBER BUNDLE ANALYSIS OF GLOBAL FEATURE OF GAUGE FIELD THEORY

1371. T'Hooft G. Nucl.Phys.,1978, vol.B138, No 1,pp.1-25.

ON THE PHASE TRANSITION TOWARDS PERMANENT QUARK CONFINEMENT

In quantized gauge field theories one can introduce sets of operators that modify the gauge-topological structure of the fields but htose physical effect is essentially local. In 2+1 dimensional non-Abelian gauge theories these operators form scalar fields and it is argued that when the local gauge symmetry is not spontaneously broken then these topological fields develop a vacuum expectation value and their mutual symmetry breaks spontaneously. It is shown that qaurks are then permanently confined. In 3+1 dimensional non-Abelian gauge theories one fonds that the topological operators and the gauge field operators form a closed algebra from which it is deduced that this system can be in one of four different phases. 1. Spontaneous breakdown via an explicit or composite Higgs field. 2. No Higgs field but permanent confinement of gauge quantum numbers.3.Higgs effect and still confinement, presumably only if there is unbrojen subgroup, and 4. An intermediate phase (critical point) with massless particles. Finally, the algebra can be realized in a simple model where phases 1 and 2 can be obtained from each other by a dual transformation.

1372. Horndeski G.W. J.Math.Phys.,1978, vol.19, No 3, pp.668-674.

BIRKHOFF'S THEOREM AND MAGNETIC MONOPOLE SOLUTIONS FOR A SYSTEM OF GENERALIZED EINSTEIN-MAXWELL FIELD EQUATIONS

In this note I establish a "Birkhoff's type theorem" for the most general second-order vector-tensor theory of gravitation and electromagnetism, which is such that its field equations are (i) derivable from a variational principle,(ii) consistent with the notion of conservation of charge,(iii) compatible with Maxwell's equations in a flat space, and (iv) in agreement with Einstein's equations in the absence of electromagnetic fields. I also present solutions to these field equations which can be regarded as representing the gravitational and electromagnetic field outside a magnetic monopole. It turns out that these magnetic monopole solutions admit event horizons when the mass of the source is sufficiently large.

1373. Horvath Z., Palla L. International Center for Theor. Physics, IC-78-37, Trieste,1978.

SPONTANEOUS COMPACTIFICATION AND "MONOPOLES" IN HIGHER DIMENSIONS

1374. Horvath Z., Palla L. Nucl.Phys.,1978, vol.B142, No 3, pp.327-343.

SPONTANEOUS COMPACTIFICATION AND "MONOPOLES" IN HIGHER DIMENSIONS

Using the Wu-Yang global description, the minimal gauge group is found which compactifies the extra even D dimension into a sphere, namely SO(2N). These gauge theory solutions are associated with non-vanishing topological charges. An SO(2N) gauge theory solution is obtained in D=2N+1 dimension which describes a genralized singular magnetic monopole which conforms to the Yang definition.

1375. Hosoda M., Kozakai H. Progr.Theor.Phys.,1978, vol.59, No 6, pp.2080-2095.

CONVERSION OF ISOSPIN DEGREE OF FREEDOM INTO SPIN DEGREE OF FREEDOM

After reviewing briefly canonical quantization for coupled Yang-Mills field to matter field within Coulomb gauge, it is studied in detail that isospin degree of freedom is converted into spin degree of freedom in the field of the Yang-Mills-Higgs magnetic monopole. Comments are made on the behaviour of static and classical solutions for Yang-Mills-Higgs theory and also on surface effects, which appear in the total angular momentum.

1376. Hrasko P., Balog J. Nuovo Cimento,1978, vol.45B, No 2, pp.239-254.

ROTATIONAL SYMMETRY IN THE HAMILTONIAN DYNAMIC

The motion of a mass point in a central potential is considered. It is usually assumed that the projection of the angular momentum on the radius vector is equal to zero. It is shown that if this assumption is relaxed, the angular part of the Hamiltonian becomes identical to the angular part of the monopole Hamiltonian given by Dirac.

1377. Hruby J. Joint Inst. for Nucl.Research, JINR-E2-11950, Dubna,1978.

ON THE SUPERSYMMETRIC SOLITONS AND MONOPOLES

The basic result in a new trend in supersymmetry and soliton theory are presented. It is shown that the soliton expectation value of the energy operator is mass of the soliton without the quantum corrections. A new supersymmetric monopole model in three dimensions is constructed by generalization of the supersymmetric Sine-Gordon model in one space dimension.

1378. Hsu J.P. Found.Phys.,1978, vol.8, No 9, pp.667-675.

OBSERVABLE PHASE FACTORS AND SYMMETRY OF ELECTRIC AND MAGNETIC CHARGES

The observable phase factor is taken as a basic concept for the description of electromagnetism. Generalization of this concept to SU(2) and SU(2) x U(1) groups is carried out in such a way that the monopoles with quantized charges appear naturally and that the symmetry between the electric and magnetic phenomena is preserved. Some physical implications are discussed,

1379. Hsu J.P. Space Science Laboratory, NASA/Marshall Space Flight Center,78-132,Huntsvill, Alabama,1978.

STATIC YANG-MILLS FIELD WITH A FINITE ENERGY AND ITS PHYSICAL IMPLICATIONS

The static SU(2) gauge field $B^a_\mu(x)$ postulated to satisfy the physical boundary conditions that B^a_μ should be finite at the origin $\vec{r}=0$ and vanish as $r \to \infty$ because there is no divergence in nature. A modified Wu-Yang solution has been found and its "source" is $r^{-1} d\delta(r-L)/dr$. The interpretations of the solutions as the magnetic monopole and the dyon with finite energies are discussed. Furthermore, the finite classical solution sheds some light on a quantum theory free from divergences. It suggests that the Feuman propagator for B^a_μ should be modified to the form $-\delta_{ab}\, g_{\mu\nu} \vec{K}\, J(K)$ where $J = \cos(-k^2L^2)^{1/2}$ for $K^2 = K_0^2 - \vec{K}^2 < 0$ and $J = \exp[-(K^2L^2)^{1/2}]$ for $K^2 > 0$ This will lead to a change of the high-energy behaviour due to the exchange of gluons between quarks in hadron physics.

1380. Inomata A., Trinkala M.J. Phys.Rev.,1978, vol.D18, No 6, pp.1861-1867.

CHARGE QUANTIZATION IN CURVED SPACE-TIME

Charge quantization is studied in the Kaluza-Klein background. First the scalar field obeying the Klein-Gordon equation in the six dimensional Kaluza-Klein-Hoffmann space is reduced to the Mandelstam field for an electrically and magnetically charged particle. The singularity argument of

Wu and Yang is then incorporated into the Cabibbo-Ferrari formalism to derive the quantization condition $e\tilde{e} - e\tilde{e} = n/2$ (n =integer) in a manner independent of the background curvature.

1381. Jang Pong Soo, Park Soo Yong, Wali K.C. Phys.Rev.,1978, vol. D17, No 6, pp.1641-1650.

CONCERNING AXIALLY SYMMETRIC MONOPOLE-TYPE SOLUTIONS

We study axially symmetric static, finite-energy solutions to Yang-Mills-Higgs field equations. The Lagrangian consists of a triplet of Higgs fields and a triplet of gauge fields and has local SO(3) gauge invariance. The solutions can describe, in principle, field configurations with arbitrary monopole charge. Although we have not found analytic solutions to the coupled partial differential equations involving sin unknown dunctions, we do find consistent solutions in the asymptotic region as well as in the region near the axis of symmetry. We investigate the cylindrically symmetric configuration which is a particular case of our axially symmetric formulation and demonstrate that a vortex-type solution exists. We thus have a non-Abelian version of the Nielsen-Olesen model. We discuss the relevance of this vortex-type solution to our axially symmetric system and present plausibility arguments concerning the emergence of a non-Abelian stringlike configuration.

1382. Jang Pong Soo, Park Soo Yong, Wali K.C. Syracuse Univ., SU-4211-101, New York,1978.

CONCERNING AXIALLY SYMMETRIC MONOPOLE-TYPE SOLUTIONS

1383. Ju I. Phys.Rev.,1978, vol.17, No 6, pp.1637-1640.

SOME EXACT DYON SOLUTIONS FOR THE CLASSICAL YANG-MILLS FIELD EQUATION

Systematic means of finding solutions to the spontaneously-broken theory in Minkowski space are proposed,based on an anszts for the self-dual sourceless Euclidean theory.

1384. Kadanoff L.P. J.Phys.A,1978, vol.11, No 7, pp.1399-1417.

LATTICE COULOMB GAS REPRESENTATIONS OF TWO-DIMENSIONAL PROBLEMS

Many of the standard two-dimensional problems of statistical physics can be transformed into "Coulomb gas" problems in which there two kinds of "charges" represented by integers n and m. Such a transformation works for the Ising model, the three-and four- state Jotts models, the Askin-Teller model, and many others. In general the n-n and m-m interactions have the Coulombic character in which the interaction is, for large separations proportional to the logarithm of the distance. On the other hand, the $n(\vec{r})-m(\vec{R})$ interaction is for large distances proportional to i times the angle $\Phi(\vec{r}-\vec{R})$ which measures the angular position of $\vec{R}$ relative to $\vec{r}$. This latter interaction is akin to that between a magnetic monopole and an electric charge.

1385. Kalb M. Phys.Rev.,1978, vol.D17, No 10, pp.2713-2716.

MAGNETIC MONOPOLES IN A GAUGE FIELD THEORY FROM VORTEX STRINGS

A realization of the antisymmetric tensor and vector potentials, having the open dual vortex string as a source, is shown to be given by the fields of the 't Hooft-Polyakov model. The non-Abelian gauge tranformations map into Abelian transformations characterized by a Minkoski vector and scalar. Magnetic current conservation is assured.

1386. Kalb M. Phys.Rev.,1978, vol.18, No 8, pp.2909-2913.

TIME-INDEPENDENT YANG-MILLS STATISTICS

We investigate classical Yang-Mills theory with sources in the limit of no time dependence and find a class of "Abelian" solutions with non-vanishing magnetic field, even without spatial source-current density. The field is due

to nontrivial point magnetic monopoles of topological origin.

1387. Kalb M. Center for Theor. Phys., Massachusetts Inst. of Technology, CTR-716, Cambridge, 1978.

TIME-INDEPENDENT YANG-MILLS STATISTICS

1388. Kamat R.V. Nuovo Cimento, 1978, vol. B43, Ser. 2, No 1, pp. 141-150.

DIRECT ACTION AND MAGNETIC MONOPOLES

In the absence of any experimental support, starting from some reasonable assumptions based on the previous theoretical considerations about monopole-monopole and charge-monopole interactions, it is shown that it is not possible to derive the equations of motion from an action principle, for both electric charges and magnetic monopoles, in the framework of classical electrodynamics of direct interparticle action. Maxwell's equations of the equivalent field theory exist and are contained in the suitably defined potentials of direct interparticle action. This seems to imply that the existence of magnetic monopoles is incompatible with action-at-a-distance electrodynamics.

1389. Kamata M. Progr. Theor. Phys., 1978, vol. 59, No 4, pp. 1346-1360.

SINGULAR GAUGE TRANSFORMATIONS AND MONOPOLE-VORTEX-LINE SYSTEMS

Semi-infinite and finite monopole-vortex-line systems are constructed from the Nielsen-Olesen SU(2) Higgs model. We clarify a connection between the Nambu model and the Nielsen-Olesen U(1) and SU(2) Higgs models in terms of singular gauge transofrmations. It is shown that under the singular gauge transformation Ω the field tensor $F_{\mu\nu}$ acquires an additional non-zero term $-(i/e)\Omega(\partial_\mu\partial_\nu - \partial_\nu\partial_\mu)\Omega^{-1}$ which leads to Dirac's strings. The behaviour of the gauge potential and the Higgs scalars is discussed near

the axis of symmetry and at large distances from the vortex line.

1390. Kazama Y. New York Univ.Conference on Monopole,1978. Int.J.Theor.Phys.,1978, vol.17, No 4, pp.249-265.

DYNAMICS OF ELECTRON-MONOPOLE SYSTEM

1391. Kirznits D.A. Uspekhi Fiz. Nauk,1978, vol.125, pp.169-194.

SUPERCONDUCTIVITY AND ELEMENTARY PARTICLES
(In Russian)

1392. Lee Hua-chung, Kuo Shuo-hung, Hsien Ting-chang Phys.Energ.Fortis & Phys.Nucl.(China),1978, vol.2,No1, pp.23-34.

ON THE PROBLEM OF THE DUAL CHARGE (MAGNETIC MONOPOLE) OF NON-ABELIAN GROUPS.II. (In Chinese)

The method of relating the gauge potential to the connection on a spherical surface developed previously is generalized to the discussion of the potential of an SU(2) magnetic monopole with O(5) symmetry. Expressions for the potential of the monopole with double string singularity or single string singularity are obtained. Finally by a combined coordinate-gauge transformation the authors obtain a string free expression for an SU(2) magnetic monopole with O(5) symmetry.

1393. Lee Tze-Ping Phys.Energ.Fort.Phys.Nucl.,1978, vol.2, pp.378-381.

ON CLASSICAL ANGULAR MOMENTUM OF AN ELECTRON-MAGNETIC MONOPOLE(In Chinese)

Contribution to angular momentum from static electron-magnetic monopole total angular momentum and from electric and magnetic moments are derived.These contributions were

found to be equivalents to the change in electron mass.

1394. Leinaas J.M. Physica Scripta(Sweden),1978, vol.17 , No 5, pp.483-486.

A MECHANICAL MODEL OF THE CHARGE-MONOPOLE SYSTEM

The motion of a spinning particle, whose spin is constrianed to point towards a fixed point in space, is identical to that of a charged particle moving in a magnetic monopole field. Qunatization of this mechanical system is straightforward. In contrast to the quantum description of the charge-monopole system, no singularities are present. Only when suppressing the cyclic spin coordinate,a singularity corresponding to the "Dirac string" of the magnetic monopole will arise.

1395. Leinaas J.M. Nuovo Cim. A,1978, vol.47, No 1,pp.19-34.

STATISTIC OF CHARGE-MONOPOLE COMPOSITES

A formalism is described in which the symmetry of the wave functions of identical particles is related to the presence of a global gauge effect. The formalism is used to investigate in detail the statistics of composite particles which are bound systems of a charged particle and a magnetic monopole. For such composites the phase factor which determines their statistics can be shown to be influenced by the gauge field which is present.

1396. Leznov A.N., Sarelev M.V. Serpukhov Inst.High Energy Phys., IFVE-78-176,Serpukhov,1978.

EXACT MONOPOLE SOLUTIONS IN GAUGE THEORIES FOR AN ARBITRARY SEMISIMPLE COMPACT GROUP

1397. Lohe M.A. Nucl.Phys.,1978, vol.B 142, No 3, pp.236-252.

MAGNETIC MONOPOLES AND BÄCKLUND TRANSFORMATIONS

We display Bäcklund transformations for the equations which describe SU(2) magnetic monopoles in the limit of a vanishing potential. With these transformations we obtain a real, exact solution describing a three-monopole system, possessing cylindrical symmetry. However, due to gauge-invariant singularities, the system has infinite energy.

1398. Maciejko R. J.Math.Phys.,1978, vol.19, No 12, pp.2491-2493.

YANG-MILLS EQUATIONS IN MAXWELL FORM

1399. Madore J. Phys.Rev.,1978, vol.D17, No 2, pp.562-564.

ANGULAR MOMENTUM AND MAGNETIC CHARGE

The angular momentum of a scalar isodoublet in the field of a magnetic monopole is expressed in gauge-invariant form.

1400. Magruder S.F. Phys.Rev.,1978, vol.D17, No 12, pp.3257-3261.

CLASSICAL INTERACTIONS OF 'T HOOFT MONOPOLES

We find upper bounds on the interaction energies between two 't Hooft monopoles and between a monopole and an anitmonopole. Our results may alter the confinement picture in the Georgi-Glashow model for certain small values of the Higgs mass parameter.

1401. Magruder S.F. Phys.Dept.Univ.of Illinois,Ill-(TH)-78-2, Urbana,1978.

THE CLASSICAL INTERACTIONS OF 'T HOOFT MONOPOLES

1402. Mandelstam S. Calif.Univ.,Berkeley,1978. 64 p.

CHARGE MONOPOLE DUALITY AND THE PHASES OF NON-ABELIAN GAUGE THEORIES

1403. Manton N.S. Nucl.Phys.,1978, vol.B135, No 2, pp.319-332.

COMPLEX STRUCTURE OF MONOPOLES

Instanton techniques are applied to the classical monopole equations. The Prasad-Sommerfield monopole is rederived in a curious way, and new complex solutions are found, representing a distorted monopole.

1404. Marciano W. and Pagels H. Phys.Reports(Section C of Phys.Lett.),1978, vol.36, No 3, pp.137-276.

QUANTUM CHROMODYNAMICS

Quantum chromodynamics (QCD) is a quantum field theory of the strong interaction with non-Abelian gauge fields mediating the interactions between quarks.The experimentally observed strong interactions are to be epiphenomena of these fundamental interactions. The experimental successes of QCD form the basis for our present optimism that a theory of the strong force has been found. However, QCD is still very unre liable to default on both experimental and theoretical grounds In this article we offer the reader a review of the properties and attempted solutions of QCD. Each section of this review can be read independently of others. In the introduction we describe the properties of QCD and the hoped for confinement and PCAL phase transitions. This is followed by a section on the renormalization of non-Abelain gauge field theories: the functional methods and the path integral, the BPHZ program, the BRS transformation and proof of renormalizability, the Slavnov-Taylor identies and Schwinger-Dyson equations.The renormalization group equations are derived and applied to physical processes. Two dimensional prototypes of QCD, the Abelian-Schwinger model and 2-D QCD, are reviewed.An extensive review of the perturbative development of QCD is given with emphasis on infrared divergences, exponentiation of leading logarithms, the Cornwall-Tiktopoulos equation and a non-perturbative approach to QCD. A self-contained section on topological solitons follows with disenssion of homotopy theory, vortices,monopoles and especially instantons,and

the periodic vacuum. Recent results, the attempt to study phase transition in QCD using the dilute gas approximation and Borel resummations in QCD, are examined. Most of the major areas of interest in QCD are covered in this review: the prime exceptions are lattice gauge theories and phenomenological QCD like the parton and potential models.

1405. Marciano W.J. New York University Conference on Monopoles,1978.Int.J.Theor.Phys.,1978, vol.17, No 4, pp.275-286.

MAGNETIC MONOPOLES AND NON-ABELIAN GAUGE THEORIES

We review some properties of magnetic monopoles in non-Abelian gauge theories. Removal of Dirac string singularities and generalizations of the Wu-Yang solution that follow tromfhis procedure are described.A discussion of the possible relevance of monopoles in strong interaction models and their role in quark confinement schemes is given.The magnetic monopole soliton discovered by 't Hooft and Polyakov the first order formalism developed by Bogomol'ny, and extensions of these ideas are illustrated.

1406. McKeon G. Phys.Rev.,1978, vol.D17, No 2, pp.557-561.

GAUGE-INDEPENDENT FORMULATION OF MAGNETIC MONOPOLES

Mandelstam's gauge-independent treatment of electrodynamics provides a model for a similar gauge-independent study of the Dirac monopole introduced by Cabbibo and Ferrari (1962).

1407. McKeon G. Can.J.Phys.,1978, vol.56, No 9,pp.1195-1201.

SELF-COUPLED VECTOR FIELDS

By use of Dirac's quantization procedure for constrained systems,it is possible to derive the Schwinger treatment of magnetic monopoles from a Lagrangian. A generalization of this Lagrangian leads to a self-coupled vector field.The techniques used are also applied to an extended Yang-Mills Lagrangian based on Zwanziger's local Lagrangian theory of

of magnetic monopoles. These systems exhibit CP violation.

1408. McKeon G. Can.J.Phys.,1978.,vol.56, No ,pp.656-658.

PATH DEPENDENT FORMULATION OF AN EXTENDED YANG-MILLS SYSTEM

1409. Mecklenburg W., O'Brien D.P. Phys.Rev.,1978,vol.D18, No 4, pp.1327-1328.

TIME-DEPENDENT PROPERTY OF THE PRASAD-SOMMERFIELD MONOPOLE

We show that Prasad-Sommerfield solution for the 't Hooft monopole can be transformed to an exact time-dependent solution (which is singular on the light cone) of the SU(2) Yang-Mills-Higgs system.

1410. Mignani R. Lett.Nuovo Cim.,1978, vol.22, No 15, pp.597-600.

GRAVITATIONAL ANALOGUES OF MAGNETIC MONOPOLES FROM THE PATH-DEPENDENT FORMALISM

It is shown within the framework of the path-dependent approach to the gravitational field, gravitational "magnetic" monopoles (i.e. sources of the dual Riemann tensor) arise straightforwardly from a consistency requirement for the theory. Moreover, their existence implies a local violation of energy-momentum conservation law. Implications of gravitational monopoles existence are briefly considered.

1411. Mignani R. In:TACHYONS,MONOPOLES,AND RELATED TOPICS. Proc. of the first session of the interdisciplinary seminars on "Tachyons, and related topics", held in Erice,Italy, 1-15 sept.,1976. Ed. Recami E.,Amsterdam,1978, pp.67-78.

QUATERNIONS AND LORENTZ TRANSFORMATIONS

In the last years, it was argued by some authors that number systems with non-commutative multiplication laws can provide a deeper physical insight into many open theoretical

problems. The generalization of the Lorentz group to transformations with faster-than-light speed parameters(the so-called "extended theory of relativity") has shown itself-apart from the real existence of tachyons - to be a useful tool in order to deal, within a purely classical (i.e. relativistic but non quantum-mechanical) framework, with antiparticles, discrete symmetries, CPTU covariance, and so on. Therefore, it seems worthwhile looking for possible connections between non-commutative number systems and "superluminal" Lorentz transformations. In this paper, the author reviews how Lorentz transformations (both subluminal and superluminal) have been translated in quaternion languag Besides, some considerations are made on possible,further developments of the theory, according to the suggestions by the group properties of quaternionic (generalized) Lorentz transformations(QGLT).

1412. Mignani R. Instituto di Fisica G.Marconi, Univ.' di Roma, I.N.F.N.,Roma,1978.

PATH-DEPENDENT APPROACH TO GRAVITATIONAL MONOPOLES

We discuss the possibility of introducing gravitational analogues of magnetic monopoles(i.e. sources of the dual Rieman tensor) into Einstein's equations, in the framework of Mandelstam's path-dependent formulation of gravitational field. It is shown that by this approach, gravitational mono poles arise straightforwardly from a consistency requirement for the theory. Moreover, thier existence implies a local violation of energy-momentum conservation law.Possible consequences and developments of the theory are considered.

1413. Milton K.A., De Raad L.L.,Jr. J.Math.Phys.(USA),1978, vol.19, No 2, pp.375-382.

STRINGS AND GAUGE INVARIANCE

Considers the quantum theory of magnetic charges.The two-body Schrödinger equation with a line of singularities (string) is solved for an arbitrary position of the string.

Charge quantization is then a consequence of the requirement that the wave function is single-valued. Formulations in terms of vector potentials and of intrinsic spin are compare and found to imply gauge invariance.

1414. Mottola E. Phys.Lett.,1978, vol.B79, No 3, pp,242-244.

ZERO MODES OF THE 'T HOOFT-POLYAKOV MONOPOLE

The zero energy eigenvalue problem for quantum fluctuations about the 't Hooft-Polyakov monopole solution is solved explicitly in the Prasad-Sommerfield limit, by exploiting the formal similarity with self-dual euclidean field configurations. The relevance of the results to the spin of the quantized monopole is examined.

1415. Mottola E. Columbia Univ.,Dept. of Phys., CU-TP-142, New York,USA,1978.

NORMALIZABLE SOLUTIONS TO THE DIRAC EQUATION IN THE PRESENCE OF A MAGNETIC MONOPOLE

The zero energy Dirac equation of a massless isovector particle in the background field of the 't Hooft-Polyakov magnetic monopole is shown to have only two normalizable solutions.

1416. Nahm W. Phys.Lett.,1978, vol.B79, No 4/5, pp.426-428.

THE INTERACTION ENERGY OF 'T HOOFT MONOPOLES IN THE PRASAD-SOMMERFIELD LIMIT

In the Prasad-Sommerfield limit of vanishing Higgs mass the size of 't Hooft monopoles increases when they interact with each other.For monopoles of like charges, their interaction energy decreases at least with the fourth power of the distance.

1417. Nahm W. European Organization for Nuclear Research, CERN-TH-2550,Geneva,1978.

THE INTERACTION ENERGY OF 'T HOOFT MONOPOLES IN THE PRASAD-SOMMERFIELD LIMIT

1418. Nambu Y. New York Univ.Conference on Monopoles,1978. Int.J.Theor.Phys.,1978, vol.17, No 4, pp.287-292.

SOME TOPOLOGICAL CONFIGURATIONS IN GAUGE THEORIES

A Higgs vacuum field ϕ is characterized by the set of conditions $D_\mu \phi = 0$, which lead to a generalized Meissner effect and partially determine the vector potential A_μ in terms of ϕ. Applyign this method to the Weinberg-Salam theory we assert that there exist stringlike configurations in which a pair of magnetic poles are bound by a flux string of the Z° field, with an energy scale in the TeV range.We also point out that pure gauges in non-Abelian gauge theories are not well-defined due to topological singularities.In order to be meaningful, they must be enlarged to a class of almost pure gauges which include the various known topological configurations.

1419. Nambu Y. The Enrico Fermi Inst.,Univ.of Chicago,EFI-78-13, Chicago,1978.

TOPOLOGICAL PROBLEMS IN GAUGE THEORIES

1420. Oh C.H. Progr.Theor.Phys.,1978, vol.59, No 2, pp.678-680.

DYONS IN THE WEINBERG-SALAM UNIFIED GAUGE THEORY

1421. Oh C.H. Penang Malaysia Univ., preprint,1978.

DYONS IN THE WEINBERG-SALAM UNIFIED GAUGE THEORY

1422. Oh C.H. Phys.Rev.,1978, vol.18, No 12, pp.4817-4818.

NOTE ON A CLASSICAL SOLUTION FOR 'T HOOFT MONOPOLE AND THE JULIA-ZEE DYON

A real stable solution for the SU(3) Ynag-Mills field coupled to the Higgs field is constructed from a complex

sourceless solution of the Yang-Mills equation. It has the same properties as the Prasad-Sommerfield solution except for a singularity at the origin.

1423. Oh C.H. Penang Malaysie Univ.,preprint,1978.

A NOTE ON CLASSICAL SOLUTION FOR THE 'T HOOFT MONOPOLE AND THE JULIA-ZEE DYON

1424. Olive D. Imperial College,Dept. of Theor.Phys.,ICTP-77-78-20,London,1978.

LECTURE ON MAGNETIC MONOPOLES

1425. Olive D. Imperial College,Dept.of Theor.Phys.,ICTP-78-78-5, London,1978.

THE ELECTRIC AND MAGNETIC CHARGES AS EXTRA COMPONENTS OF FOUR MOMENTUM

1426. O'Raifeartaigh L., Rawnsley J. Phys.Lett.,1978, vol.B72, No 4, pp.465-470.

MASS-SPECTRUM FOR MONOPOLES OF INTEGRAL ISOSPIN. BAG-MODEL AS THE HIGH ISOSPIN LIMIT

In two or three space dimensions solutions of the Yang-Mills-Higgs equations with finite energy $0 < E < \infty$ and unit topological charge exist for all SO(2) and SO(3) representations of the Higgs field, and hence define a mass spectrum E(I) where I is the Casimir of the representation. It is shown that E(I) increases monotonically with I, but tends to a finite limit as $I \to \infty$ and that in this limit, the system becomes a bag model, in which the massive gauge fields are completely confined and the Higgs field plays the role of a surface tension.

1427. O'Raifeartaigh L. Dublin Inst.Advanced Studies,preprint Dublin,1978.

FINITE ENERGY SOLUTIONS OF GAUGE THEORIES

1428. Ozaki S. Preprint, Jan.1978.

QUANTUM FIELD THEORY OF MAGNETIC CHARGES II.
TWO-DIMENSIONAL SPACE THEORY OF MAGNETIC MONOPOLES

1429. Parisi G. In: TACHYONS,MONOPOLES AND RELATED TOPICS, Proc. of the first session of the interdisciplinary seminars on "Tachyons, and Related Topics", held in Erice, Italy, 1-15 Sept.,1976. Ed. Recami E., Amsterdam,1978, pp.233.

NON-CONVENTIONAL MONOPOLES IN FIELD THEORY

Published in summary form only.

1430. Pestov A.B. Joint Inst. for Nuclear Research,JINR P2-11630, Dubna,1978.

THEORY OF MAGNETIC CHARGE(In Russian)

If the problem of magnetic charge is attempted to analyse within the framework of the Ampere hypothesis, then it can be established what is the field of non-zero magnetic charge and what are equations of this field. The main conclusions are as follows: there exist four independent types of particles with magnetic charge which compose an unique family each of such particles has also an electric charge; in processes involving particles with magnetic charge the parity violation should be observed. The problem of the deutron magnetic charge is discussed as well.

1431. Price P.B., Shirk E.K., Osborn W.Z. and Pinsky C.S. Phys.Rev.,1978, vol.D18, No 5, pp.1382-1421.

FURTHER MEASUREMENTS AND REASSESSMENT OF THE MAGNETIC -MONOPOLE CANDIDATE

A possible event of magnetic monopole formation in a stack of 35 lexan detectors and in 3 layers of nuclear emulsion is discussed. New data of new gauge measurements is given.

1432. Rajput B.S., Parkash O. Indian J. Pure and Appl. Phys., 1978, vol.16, No 6, pp.593-597.

SYMMETRIES OF GENERALIZED ELECTROMAGNETIC FIELDS

1433. Ramsay N.F. Inst. of Physics., Conference series No 42, Bristol, 1978.

FUNDAMENTAL PHYSICS WITH REACTOR NEUTRONS AND NEUTRINOS

1434. Rossi P. Pisa Scuola NormSup., S.N.S.7-78, Italy, 1978.

PROPAGATION FUNCTIONS IN THE FIELD OF A MONOPOLE

1435. Ružička J. Joint Inst. for Nuclear Research, JINR P2-11338, Dubna, 1978.

CONNECTION BETWEEN THE SPIN MAGNETIC MOMENT OF ELECTRON AND THE DIRAC MONOPOLE (In Russian)

It is shown that the theoretical value for the spin magnetic moment of electron μ is the product of a magnetic charge value g, predicted by Dirac, and a classical electron radius r_e.

1436. Ryder L.H. Physics Laboratory, Univ. of Kent, Canterbury, England, 1978.

DIRAC MONOPOLES, INSTANTONS AND HOPF MAPS

It is shown that in the presence of bare (Dirac) magnetic charges, the S^1 gauge transformations of electromagnetism are fibres over S^2, with total space S^3, and the magnetic charge is the Hopt invariant of the map $S^3 \rightarrow S^2$. The nature of the construction makes it clear that instantons are simply higher dimensional analogues, and described by the Hopf map $S^7 \rightarrow S^4$, the fibre S^3 corresponding to Yang-Mills gauge transformations

1437. Sawada T. Progr. Theor. Phys., 1978, vol. 59, No 1, pp. 149-158.

PROPOSAL TO SONFIRM THE STRONG VAN DER WAALS INTERACTION IN LOW ENERGY P-P SCATTERING

It is shown that the low energy p-p data, especially the Wisconsin data, already indicate the existence of the strong long-range force acting between the nucleons, which is expected to occur in the magnetic monopole model of hadrons. In arriving at the conclusion, the detailed information concerning the two-pion exchange spectrum is not requir It is proposed to measure accurately the angular distributio of proton-proton scattering at low energy (0.1 MeV $\leq T \leq$ 25 MeV), and to estimate the power; of the long-range tail of the extra nuclear potentials: $V^{extra}(r) \sim -Gr^{-\beta}$.

1438. Sawada T. Institute of Physics, Univ. of Tsukuba, Ibaraki Japan, 1978, UTHEP-34.

PRESENT STATUS OF THE STRONG VAN DER WAALS FORCE IN THE HADRON-HADRON SCATTERING

Existence of the strong Van der Waals force between hadrons is expected in the magnetic monopole model of hadrons The long-range potential $V(r) \approx -C/r^4$ for large r implies the singularity $C't^2$ of the scattering amplitude $A(\nu,t)$. The pion-pion and the nucleon-nucleon scattering data are analysed in search of such a singularity at t=0. P-wave amplitudes are the most convenient place to find the singularity since at $\nu=0$ $a_1(\nu)/\nu$ have a cusp $C''\nu \ln(\nu)$. From the cusp of the π-π amplitude of $\ell=1$ the coefficien of the Van der Waals potential is determined: $C=3.1$ in $\mu_\pi=1$ unit. On the other hand the cusp of the cnetral P-wav amplitude of the proton-proton scattering, after separating the Coulomb and the vacuum polarization effect, gives C=10. also in $\mu_\pi=1$ unit. It is pointed out that the very precis data of p-p scattering at $0.3 < T < 1$ MeV also suggest the existence of the long-range attractive force. Implications of the discovered strong Van der Waals force in the hadron physics are discussed.

1439. Schiff H. J.Phys.,1978, vol.11, No 1, pp.173-177.

COLLINEAR TOPOLOGICAL MONOPOLES AND TOPOLOGICAL LINES

Starting with the magnetic field of an arrangement of magnetic monopoles on a line we construct an appropriate uni isovector and gauge fields. We find examples of monopoles connected by topological lines where the total pole strength must be integral but the individual monopoles neeed not be integers.

1440. Schlitt D.W. Physica A (Netherlands),1978, vol.91, No 1-2, pp.133-138.

A MANIFESTLY GAUGE-INVARIANT HAMILTONIAN FORMULATION OF CLASSICAL ELECTRODYNAMICS INCLUDING MAGNETIC MONOPOLES

The formulation of classical electrodynamics of Balescu and Poulain(1974) is extended to include magnetic monopoles. It is found that this can be done consistently if it is assumed that a magnetic charge and an electric charge never occupy the same space time point.

1441. Scott D.M. International Center for Theoretical Physics, ICTP/78-79, Trieste,1978.

ON THE EXISTENCE AND SMOOTHNESS OF SPHERICALLY SYMMETRIC MONOPOLE SOLUTION IN NON-ABELIAN GAUGE THEORIES

1442. Silvie P.,Weiss N. Stanford Linear Accelerator Center SLAC-PUB-2147, Stanford,1978.

CLASSICAL YANG-MILLS THEORY IN THE PRESENCE OF EXTERNAL SOURCES

1443. Silvie P.,Weiss N. Phys.Rev.,1978, vol.D18, No 10, pp.3809-3821.

CLASSICAL YANG-MILLS THEORY IN THE PRESENCE OF

EXTERNAL SOURCES

We study in detail the classical Yang-Mills field equations in the presence of static external sources. Their formulation as an initial-value problem in the $A_o = 0$ gauge provide as with a powerful tool for determining the existence of new solutions. In the case of point sources, the only static solutions known so far are the various Coulomb solutions which we classify according to their total energy and isospin. In the case of a localized but extended source, there are, besides the well-known Coulomb solution, two new types of solutions: the "magnetic dipole" solution which has the long-range behaviour of a magnetic dipole field and which has lower enrgy than the Coulomb solution when the total external charge is large enough, and the "total sceening" solution which has no long-range field strengths at all and which can have an arbitrarily low energy. We present a detailed study of these new solutions.

1444. Silvie P., Weiss N. Phys.Rev.Lett., 1978, vol.40, No 22, pp.1411-1413.

SCEENING SOLUTIONS TO CALSSICAL YANG-MILLS THEORY

We present two new solutions to the classical Yang-Mills equations in the presence of a localized external source. Those solutions totally screen the charge of the source. They have lower energy than the corresponding Coulomb solution.

1445. Silvie P., Weiss N. Stanford Linear Accelerator Center, SLAC-PUB-2101, Stanford, 1978.

SCEENING SOLUTIONS TO CALSSICAL YANG-MILLS THEORY

1446. Sinha A. Ph.D.Thesis, Columbia Univ., New York, USA, 1978. University microfilms order No 78-19,434.

GAUGE THEORY MONOPOLE SOLUTIONS

The simplest examples of monopole solutions in a SU(3) gauge theory corresponding to the generators of the homotopy goups. These monopoles are characterized either by two-Abeloan magnetic charges, when the residual symmetry group H is U(1) x U(1) or by combined Abelian and non-Abelian magnetic charges when the residual symmetry group is U(2). The magnetic charges do not always satisfy the Dirac quantization condition but do satisfy a genralized quantization condition. The Poincare group transformations in the presence of monopole solutions in gauge theories using the canonical formalism developed by Christ,Guth and Weinberg. It is shown that the infinitesimal transformations generated by the Dirac brackets with the generators, defined,as usual, by the Belinfente tensor satisfy the Poincare group algebra, in a particular version of axial gauge.

1447. Slad L.M. J.Nucl.Phys.(Russ.),1978, vol.27, No 5, pp.1417-1419.

NEUTRINO AS A SOURCE OF AXIAL ELECTROMAGNETIC FIELD(In Russian)

1448. Stone M.,Thomas P.R. Phys.Rev.Lett.,1978, vol.41,No 6, pp.351-353.

CONDENSED MONOPOLES AND ABELIAN CONFINEMENT

We show that contribution of monopole loops to the functional integral in four-dimensional lattice (quantum electrodynamics) can be mapped on to scalar quantum electrodynamics. The phase transition where the monopole loops become very long then corresponds to the onset of the Higgs-Kibble mechanism and confinement due to the dual Meissner effect.

1449. Stone M.,Thomas P.R. Cambridge Univ.,Dept.of Applied Mathematics and Theoretical Physics, DAMTP-78/7,1978.

CONDENSED COMONOPOLES AND QUARK CONFINEMENT

It is shown that contribution of monopole loops to

the functional integral in Q.E.D. can be mapped on to scalar Q.E.D. The phase transition where the monopole loops become very long then correspond to the onset of the Higgs-Kibble mechanism.

1450. Stone M.,Thomas P.R. Dept. of Applied Mathematics and Theoretical Physics,Univ.of Cambridge,DAMTP-78-7,Cambridge, 1978.

CONDENSED MONOPOLES AND ABELIAN CONFINEMENT

1451. Sun Xin, Lu Tan, Luo Liao-Fu. Acta Phys.Sinica(China), 1978, vol.27, No 4, pp.430-438.

THE SPECTRA OF THE MONOPOLE OF HYDROGEN ATOMS

The energy levels, the transition probabilities,the spectra and the intensities of atom spectral lines, at which the magnetic monopole plays the role of a nucleus (the monopole of hydrogen atoms) have been calculated.

1452. Tchrakian D.H. Fachbereich Physik,Univ. Kaiserslautern, Univ.,1978, Kaiserslautern,11p.

N-DIMENSIONAL INSTANTONS AND MONOPOLES

1453. Tchrakian D.H. Fachbereich Physik Univ.,Kaiserslautern, Kaiserslautern,1978.

THE MAGNETIC CHARGE OF A SPHERICALLY SYMMETRIC CLASS OF SU(2) MONOPOLES

The magnetic monopole charge of a certain class of spherically symmetric solutions of the Yang-Mills-Higgs system with arbitrary "isospin" Higgs fields, is computed. It is found that for odd "isospin" this charge is always unity, while for even "isospin" $-\ell$ it is equal to $(1-4\ell)$.

1454. Thomas G.H. Argonne National Lab.,ANL-HEP-PR-78-23, Argonne,1978.

INTRODUCTORY LECTURES ON FIBRE BUNDLES AND TOPOLOGY FOR PHYSICISTS

1455. Troost W. KUL-TF-781006, Leuren,Belgium,1978.

SOLUTION OF A PARADOX CONCERNING THE MOTION OF AN ELECTRIC AND A MAGNETIC POINT CHARGE

D.Rosenbaum noted a paradox connected with the motion of an electric charge in the field of a magnetic monopole, if the initial velocity is directed towards this monopole. This paradox is resolved by smearing out the electric charge over the surface of a sphere, and taking the point limit.

1456. Tsou Sheng Tsun. European Org.for Nucl.Research, CERN-TH-2535, Geneva,1978.

A SHORT INTRODUCTION TO THE MATHEMATICAL FORMULATION OF GAUGE THEORY(Talk)

1457. Tucker R.W. European Organization for Nuclear Research, CERN-TH-2520,Geneva,1978.

AXIALLY SYMMETRIC MAGNETOSTATICS IN SU(2) GAUGE THEORY

A study is made of axially symmetric solutions of the Bogomolny equation having finite energy. The theory is reformulated in the language of quaternion valued differential forms and the techniques of the exterior calculus used through out. With boundary conditions appropriate to a configuration of definite magnetic charge the forms studied lead unambiguously to the 't Hooft-Polyakov monopole. The implications of this result for the conjectured gauge field-monopole duality are discussed.

[Inst. voor Theoretische Fisica Univ. Leuven,

1458. Tu Tung-Sheng, Ruan Tu-nan Phys. Energ. Fortis & Phys. Nucl. (China), 1978, vol. 2, No 1, pp. 49-60.

VARIOUS EXPRESSIONS FOR THE FIELD STRENGTHS OF A MONOPOLE WITH DIFFERENT VELOCITIES AND THE INTEGRAL FORM OF THE POTENTIAL OF A MONOPOLE (In Chinese)

Various expressions for the field strengths of an accelerated monopole are given. In the integral form, the authors discuss the potentials for static, uniformly moving and accelerated monopoles. In the static case, the Wu-Yang potential is obtained. In the case of constant velocity the authors obtain a potential which can also be obtained through Lorentz transformation from the Wu-Yang potential. However, for an accelerated monopole, the correct potential cannot be obtained through Lorentz transformation. On the contrary, the correct Lienard-Weichert potential of an accelerated electron can be obtained through Lorentz transformation.

1459. Tzu Tung-Pei Phys. Energ. Fortis & Phys. Nucl. (China), 1978, vol. 2, No 1, pp. 93-96.

NON-SINGULAR VECTOR POTENTIAL OF A MAGNETIC MONOPOLE IN THE DIRECTION OF MERIDIAN (In Chinese)

After a brief discussion of Dirac's magnetic monopole potential and various solutions, the author derived a wave function for electron motion in a monopole potential.

1460. Urrutia L.F. Phys. Rev., 1978, vol. D18, No 8, pp. 3031-3034.

ZEROTH-ORDER EIKONAL APPROXIMATION IN RELATIVISTIC CHARGED -PARTICLE-MAGNETIC-MONOPOLE SCATTERING

The relativistic spin-1/2 charged-particle-magnetic-monopole scattering is considered in the high-energy, low-momentum-transfer limit. Under these circumstances the differential cross section is calculated in the zeroth-order eikonal approximation and shown to be independent of the choice of the singularity line. In the same context the remote

contribution to the variation of the action induced by a change in the singularity line is shown to be non-zero contrary to what is usually assumed.

1461. Urrutia L.F. Calif.Univ. Los Angeles, UCLA-78-TEP-7, Los Angeles,1978.

ZEROTH-ORDER EIKONAL APPROXIMATION IN RELATIVISTIC CHARGED-PARTICLE-MAGNETIC-MONOPOLE SCATTERING

1462. Vysin V. Lett,Nuovo Cimento,1978, vol.22, ser.2,No 2, pp.76-80.

APPROACH TO TACHYON MONOPOLES IN R^6 SPACE

The existence of tachyon magnetic monopoles with an elementary magnetic charge has been proposed in studies using extended Lorentz transformations. Further investigations into these monopoles, based on the introduction of superluminal transformations into Dirac's theory of electricity and magnetism, is presented. The formalism allows space and time to play a symmetrical role by assuming time is a vector in T^3 Euclidean space.

1463. Wang Ming-chung, Cheng Hsi-teh, Wang Ke-Lin, Chang Cheng-kang, Hsien-Ting-chang. Phys.Energ.Fortis & Phys.Nucl.(China), 1978, vol.2, No 1, pp.35-41.

SPINOR MONOPOLE SOLUTION IS POSSIBLE
(In Chinese)

By introducing a direct scalar coupling between the spinor field and the Higgs field, the authors are able to show that in the non-Abelian case, a spinor monopole bound state solution exists. The distribution of the spinor field in the solution concentrates near the origin, which is unlike the shell distribution of the SLAC solution.

1464. Wang Ke-Lin, Hsien Ting-Chang, Cheng Hsi-Teh. Phys. Energ. Fort. Phys. Nucl. (Chinese), 1978, vol. 2, pp. 403-430.

ON THE SU(4) MONOPOLE AND DYON SOLUTIONS
(In Chinese)

1465. Wang Yun-Kong, Chang Kuo-Yiu, Hou Bo-Yu. Phys. Energ. Fort. & Nucl. Phys. (China), 1978, vol. 2, No 4, pp. 368-370.

A SERIES OF SOURCELESS SOLUTION OF SU(2) GAUGE FIELDS- THE SU(2) AND U(1) POTENTIAL OF STATIC MONOPOLE SYSTEMS (In Chinese)

1466. Wang Ke-Lin, Hsien Ting-Chang, Cheng Hsi-Teh Phys. Energ. Fortis & Phys. Nucl. (China), 1978, vol. 2, No 3, pp. 275-279.

ON THE MAGNETIC MONOPOLE AND DIPOLE SOLUTION OF THE SU(N) GAUGE FIELD THEORY IN A CURVED SPACE (In Chinese)

Detailed investigation is made of a solution to the coupled Einstein-SU(n)-Higgs field.

1467. Von Westenholz C. Ann. Inst. Henri Poincare, 1978, Section A, vol. 29, pp. 285-303.

TOPOLOGY OF VORTICES

A conceptional new approach to field theory is given in terms of unified intrinsic field quantities which consistently describe interacting elementary particle systems. These non-local field quantities provide a classification of vortices in terms of homotopy theory and the Rham's cohomotopy framework. By way of such a classification scheme, interacting vortex lines, i.e. interacting particles associated with these vortex lines are described in terms of a topological linkage property. A topological scattering set-up of this type displays similar features as Born-scattering.

1468. Wilkinson D. & Bais A. Fermi National Accelerator Laboratory, FERMILAB-PUB-78/77-THY, Batavia, 1978.

EXACT SU(N) MONOPOLE SOLUTIONS WITH SPHERICAL SYMMETRY

1469. Wu Tai-tsun, Tu Tung-sheng, Yang Chen-ning. Sci. Sinica, 1978, vol.21, No 3, pp.317-326.

INTERACTION OF ELECTRONS, MAGNETIC MONOPOLES AND PHOTONS

A secondary quantized theory of interacting electrons, magnetic monopoles and photons is built by means of the so-called monopole harmonics. Electrons and monopoles are considered to be the Dirac 1/2 spin particles with non-fille states of negative energy.

1470. Wu Yong-Shi, Chen Shih, Tu Tung-Sheng, Kuo Han-Yink. Kexue Tongbao (China), 1978, vol.23, No 3, pp.150-153.

MAGNETIC MONOPOLES IN BROKEN SO_3 AND SU_2 GAUGE THEORIES (In Chinese)

The e.m. potential representation of magnetic monopoles in broken SO_3 and SU_2 gauge theories is derived and possible conclusion are drawn.

1471. Wu Yong-Shi, Chen Shih, Kuo Han-Ying Sci. Sinica, 1978, vol.21, No 2, pp.193-206.

U_2 $SU_2 \times U_1$ INVARIANCE OF PRINCIPAL BUNDLES FOR MAGNETIC MONOPOLES AND ITS PHYSICAL IMPLICATIONS

It is proved that the main U(1) stratifications for monopoles, i.e. the Hopff S^3/Z_D stratifications (where D is any integer) allow the invariance which preserves the structure of stratification. The SU(2) generators are identified with angular momentum operators (including an additional term $Zeg\vec{r}(r)$ of space rotations near the magnetic monopole, and U(1) is a generator with an operator charge.

1472. Yang Chen-Ning J.Math.Phys.,1978, vol.19, No 1,pp.320-328.

GENERALIZATION OF DIRAC'S MONOPOLE TO SU_2 GAUGE FIELDS

Dirac's monopole is generalized to SU_2 gauge fields in five-dimensional flat space or four-dimensional spherical space. The generalized fields have SO_5 symmetry. The method used is related to the concept of orthogonal gauge fields which is developed in an appendix. The angular momenta operators for the SO_5 symmetrical fields are given.

1473. Yang C.N. J.Math.Phys.,1978, vol.19, No 12, pp.2622-2627.

SU(2) MONOPOLE HARMONICS

1474. Zeldovich Ya.B.,Khlopov M.Yu. Phys.Lett.,1978, vol.B79, No 3, pp.239-241.

ON THE CONCENTRATION OF RELIC MAGNETIC MONOPOLES IN THE UNIVERSE

The modern concentration of relic 't Hooft-Polyakov monopoles is shown to amount to $\sim 10^{-19} cm^{-3}$, being determined by the diffusion annihilation rate at $t < 10^{-5}$ s. To eliminate the contradiction with experimental upper limits some mechanism similar to quark confinement should forbid free monopole existence.

1475. Zrelov V.P. Nucl.Instr. & Meth.,1978, vol.153, No pp.145-147.

ON POSSIBLE IMPROVEMENT OF A PHOTOGRAPHIC DETECTOR TO SEARCH FOR THE DIRAC MONOPOLE BY VAVILOV-CHERENKOV RADIATION

The disadvantages of a Cherenkov photographic detector applied to investigate the composition of cosmic radiation

by Z values are considered. It is shown that the use of a lens-raster radiator makes it possible to reduce considerably the requirements to photoplayer sensitivity, to simplify the determination of the velocity and the direction of relativistic particles and to search for the Dirac monopole more reliably.

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1476. Actor A. Lett.Math.Phys.,1979, vol.3, pp.345-349.

MERON ANTIMERON SOLUTION IN MINKOWSKI SPACE

1477. Actor A. Rev.Mod.Phys.,1979, vol.51, No 3, pp.461-526.

CLASSICAL SOLUTIONS OF SU(2) YANG-MILLS THEORIES

A comprehensive review of the known classical solutions of SU(2) gauge theories is presented. The author follows the historical development of this subject from its begining (the first explicit solution found was an inbedded Abelian static Coulomb solution) up to the most recent work. in the field (in particular the solution which represent monopoles, instantons and merons). As well as being a detail survey, this article is intended to serve as a self-contained introduction to the subject.

1478. Ahlen S.P. Lawrence Berkeley Lab.,LBL-9353,Berkeley, 1979.

THEORETICAL AND EXPERIMENTAL ASTECTS OF THE ENERGY LOSS OF RELATIVISTIC HEAVILY IONIZING PARTICLE

1479. Anandan J. Nuovo Cimento,1979, vol.53A, No 2, pp.221-250.

INTERFERENCE,GRAVITY AND GAUGE FIELDS

1480. Asorey M.,Boya L.J. Dept. de Fisica Teorica,Univ. Zaragoza, Zaragoza,Spain,1979.

ELECTROMAGNETISM WITHOUT MONOPOLES IS POSSIBLE IN NON- TRIVIAL U(1)-FIBRE BUNDLES

1481. Asorey M., Boya L.J. J.Math.Phys., 1979, vol.20, No 11, pp.2327-2329.

ELECTROMAGNETISM WITHOUT MONOPOLES IS POSSIBLE IN NON-TRIVIAL U(1)-FIBRE BUNDLES

If the first homotopy group of a spacetime manifold $\mathcal{M}$ is paydic with $p > 1$, we prove that there exists (p-1) nontrivial and nonequivalent fibre bundles on $\mathcal{M}$ with gauge group U(1) in which all the connections describe electr magnetic gauge field without monopoles. Some spacetimes verifying this condition are introduced. These stresses the physical relevance of the difference between first Chern classes with integer coefficients and those with real coefficients.

1482. Baaklini N.S. Nucl.Phys., 1979, vol.B142, No 4, pp.510-524.

QUANTIZATION OF SUPERPARAMETRIZED MONOPOLES

Classical finite-energy solutions of the SU(2) Yang-Mills-Higgs system in four-dimensional space-time are embedded in the supersymmetric extension of the theory. Finite supertranslationa are constructed and are used to obtain a family of solutions to the supersymmetric field equations parametrized by fermionic Majorana spinor parameters. The quantum theory around arbitrary classical solutions, parametrized by arbitrary bosonic (global and local) as well as fermionic (global) parameters, is constructed and discussed.

1483. Bacry H., Nuyts J. Nucl.Phys., 1979, vol.B151, No 3, pp.469-484.

PURE CLASSICAL SU(2) YANG-MILLS THEORY WITH POTENTIALS INVARIANT UNDER A U(1) GAUGE SUBGROUP

The present article is devoted to pure SU(2) classical Yang-Mills theories whose potentials are invariant under a U(1) gauge subgroup. Such potentials are shown to be associa-

ted with classical Maxwell-like fields with magnetic sources, as 't Hooft's monopole is associated with the Dirac magnetic monopole. Conversely the authors give Yang-Mills potentials corresponding to some Maxwell-like fields, in particular (I) static magnetic fields with emphasis on those with cylindrical symmetry (including the dipole and other multipoles); (II) the "ephemerons" corresponding to an instantaneons magnetic monopole.

1484. Bacry H., Nuyts J. Proc. Group Theoretical Methods in Physics, Austin, 1978. Berlin, 1979, pp. 25-26.

SOME CLASSICAL SOLUTIONS OF SU(2) YANG-MILLS EQUATIONS (Talk)

1485. Bais F.A. KUL-TF-79/021, Louvain, Belgium, 1979.

O(3) SYMMETRIC MONOPOLES AND INSTANTONS

1486. Bais F.A., Troost W. Louvain, KUL-TF-79/033, Louvain, Belgium, 1979.

ZERO MODES AND BOUNDSTATES OF THE SUPER-SYMMETRIC MONOPOLE

We study the zero modes and boundstates of elementary fields in the presence of the Prasad-Sommerfield monopole in N=2 supersymmetric SU(2) gauge theory. The problem is reduced to a single one-dimensional Schrödinger problem due to a simple relation between the solutions of the spinor (pseudo)scalar and vector equations. An infinite number of boundstates is shown to exist which form degenerate supermultiplets. There is only one zeromode in the pseudoscalar field which corresponds to a global chiral symmetry of the theory, confirming the existing interpretation of the zero-modes in this model.

1487. Bais F.A. Phys.Rev.,1979,vol.D18, No 4, pp.1206-1210.

CHARGE-MONOPOLE DUALITY IN SPONTANEOUSLY BROKEN GAUGE THEORIES

The conjecture of Montonen and Olive(1977) concerning an electric-magnetic dual symmetry in the O(3) Georgi-Glashow model is generalized to theories with an arbitrary compact gauge group.

1488. Baker W.M. Nuovo Cim.,1979, vol.A54, No 1, pp.63-80.

ON DUALITY INVARIANCE IN SIMPLE GAUGE THEORIES INCLUDING ELECTROMAGNETIC-TYPE FIELDS WITH SOURCES

Duality transformations of the type defined in electromagnetic theory are discussed and classified in terms of those having a direct relationship to an internal-symmetry structure of a given gauge theory and those that do not. It is argued that to build a satisfactory generalized electromagnetic theory with local duality invariance into a gauge theory, as at least a part of its internal-symmetry structure, requires a group structure not "smaller" than SO_3 (or SU_2). Various reductions in a SO_3 model with sources are considered which allow one to see how the standard form of Maxwell's theory, together with some of its immediate generalizations, may be thought of as embedded in this non-Abelian gauge theory. These reductions and this type of embedding of Maxwell's theory are discussed in connection with spontaneous symmetry breaking. A simple type of "doubled" Weinberg-Salam model that could include a duality-invariant form of electromagnetic theory with magnetic monopoles is briefly considered.

1489. Balachandran A.P., Stern A.,Marmo G.,Skagerstam B.S. Syracuse Univ.,SU-4213-138,New York,1979.

MAGNETIC MONOPOLES WITH NO STRINGS

1490. Balachandran A.P., Stern A., Marmo G., Skagerstam B.S. European Organization for Nuclear Research, CERN-TH-2711, Geneva, 1979.

SUPERSYMMETRIC POINT PARTICLES AND MONOPOLES WITH NO STRINGS

1491. Balog J., Hrasko P. Phys.Rev., 1979, vol.D18, No 12, pp.4486-4488.

EXISTENCE OF MAGNETIC MONOPOLES IN THE UNIFIED FIELD THEORY

It has been stated that a unified field theory proposed recently forbids the existence of magnetic monopoles. The authors show that this result is the consequence of an unnecessarily stringed condition imposed on the magnetic-monopole solution.

1492. Bauks T., Spiegelglas M. Nucl.Phys., 1979, vol.B152, No 3-4, pp.478-492.

SPIN-DEPENDENT FORCES IN A SEMICLASSICAL MODEL OF CONFINEMENT

The model of charges immersed in a magnetic monopole superconductor, which may simulate confined quarks, is used to estimate the spin-dependent part of the confinig force. The spin-spin interaction is found to be short-range. Its range is estimated. The coefficient of the linear confining force and the density of the monopoles in the superconductor are also calculated.

1493. Banks T., Tomboulis E. Phys.Rev., 1979, vol.D20, No 2, pp.501-504.

IMPROVED FORMALISM FOR ABELIAN MAGNETIC MONOPOLES

Euclidean lattice methods are used to derive an improved version of the Schwinger-Zwanziger Lagrangian for maghetic monopoles. The formalism involves a nondynamical

string variable $X_\mu(\sigma,\tau)$. When the monopoles are coupled to a charged scalar field X_μ can be utilized to absorb the dynamics of discontinuities in the angular part of the scalar field. In the Higgs phase where such discontinuities have finite action X becomes a dynamical variable and the Lagrangian becomes manifestly covariant. The authors derive the heuristic string-monopole equations of Nambu as the classical limit of the Higgs model in the London approximation.

1494. Banks T., Tomboulis E. Princeton Inst. Adv.Study, Tel Aviv Univ., preprint,1979.

IMPROVED FORMALISM FOR ABELIAN MAGNETIC MONOPOLES

1495. Barker W.A.,Graziani F. Am.J.Phys.,1979, vol.46,No 11, pp.1111-1115.

A HEURISTIC POTENTIAL THEORY OF ELECTRIC AND MAGNETIC MONOPOLES WITHOUT STRINGS

A simple spherical distribution of electric and/or magnetic charge moves with a constant velocity with respect to an observer in the laboratory frame. The electric and magnetic potentials are written in the rest frame of the two types of charge, and in the laboratory frame by means of the Lorentz transofrmation. The E and H fields are evaluated and are shown to be consistent with Maxwell's equations, generalized to include magnetic charge. In this development a "scalar" rather than a "vector" potential is used to describe the magnetic monopole at rest, thus avoiding "string theory". This approach leads to a more complicated but still useful form for the classical Lagrangian.

1496. Barker W.A., Graziani F. Phys.Rev.,1979, D18,No 10, pp.3849-3857.

QUANTUM-MECHANICAL FORMULATION OF THE ELECTRON-MONOPOLE INTERACTION WITHOUT DIRAC STRINGS

A relativistic wave equation is used to describe the interaction of an electron with a magnetic monopole at rest. A quasipotential defined in terms of an integral involving the pseudoscalar potential $\phi_m = g/r$ is used in this Dirac string-free formalism. This equation written in non-relativistic form, is used in conjunction with the appropriate angular momentum operators to obtain the Dirac quantization condition. An argument using gauge invariance shows that this condition is not modified by a relativistic treatment. A detailed comparison is made with conventional string theory, which is also formulated relativistically.

1497. Barricelli N.A. Oslo Univ., Mathemat. Inst., preprint No 3, Oslo, Norway, 1979.

HEAVY NEUTRAL LEPTON PREDICTED BY A MAGNETIC QUARK MODEL

Magnetic quark model interpretations of the tau lepton (Barricelli, 1978) involve the charmed quark C and may in this respect consider tau as a charged lepton. If this interpretation is correct there is nor reason why there could not exist also a strange lepton ${}_s\mathcal{P}$ in which C is replaced by the strange quark S. The strange lepton constructed in this way would be electrically neutral. Its mass is calculated in one of the possible magnetic quark interpretations, and a few decay possibilities are identified for tau and ${}_s\mathcal{P}$ including some tau decays which would lead to the formation of ${}_s\mathcal{P}$ leptons.

1498. Barut A.O. J. Phys., 1979, vol. A11, No 10, pp. 2073-2081.

COVARIANT FIELD EQUATIONS FOR AN ELECTROMAGNETIC STRING WITH MASS POINTS AT THE ENDS

A new set of covariant field equations for the interacting charge-monopole systems have been obtained which treats the string singularities of the electromagnetic potentials dynamically. The nonrelativistic monopole potentials are derived from the covariant theory.

1499. Barut A.O. Fiz.Elem.Chastits and At.Yadra,1979,vol.10, No 3, pp.539-550.

THE THEOREM OF CHARGE QUANTIZATION (In Russian)

The relativistic action principle of Dirac for the interacting electric charges and magnetic monopoles accords a certain physical reality to the singularity lines of the vector potential. This fact removes various difficulties in the derivations of the charge quantization condition via the angular momentum and flux quantizations conditions and has consequences in experimental search for monopoles and in hadron models.

1500. Barut A.O. In: TACHYONS,MONOPOLES AND RELATED TOPICS, Ed. E.Recami, pp.227-231.

ELECTRODYNAMICS WITH STRINGS AND MONOPOLES

The author reviews some newer results in the theory of interacting electric and magnetic charges. The significance of the singularities of the electormagnetic potential is particularly emphasized both in the formulation of a consistent field theory based on Dirac's action principle and the many other topological quantum properties of charge-monopole or dyonium systems.

1501. Bartlett D.F.,Soo D., Whita M.G. Phys.Rev.,1979, vol. D18, No 7, pp.2253-2261.

SEARCH FOR TACHYON MONOPOLES IN COSMIC RAYS

The authors have searched for a particle which combines the properties of a tachyon with those of a magnetic monopole. The tachyon monopole is assumed to exist in cosmic rays striking the earth and to be influenced by the extensive magnetic fringing field of Fermilab's 15-th bubble chamber. By hypothesizing that the tachyon monopoles will either emit Cherenkov radiation in air or ionize Lexan plastic they set an upper limit of 5×10^{-12} cm^{-2} sec^{-1} on thier flux.

1502. Bazhanov V.V. ,Borodulin V.I.,Proviko G.P.,Soloviev L.D. J.Theoret. and Math.Phys.,1979, vol.40, No 3, pp.355-362.

ELECTRON-MONOPOLE SCATTERING AT SMALL ANGLES IN THE QUANTUM THEORY OF THE DIRAC-SCHWINGER MONOPOLE

In the framework of the quantum theory of the Dirac-Schwinger magnetic monopole, an exact amplitude of the monopole-charge scattering at small angles is evaluated. The amplitude obtained satisfies the relativistic invariance condition. Feynman rules are obtained for monopole- monopole and electron-electron scattering for a photon, electron and monopole. The problem related to redetermining the Feynman amplitude of monopole-charge scattering at small angles is studied. The amplitude obtained has an analytic structure, it can be easily continued in the annihilation channel.

1503. Ben-Menahem S. Phys.Rev.,1979, vol.20, No 8, pp.1923-1933.

CONFINEMENT IN COMPACT QED FOR LOW COUPLINGS

A comparison is made between several models of lattice QED, in 2+1 dimensions which have been shown to exhibit confinement for small couplings. We also compare two different approaches which have been employed to study this phenomenon: the variational and path-integral methods. The reason for differences in the results are explored. The importance of compactness for low-coupling confinement is demonstrated.

1504. Ben-Menahem S. Stanford Linear Accelerator Center,SLAC-PUB-2335,Stanford,1979.

CONFINEMENT IN COMPACT QED FOR LOW COUPLINGS

1505. Blagojevic M.,Sijacki Dj.,Nesic D.,Senjanovic P.,Zivanovic Dj. Phys.Lett.,1979, vol.B79, No 1-2,pp.75-78.

A NEW APPROACH TO THE QUANTUM FIELD THEORY OF

ELECTRIC AND MAGNETIC CHARGE

The authors propose a formulation of quantum field theory of electric and magnetic charge closely patterned after Dirac's quantum-mechanical theory. This formulation possesses an extremely transparent canonical structure and picture of the physical photon degrees of freedom.

1506. Blagojevic M., Senjanovic P. Nucl. PHys., 1979, vol. B161, No 1, pp. 112-124.

A ONE-POTENTIAL FORMULATION OF THE QUANTUM FIELD THEORY OF MAGNETIC POLES

We formulate a new approach to the quantum field theory of electric and magnetic charges. Its advantages relative to existing formulations are that (a) it is a one-potential Lagrangian one, (b) it has a canonical structure and (c) it represents a natural generalization of Dirac's quantum mechanical theory to field theory. Our formulation is non-local in coordinate space, but yields Feynmann rules that are local in momentum space.

1507. Borodovitsyn V.A., Byzov N.N. Izv. Vyzov Fiz., 1979, No 3, pp. 107-109.

CLASSICAL EQUATIONS OF MOVING MAGNETIC MONOPOLE WITH INHERENT ELECTRIC DIPOLE MOMENT

Magnetic monopole with inherent electric moment moving in the random external electromagnetic field is considered. The derivation of equations for the monopole movement is presented within the framework of classical relativistic mechanics. It is noted that the substitution of electric charge for the monopole charge (R) with simultaneous substitution of the electromagnetic field tensor with a tensor dual to it in one of the derived equations leads to the equation obtained earlier by Good, Neiborg et al. for charged electric particle with inherent magnetic moment. In case of homogeneous fields the obtained equation changes into the Bergman-Michel-Telegdi equation. It is noted that this equation may be used for developing new methods of searching for magnetic monopoles.

1508. Boutaleb J.H., Chakrabarti A. Phys.Rev.,1979, vol.D19, No 2, pp.457-466.

KERR-SCHILD GEOMETRY,SPINORS,AND INSTANTONS

The spin connection is studied for the Kerr-Schild metric. Our choice of tetrad leads to particularly simple results. The associated complex SU(2) gauge fields for many important particular cases, including the axially symmetric stationary Kerr metric, are thus presented in a unified fashion. Static spherically symmetric cases are studied in detail, including a cosmological term. A Lorentz gauge transformation is introduced for this class such that a further (inverse Finkelstein) coordinate transformation of a very simple form is obtained in the diagonal static metric. Using this, we study the passage to the Euclidean section, leading to real (anti) self-dual SU(2) gauge fields for the uncharged case. The role of the cosmological constan concerning the Pontryagin indices is elucidated. Finally, a class of solutions of the zero-mass Dirac equation is studied in a appendix. The relation of such solutions possessing stringlike singularities, to similar ones in flat space, in the presence of non-Abelian monopoles and instantons is pointed out.

1509. Boutaleb J.H., Chakraborti A., Comtet A. Paris Ecole Polytechnique, A 329.0379,Paris,1979.

GAUGE FIELD CONFIGURATIONS IN CURVED SPACETIMES;I

1510. Boutaleb J.H., Chakrabarti A. ,Comtet A. Phys.Rev., 1979, vol.D20, No 8, pp.1884-1887.

GAUGE FIELD CONFIGURATIONS IN CURVED SPACETIMES.II

We study classical solutions of SU(2) Yang-Mills field equations,with or without coupled scalar fields, in curved spacetimes.We consider, essentially, only static, spherically symmetric background metrics, for both Lorentz and Euclidean signatures. Section I presents the motivation for searching such solutions. In Sec.II the equations of motion

for a class of Ansätz and several static solutions are given, namely, a class of scalar fields competible with a point monopole and particular solutions, for gauge fields alone, in background Schwarzschild and de Sitter metrics, respectively. Some interesting properties are discussed. In Sec. III a finite action, Prasad-Sommerfield-type solution is constructed for the O(4,1) de Sitter metric. In Sec.IV it is shown how one single, simple de Sitter solution can lead to various well-known flat-space solutions, and to new ones, through a systematic exploitation of conformat equivalence. Self-duality constraints are formulated explicitly in Sec.V. for a static spherically symmetric metric.Certain results for the Robinson-Bertott metric are given in Sec.VI.

1511. Bounardeau M.,Drukier A.K. Astrophys. & Space Sci., 1979, vol.60, No 2, pp.375-399.

ON THE CREATION OF MAGNETIC MONOPOLES IN PULSARS

1512. Bounardeau M., Drukier A.K. Nature,1979, vol.277, No 5697, pp.543-544.

CREATION OF MAGNETIC MONOPOLES IN PULSARS

It is suggested that magnetic monopoles are created in pulsars by the impact of accelerated electrons on the neutron star crust. A cross-section for monopole production is derived. It is proposed that half of the monopoles produced in this way are accelerated towards the neutron star surfaces(the rest are expelled into the interstellar medium) and produce a decrease in the pulsar magnetic field. This decrease in the magnetic field implies that the characteristic ages of pulsars are greater than their real ages a conclusion that is consistent with the observed discrepancy between the characteristic ages and kinematic ages of pulsars.

1513. Brandt R.A., Neri F., Zwanziger D. Phys.Rev.,1979, vol. D19, No 4, pp.1153-1167.

LORENTZ INVARIANCE FROM CLASSICAL PARTICLE PATHS IN QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

We establish the Lorentz invariance of the quantum field theory of electric and magnetic charge. This is a priori implausible because the theory is second-quantized version of a classical field theory which is inconsistent if the minimally coupled charged fields are smooth functions. For our proof we express the generating functional for the gauge-invariant Green's functions of quantum electrodynamics with or without magnetic charge as a path integral over the tragectories of classical charged point particles. The electric electric and electric-magnetic interactions contribute factors exp.(JOJ) and exp.(JD'K), where J and K are the electric and magnetic currents of classical point particles and D is the usual photon propagator. The propagator D' involves the Dirac string but exp.(JD'K) depends on it only through a topological integer linking string and classical particle trajectories. The charge quantization condition $(e_i g_j - g_i e_j)/4\pi$ =integer then suffices to make the gauge-invariant Green's function string independent. By implication, our formulation shows that if the Green's functions of quantum electrodynamics are expressed, as usual, as functional integrals over classical charged fields, the smooth field configurations have measure zero and all the support of the Feynman measure lies on the trajectories of classical point particles.

1514. Brandt R.A., Neri F. Phys.Rev.,1979, vol.D18,No 6, pp.2080-2090.

REMARKS ON ZWANZIGER'S LOCAL QUANTUM FIELD THEORY OF ELECTRIC AND MAGNETIC CHARGE

1515. Brandt R.A., Neri F. Dept. of Phys. New York Univ., NYU/ TR 1/79, New York,1979.

STABILITY ANALYSIS FOR SINGULAR NON-ABELIAN MAGNETIC-MONOPOLES

1516. Brandt R.A., Neri F. Nucl.Phys.,1979, vol.B161, No 2-3, pp.253-282.

STABILITY ANALYSIS FOR SINGULAR NON-ABELIAN MAGNETIC MONOPOLES

The Dirac magnetic monopole potential $gA(r) = (g/4\pi)(\hat{r} \times \hat{n}) \cdot (r - \vec{r}\hat{n})^{-1}$ is a stable solution to the Abelian-Maxwell equations. The simple generalization $\underline{A} = \underline{M} A$ is a solution to the classical non-Abelian generalized Yang-Mills euqations, where $\underline{M}$ is a matrix in the Lie algebra $\mathcal{G}$ of the gauge group. In this paper the stability problem for these non-Abelian monopoles is posed and solved. Although $\underline{A}$ is essentially Abelian in that $\underline{A} \times \underline{A} = 0$ the stability analysis is non-trivial because it involves the full non-Abelian structure of the theory. It is first shown that the potential $\underline{A}$ leads to a rotationally invariant classical theory, only if the quantization condition $g^\beta = \frac{1}{2} n^\beta$ (g^β =eigenvalue of $\underline{M}/4\pi$, n^β = integer=0, ± 1, $\pm 2, \ldots$, $0 \leq \beta \leq \dim \mathcal{G}$; gauge field coupling constant = e =1) is satisfied.(In contrast, the Abelian -Dirac quantization condition $g/4\pi = \frac{1}{2} n$ is necessary only in quantum ,mechanics), The stability analysis is performed by solving the linearized equations for the perturbed potentials $\underline{A}(\vec{r}) + \underline{a}(\vec{r}, t)$ .Thus the existence of a solution $\underline{a}(\vec{r}, t)$ which grows exponentially in time t is equivalent to the instability of $\underline{A}$ .Using a convenient choice for the basis of $\mathcal{G}$ and the background gauge condition, the equation for a particle of unit spin, unit charge and unit anomalous magnetic moment moving in the potential $4\pi g^\beta A$. This equation is separated using the Yang-Wu monopole harmonics, generalized to include unit spin.The radial equation is them solved in terms of the eigenvalues of an operator related to the spin and orbital angular momentum operators. The result is that $\underline{A}$ is stable if and only if each integer n^β is either 0 or ± 1. The monopoles with $|g^\beta| > 1/2$ are thus unstable and therefore no quantum-mechanical significance. This conclusion is used to speculate about the empirical absence of monopoles, the stability of the non-singular ('t Hooft-Polyakov) monopoles, and their existence of magnetic confinement.

1517. Brezin E., Gervais J.L. Proc. of Les Houches Winter Advanced Study Institute, March,1978. Phys.Rep.,1979, vol.49, pp.91-272.

NON-PERTURBATIVE ASPECTS IN QUANTUM FIELD THEORY

1518. Broderick J.J., Ficenec J.R., Teplitz D.C., Teplitz V.L. Phys.Rev.,1979, vol.19, No 4, pp.1046-1050.

OBSERVATIONAL LIMITS ON THE MAGNETIC-MONOPOLE STRUCTURE OF PROTONS

The authors report the results of a search for absorption of 42-cm radiation in neutral galactic hydrogen. One explanation of a positive result would be the existence of a type of anomalous proton whose magnetic moment arises from a distribution of magnetic charge rather than from a distribution of circulating currents. No absorption 42-cm radiation was seen, this implies an upper limit of 2.3×10^{-4} for the abundance of this type of anomalous proton relative to protons which radiate at 21 cm. The observed absence of anomalous protons also implies an absence of primordial anomalous protons since they could not have been swept up by heavier elements during cosmic nucleosynthesis. The observation is sensitive only to anomalous protons with exactly the same value for their magnetic moment that conventional ones have.

1519. Bruce D.J. Nucl.Phys.,1979, vol.B142, No 3, pp.253-257.

BACKLUND TRANSFORMATIONS AND MAGNETIC MONOPOLES

The author shows that a recent solution of an SU(2) gauge theory (see Lohe, ibid., vol.B142, p.236,1978) claimed to be a 3-monopole solution, is in fact an infinite-energy solution.

1520. Brydges D., Froehlich J.,Seiler E. Nucl.Phys.,1979, vol.B152, No 3-4,pp.521-532.

DIAMAGNETIC AND CRITICAL PROPERTIES OF HIGGS LATTICE GAUGE THEORIES

Diamagnetic and critical properties of non-Abelian and Abelian lattice Higgs models are discussed:matter fields always behave diamagnetically under coupling to gauge fields.For some Abelian models, the photon-photon interaction is found to be attractive , a Higgs mechanism is exhibited , and in two dimensions fractionally charged quarks are permanently confined. In three dimensions there is a Higgs -QED phase transition, with confinement in the QED phase. It is argued that a similar transition occurs in four dimensions, with liberated magnetic monopoles in QED phase, but electric monopoles,"quarks", are never confined. Conjuctures concerning confinement in non-Abelian models are described.

1521. Bunjatov S.A. Fiz. Elem.Chastitz and Atomn.Yadra (Russ.) 1979, vol.10, part 3, pp.657-692.

SEARCH FOR NEW PARTICLES AND ANTINUCLEI
(In Russian)

The present review devoted to the search experiments which were implemented by staff members of JINR(Dubna) and participants-countries in the Inst. of High Energy Physics(Serpukhov) during last ten years.

The first part of the review is concerned in the search relative long loved particles with the lifetime $\tau > 10^{-8}$ - 10^{-12} sec. and stable antinuclei. These experiments are completed already.

The second part of review is devoted to experiments on the searching for new particles and nuclei with the lifetime $\tau \leq 10^{-12}$ -10^{-14} sec. These experiments are in progress basically, so this part of review some completed steps of the implemented investigations will be discussed.

1522. Carmeli M. Fortschr.Phys.,1979, vol.27, No 6, pp.261-312.

EINSTEIN-MAXWELL EQUATIONS GAUGE FORMULATION AND SOLUTIONS FOR RADIATING BODIES

The subject of the SL(2,0) gauge theory of gravitation is reviewed. A ditailed discussion is given on the differential geometry and the fibre bundle structure of such a theory. The coupling of Maxwell's field equations to those of gravitation is also given. The field equations obtained, which are shown to be equivalent to the coupled Einstein-Maxwell's equations, are subsequently solved. The solutions sought after are radiating type ones of the kind of the Kerr metric, but with the mass of the body being variable and is a function of the retarded time. A generalization of the Kerr metric is presented and its energy-momentum tensor is analyzed in detail. The classification of the field obtained according to the Petrov scheme is also given.

1523. Cheng Kuo-Shung Phys.Rev.,1979, vol.D18, No 2, pp.549-551.

CLASSICAL LAGRANGIAN THEORY WITH RADIATIVE REACTION: ee TENSOR OF THE ROHRLICH TWO-FIELD FORMALISM TO INCLUDE MONOPOLES

The author gives an action integral $L(x, X, A_\mu, a_\mu)$. The stability of L against the variations $\delta A_\mu(\xi)$, $\delta X_\mu(\theta)$ and $\delta X_\mu(T)$ gives the coupled Maxwell equations and the Lorentz-Dirac equation for the position and monopole.

1524. Chischolm J.S.R., Farwell R.S. Canterbury Univ.,preprint, 1979.

A GAUGE FIELD THEORY OF ELECTRONS AND MONOPOLES

1525. Chischolm J.S.R.,Forwell R.S. Proc.Mathematical Problems in Theoretical Physics,Lausanne,1979, pp.305-307.

SPIN GAUGE THEORY OF ELECTRIC AND MAGNETIC SPINORS

1526. Cho Y.M. Muenchen MPI Phys.Astophys.,MPI-PAE-PTH-5-79,1979.

A GAUGE THEORY OF THE NON-ABELIAN MAGNETIC CHARGES

1527. Cho Y.M. Muenchen MPI Phys.Astrophys.,MPI-PAE-PTH-11-79,1979.

MAGNETIC CONFINEMENT OF THE QUARKS

1528. Cho Y.M. Muenchen MPI Phys.Astrophys., MPI-PAE-PTH-5-79,1979.

A RESTRICTED GAUGE THEORY

1529. Comtet A. Institut de Physique Nucleaire, IPNO-TH 79-64, Orsey,1979.

MAGNETIC MONOPOLE IN CURVED SPACETIMES

1530. Cope F.W. Physiol.Chem.,& Phys.,1979, vol.10, No 6, pp.541-545.

MAN IN A GAS OF TACHYON MAGNETOELECTRIC DIPOLES- A NEW HYPOTHESIS. II INTRODUCTION TO THE THEORY

For part I see ibid,1978, vol.10, No 6, pp.536.

Some unexplained biocosmic observations are shown probably to be reliable. It is pointed out that there is no reason to distinct results of experiments which use man as a detector provided appropriate precautions of design and conduct of the experiments were taken. In the theory developed in the third paper in this series to explain the biocosmic phenomena summarized in the first paper, mostly classical electromagnetic concepts are used. However, a few concepts from advanced theoretical physics are also used; namely, tachyons, magnetic monopoles, and magnetic dipoles.

1531. Christ N., Jackiw R. Columbia Univ., Dept. of Phys., CU-TP-168, New York, 1979.

EQUALITY OF MAGNETIC CHARGE AND PONTRYAGIN INDEX FOR YANG-MILLS DYONS

A description of Ynag-Mills dyons is given solely on terms of Ynag-Mills fields. For an SU(2) gauge group the magnetic pole strength is shown to coincide with the Pontryagin index of the dyon configuration, treated as periodic in time and hence defined on $S^1 \otimes R^3$.

1532. Daniel M., Lazarides G., Shafi Q. European Org. for Nuclear Research, CERN-TH-2800, Geneva, 1979.

SU(5) MONOPOLES, MAGNETIC SYMMETRY AND CONFINEMENT

The monopoles of the unified SU(5) gauge theory broken down to $H_F=SU(3)_c \otimes U(1)_{EM}$ or to $K_E=SU(3)_c \otimes SU(2) \otimes U(1)_Y J_1$ are classified. They belong to representations of a magnetic group $H_M(K_M)$ which is formed to be isomorphic to $H_E(K_E)$. For SU(5) broken down to H_E, there exists a regular and stable monopole which is a colour magnetic triplet, and carries a non-zero Abelian magnetic charge. It is suggested that composite operators made out of this monopole and its antimonopole fields develop a non-zero vacuum expectation value, and so lead to a squeezing of the colour electric flux. Finally, we comment on the cosmological production of SU(5) monopoles.

1533. Davies P.C.W. Nature, 1979, vol.277, No 5693, p.174.

PRIMAEVAL MAGNETIC MONOPOLES

1534. Das A. J.Math.Phys., 1979, vol.20, No 4, pp.740-743.

ON THE STATIC EINSTEIN-MAXWELL FIELD EQUATIONS

The static Einstein- Maxwell field equations are investigated in the presence of both electirc and magnetic fields. The sources or bodies are assumed to be of finite

size and not affect the connectivity of the associated space Furthermore, electromagnetic and metric fields are assumed to have reasonable differentiabilities. It is then proved that the electric and magnetic field vectors are constant multiplets of one another. Moreover, the static Einstein-Maxwell equations reduce to the static magnetorac case. If furthermore, the variational derivation of the Einstein-Maxwell equations is assumed, then both the total electric and magnetic charge of each body must vanish. As a physical consequence it is pointed out that if a suspended magnet be electrically charged then it must experience a purely general relativistic torque.

1535. Deans W.S. Durham Univ., preprint, 1979,

STRINGS IN GAUGE THEORIES II.

1536. Deans W.S. Durham Univ., preprint, 1979.

STRINGS IN GAUGE THEORIES: THE IMPORTANCE OF MAGNETIC CHARGE

1537. Dietz K., Filk T. Bonn Univ., Fysikalisches Inst., BONN-HE-79-11, Bonn, Germany, 1979.

CRITICAL HIGGS MASS FOR THE (2+1)-DIMENSIONAL GEORGI-GLASHOW MODEL

The ground state of a (2+1)-dimensional Georgi-Glashow model is discussed in a dilute monopole gas approximation. In addition to the Coulomb interaction of the latter, we include a Higgs force which is attractive irrespective of the sign of monopole charges. For Higgs masses KA comparable to the mean free distance of monopoles we find a phase transition which is presumably of first order. Strings of monopoles dominate the clustering behaviour near the critical point.

1538. Dokos G.P., Tomaras T.N. Lyman Laboratory of Physics, Harward Univ., HUTP-79/A071, Cambridge,1979.

MONOPOLES AND DYONS IN THE SU(5) MODEL

The spherically symmetric monopoles and dyons of the SU(5) model of ground unification (without quarks and leptons) are discussed. It is shown that such monopoles and dyons can exist only in the sectors corresponding to magnetic charges $m=\pm 1/2e$, $\pm 1/e$, $\pm 3/2e$ and $\pm 2/e$, where e is the charge of the positron. We investigate in detail the properties of the dyons with the smallest possible magnetic charge ($m=1/2e$).

By semiclassical reasoning we show that apart from the magnetic charge, the properties of the dyons are described by two quantum numbers n and h. The dyons come in families, denoted by $n=0,1,2,\ldots$, with electric charge $q_n = n(-4/3\ e)$, baryon minus lepton number $= n(-2/3)$ and the Q-th member of the n-th family ($k= 0,1,2,\ldots,$) transforms according to the $(n+k,k)$ for $n \geq 0$ or the $(k, |n|+k)$ for $n < 0$ representation of $SU(3)_c$. We argue that all the members of a given family are degenerate at the level we are working. This degeneracy is expected to be lifted in the full quantum theory, in which case each family collapses to one stable dyon, characterized by one integer n and whose quantum numbers are : it has electric charge $= n(-4/3)$ and baryon number minus lepton number $= n(-2/3)$, and it transforms under $SU(3)_c$ like the symmetric combination of n 3_c, for $n \geq 0$, or $|n|$ $\bar{3}$' S, for $n < 0$. Investigating processes involving monopoles and dyons are discussed; we show, for example, that the presence of a dyon strongly enhances baryon violating processes. Finally, a less detailed discussion of poles with the other possible magnetic charges is included.

1539. Doria F.A. J.Math.Phys.,1979, vol.20, No 4, pp.1464-1465.

NONCONTINUOUS GAUGE POTENTIALS WITHOUT MAGNETIC MONOPOLES

We give examples for Abelian and non-Abelian gauge fields without Dirac-like monopoles and with essentially discontinuous potentials.

1540. Dowell J.D. In:QUARKS,GLUONS AND JETS, Proc.Les Arcs, 1979, vol.I,pp.655-682, Dreux,1979.

PROTON ANTIPROTON COLLISIONS AT THE CERN SPS

1541. Duan-ishi Gue -Molin Sci.Sinica,1979, No 11,pp.1072-1081.

SU(2) GAUGE THEORY AND THE "N" ELECTRODYNAMICS OF MAGNETIC MONOPOLES

1542. Englert F., Windey P. Phys.Reports, 1979, vol.49, No 2, pp.173-179.

DYNAMICAL AND TOPOLOGICAL CONSIDERATIONS ON QUARK CONFINEMENT

Non-Abelian magnetic superconductivity provides a realization of the topological algebra of 't Hooft which does confine quarks; Its dynamical and topological aspects are discussed and the related phenomenological theory of quark confinement is sketched.

1543. Ezawa Z.F. Phys.Lett.,1979, vol.B86, No 3-4, pp.313-316.

ELECTRIC QUARK CONFINEMENT IN 3+1 DIMENSIONS

It is demonstrated that the SU(N) Georgi-Glashow model contains at least two phases while in the weak coupling regime there arise a photon and a magnetic monopole among physical particles, in strong coupling regime the photon acquires a dynamical mass and the vacuum becomes a condense phase of Wu-Yang monopoles. It is then shown that the stron coupling regime quarks are confined permanently by quantize

electric flux stretched among them. These electric vortices are argued to be characterized by the center Z_N of magnetic gauge group SU(N).

1544. Ezawa Z.F. Muenchen MPI Phys.Astrophys.,MPI-PAE-PTH 10-79,Muenchen,1979.

ELECTRIC QUARK CONFINEMENT IN 2 + 1 DIMENSIONS

1545. Ezawa Z.F. Phys. Lett.,1979, vol.B81, No 3-4,pp.325-328.

QUANTUM SOLITON OPERATORS FOR MONOPOLES AND FERMI-IONIZATION MECHANISM OF DYONS

A second quantized theory of 't Hooft-Polyakov monopole is presented. The formalism is canonical in that a standard technique is used to generate soliton vectors togéther with quantum soliton operators. Field operators are also defined for dyons which are made up of monopoles and isodoublet bosons. They are shown to obey anti-commutation relations.

1546. Ezawa Z.F. Muenchen MPI, Phys.Astrophys., MPI-PAE-PTH 14-79, Muenchen,1979.

ELECTRIC-MAGNETIC DUALITY AND QUARK CONFINEMENT

1547. Ezawa Z.F. Muenchen MPI Phys.Astrophys.,MPI-PAE-PTH 40-79, Muenchen,1979.

TOPOLOGICAL EXCITATIONS AND QUARK CONFINEMENT

1548. Falik D., Opher R. Phys.Rev.,1979, vol.D18, No 7, pp.2694-2697.

POSSIBLE EXISTENCE OF FRACTIONAL CHARGES AND MAGNETIC MONOPOLES IN MATTER

A model is suggested which explains the discovery of fractional electric charges in spite of the former failures to find quarks and quark-confinement theories, the model does not need many new assumptions about the fractionally charged particles. According to this model, the fractionally charged particles came from the decomposition of naturally occurring bound pairs of appositely charged magnetic monopoles. Such bound pairs were suggested by the authors in a recent article in this journal (vol.17, p.923,1978) to explain other phenomena.

1549. Farhoosh H., Zimmermann R.L. J.Math.Phys.,1979, vol.20, No 11,pp.2272-2279.

STATIONARY CHARGED C-METRIC

The physical properties of the stationary charged C-metric are fully investigated. Tetrad components of curvature and maxwell tensors are studied in a Bondi-Sachs coordinate system. to show that this solution represents a uniformly accelerating and rotating charged particle with magnetic monopole and NUT parameter. The physical quantities -news function, mass loss definitions are compared and it is shown that the definition given by Bondi is the more appropriate one. It is also shown that the magnetic monopole in the presence of rotation affects the electric charge.

1550. Felsager B., Leinaas J.M. Nordisk Inst. for Theoretical Atomfysik, NORDITA-79-35, Copenhagen, Denmark,1979.

GEOMETRIC INTERPRETATION OF MAGNETIC FIELDS AND THE MOTION OF CHARGED PARTICLES

A geometric representation of magnetic fields in terms of plane bundles in R^3 is examined, and for two examples, the magnetic flux string and the monopole, it is shown how the field configurations can be related to the geometry of cones and spheres. Using the normal vector of the planes as dynamical variable we treat the structure of the magnetic field in a way similar to that of an ordered medium. We especially compare it with the structure of the O(3) non-

linear σ-model. Finally a geometric interpretation of electric charge is introduced by associating with charged particles a rotating body-fixed frame which is constrained to rotate around the normal vector of the planes. The close connection with the Kaluza -Klein model is discussed.

1551. Filk T. Thesis, Bonn Univ., BONN-IR-79-20, Bonn, 1979.

PHASE TRANSITION IN MONOPOLE GAS

1552. Flyvbjerg H. Niels Bohr Inst., Copenhagen Univ., 1979, NBI-ME-79-33, Copenhagen, 1979.

TWO NEW FAMILIES OF SOLITONS OF AN INHERENT QUANTUM NATURE

Two new families of solitons in three-dimensional space are presented. The solitons are non-classical, of an inherent quantum nature in the sense that they occur in the quantized version of theories which at the classical level allow for no solitons. The solitons in question are a family of magnetic vortex lines in the Coleman-Weinberg model, quantum relatives to the classical Nielsen-Olsen vortex lines, and a family consisting of a magnetic monopole and dyons in a massless, scalar, SU(2) gauge theory. The latter solitons are quantum relatives to the classical 't Hooft-Polyakov monopole and Julia-Zee dyons.

1553. Franca H.M. Instituto de Fisica Universidade de Sao Paulo, IFUSP/P-195, Sao Paulo, Brasil, 1979.

CHARGE, MAGNETIZATION AND HADRONIC MATTER DENSITIES INSIDE THE PROTON

We present a scheme by means of which one can infer the charge and magnetization structure of any quantum system from its electromagnetic form factors. For spin 1/2 and spin 0 particles the new results here obtained lead us to a correct non-relativistic limit as well as to a

consistent description of the mean charge radii. Our analysis of the existing data on elastic electron-photon scattering suggest that the charge density should be more concentrated then the magnetization density within the proton. The hadronic matter density of proton is detained from the experimental data on PP elastic collisions at high energy, by assuming the Chon-Yang model. It is found that as the energy increases the hadronic matter becomes more similar to the magnetization then to the charge density inside the proton. The same seems to be true for the neutron.

1554. Frank I.M. Yad.Fiz.,1979, vol.29, No 1, pp.180-187.

TRANSITIONAL RADIATION FOR MAGNETIC CHARGE

Theoretical investigation of the transitional radiation of a magnetic charge is fulfilled in analogy with the radiation of an electric charge. Formulae for the spectral intensity and the polarization are obtained and analysed for two cases: normal and sloping fall on the interface of two media.

1555. Frampton P.H., Tyburski L. Lett.Nuovo Cim.,1979, vol.25, No 1, pp.13-16.

SLACE INVARIANCE AND SOLITONS

1556. Friedman J.L.,Sorkin R.D. Phys.Rev.,1979, vol.20, No pp.2511-2525.

DYON SPIN AND STATISTICS: A FIBER-BUNDLE THEORY OF INTERACTING MAGNETIC AND ELECTRIC CHARGES

The quantum mechanics of a system of non-relativistic electrically and magnetically charged particles is formulated by introducing as the classical configuration space a certain U(1) bundle over the set of physical particle configurations. In this way one obtains a well-defined and single valued classical action; and in the corresponding quantum theory, the origin of half-integral spin and of asymptotic

1557. Gambini R., Salamo S. Nuovo Cim.,1979, vol.A49, No 2, pp.276-288.

NULL-PLANE ANALYSIS OF ELECTROMAGNETISM WITH MAGNETIC CHARGES

A reduced non-constrained Lagrangian of electromagnetism including monopoles is presented. The Lagrangian depends on two degrees of freedom and is invariant under dual rotations. The Cabibbo-Ferrari formulation is studied in the infinite-momentum frame. We prove that the Lagrangian formulation of the Cabibbo-Ferrari theory has four degrees of freedom. Nevertheless, the physical observables depend on only two linear combinations of the four degrees of freedom. The mixing-gauge transformations may be clearly understood by writing them in terms of two arbitrary scalar solutions of the massless Klein-Gordon equations.

1558. Giacomelli G., Jacob M. Phys.Rep.,1979, vol.55, No 1, pp.1-132.

PHYSICS AT THE CERN-ISR

This paper review physics at the CERN-ISR and present highlights of hadron physics in the 250-2000 GeV range at this unique facility. Beginning with a general presentation of the machine and of the physics programme(section 1-) there follows a discussion of each main physics topic:total cross-section elastic and diffractive scattering, short-range order,large transverse momentum phenomena, lepton pair production and particle searches (section 4-12). Important technical developments at the ISR are only briefly reviewed (section 13). The last section (14) discusses future prospects as they may be envisaged up to 1982 with, in particular, storage of both protons and antiprotons.

1559. Gilman F.J. Proc.International Symposium on Perspective and Future Projects in High Energy Physics,Tsukuba,1979.

1560. Gopala Rao A.V. Phys.Rev.,1979, vol.D19, No 12, pp.3604-3613.

SOME PROPERTIES OF DUALITY-ROTATED MAXWELL FIELDS

Duality rotations of Maxwell fields residing in curved space-time are studied in the presence of source, and it is shown that a general duality rotation transforms the conserv magnetic-charge-free four current of a Maxwell field into a new four-current which is neither conserved nor is free of magnetic charges. The necessary and sufficient condition for two Maxwell fields, in the presence of source four-currents which are both conserved and are free of magnetic charges, to go into each other under a duality rotation is obtained. As duality rotations preserve the electromagnetic energy tensor E_{ab}, this leads to conditions under which a given E_{ab}, and hence a given metric solution of the Einstein equations for a continuous system having E_{ab} as a part of it may possess a multiple(or in particular, a dual) interpretation in terms of the electromagnetic field. In the case of non-null electromagnetic fields with vanishing Lorentz force it is shown that a direct computation involving the given Maxwell field yield the required duality rotation provided it exists. A number of examples of duality connected field pairs, some existing in vacuum and some others inside matter are discussed to illustrate the theory developed.

1561. Greensite J.P. Nucl.Phys.,1979, vol.B158, No 2-3,pp.469-496.

CALCULATION OF THE YANG-MILLS VACUUM WAVE FUNCTIONAL

Working in the Schrödinger representation and gauge, an approximate Yang-Mills ground-state wave functional $\psi[A]$ is constructed in the following way: we begin the constructing the vacuum wave functional $\psi_0[A]$ at an Abelian gauge-field with global SU(2) symmetry, and then modify and generalize $\psi_0[A]$ so that it becomes invariant under local SU(2) gauge transformations. This ansatz leads to

a solution of the Schrödinger equation $H\psi[A] = \epsilon_0 \psi[A]$ for the Yang-Mills vacuum, which, although approximate, may correctly describe its confinement properties.

Given $\psi[A]$ it is argued that the vacuum expectation values of the Wilson loop integral A(C) and of 't Hooft's flux-tube operator B(C) satisfy the Wilson-'t Hooft criteria $\langle A(C) \sim e^{-\text{area}(c)}, \langle B(C) \sim e^{-\text{perimeter}(c)}$, for the confinement phase of gauge field. The confinement mechanism is essentially identical to the one discovered by Polyakov in 3-dimensional QED. The reason for the similarity is that there is an "analog-gas" approximation to fixed-time vacuum expectation values $\langle \psi | Q | \psi \rangle$: the analog gas in this case is a plasma of smoothed Wu-Yang monopoles.

1562. Greensite J.P. Calif.Univ.,UCSC-79-125, Santa Cruz,1979.

CALCULATION OF THE YANG-MILLS VACUUM WAVE FUNCTIONAL

1563. Guth A.H., Tye S.H.H. Stanford Linear Accelerator Center SLAC-PUB-2448, Stanford,1979.

PHASE TRANSITION AND MAGNETIC MONOPOLE PRODUCTION IN THE VERY EARLY UNIVERSE

In a ground unified models, the abundance of superheavy magnetic monopoles in the universe can be suppressed of (1) the phase transition which creates the monopoles occurs after much supercooling; and (2) immediately after the phase transition, the effective monopole mass is large compared to the temperature. These requirements improve constraints on the history of the early universe. The Georgi Glashow SU_5 group probably breaks to $SU_4 \times U_1$ before it reaches $SU_3 \times SU_2 \times U_1$.

1563. Hirata K. Phys.Lett.,1979, vol.B83, No 3-4, pp.335-338.

ACTION-AT-A DISTANCE THEORY OF ELECTRO-DYNAMICS WITH DIRAC'S MONOPOLES

A classical action-at-a-distance theory of a charge-monopole system is constructed by use of strings but without recourse to Dirac's veto. An action, equations of motion and conserved linear-and angular-momenta are explicit - ly given which do not depend on the string.

1564. Hirata K. Inst.of Phys.,Univ.Tsukubo, UTHEP-45,Ibaraki, 1979.

ACTION-AT-A-DISTANCE THEORY OF ELECTRODYNAMICS WITH DIRAC'S MONOPOLES

1565. Hirata K. Inst.of Phys., Univ.Tsukuba, UTHEP-54, Ibaraki,1979.

DIRAC'S MONOPOLES AND ACTION-AT-A-DISTANCE THEORY: CLASSICAL DYNAMICS

1566. Hirata K. Phys.Lett.,1979, vol.B81, No 2, pp.169-172.

CLASSICAL LAGRANGIAN THEORY OF DIRAC'S MONOPOLE: AVOIDING DIRAC'S VETO

Redefinition of Dirac's action for a charge-monopole system as a certain limit of Wu-Yang's action solves Dirac's veto problem. The string variable $y^{\mu}(\tau,\sigma)$ plays an essential rôle in the variation principle.

1567. Ho Bo-Yu, Kexue Tongbao(China),1979, vol.24, No 1,pp.16-18.

NAGULAR MOMENTUM OPERATOR OF NON-ABELIAN GUAGE FIELD MONOPOLE

1568. 't Hooft G. Nucl.Phys.,1979, vol.B153, No 1-2, pp.141-160.

A PROPERTY OF ELECTRIC AND MAGNETIC FLUX IN NON-ABELIAN GAUGE THEORIES

Pure non-Abelian gauge models with gauge groups SU(N) are considered in a box with periodic boundary conditions at various temperatures; KA. Electric and magnetic flux are defined in a gauge-invariant way. The free energy of th system satisfies an exact duality equation, following from Euclidean invariance. The equation relates properties of the electric and the magnetic fields. Concludions that can be drawn for instance are that for $N \leq 3$ one cannot have both electric and magnetic confinement, and that the infared structure of the Georgi-Glashow model is self-dual.

1569. Hoffmann H., Kantardjian G.,S.di Liberto, Meddi F.,Romano G. Rosa G. Lett.Nuovo Cim.,1978, vol.23, ser.2,No 10,pp.357-360.

A NEW SEARCH FOR MAGNETIC MONOPOLES AT THE CERN-ISR WITH PLASTIC DETECTORS

The aim of the present experiment carried out with solid state track detectors and a longitudinal magnetic field, is that of decreasing by one to two orders of magnitude the limit on the production cross-section of poles with masses in the range of 20 to 30 m_p. The present search aims to detect monopoles immediately after their production by making use of the expected high value of their ionization energy loss(due to the magnetic charge) to differentiate them from any possible background source.

1570. Horvath Z.,Palla L. Nucl.Phys.,1979, vol.B142, No 3, pp.327-343.

SPONTANEOUS COMPACTIFICATION AND "MONOPOLES" IN HIGHER DIMENSIONS

Using the Wu-Yang global gauge description the minimal gauge group is found which compactifies the extra even D

dimensions into a sphere, namely SO(2N). These gauge theory solutions are associated with non-vanishing topological charges. An SO(2N) gauge theory solution is obtained in D=2N + 1 dimensions which describes a generalized singular magnetic monopole which conforms to the Yang definition.

1571. Honda M. Progr. Theor. Phys., 1979, vol. 61, No 4, pp. 1255-1260.

FIBER BUNDLE ANALYSIS OF GLOBAL FEATURE OF GAUGE FIELD THEORY

The global feature of the gauge field theory is discussed in the context of the fiber bundle. Especially introducing a theorem on the fiber bundle, the author studies the relation between the 't Hooft monopole and the Dirac monopole.

1572. Honda M. Sendai Tohoku Univ., TU-79-195, 1979.

FIBER BUNDLE STRUCTURE OF GAUGE FIELD AND REDUCTION BY THE HIGGS MECHANISM

1573. Hou Bo-Yu, Hou-Bo-Yuan Fort. Phys. Nucl., 1979, vol. 3, pp. 255-265.

STATICAL SPHEROSYMMETRICAL SOURCELESS SOLUTION OF SU(2) GAUGE FIELD- THE SELFDUALITY, UNIQUENESS AND THE SELFINDUCED CHARGE CURRENT (In Chinese)

1574. Houston P., O'Raifeartaigh L. Dublin Inst. Adv. Studies, DIAS-TP-79-35, Dublin, 1979.

ON MONOPOLES WITH AXIAL AND MIRROR SYMMETRY (Talk)

1575. Hsien Ting-Chang, Kuo Shud-Hung, Lee Hwa-Chung. Scientia Sinica, 1979, vol. 22, pp. 149-167.

ON THE PROBLEM OF DUAL CHARGE (MAGNETIC MONOPOLE)

IN NON-ABELIAN GAUGE GROUPS

1576. Huerta R., Parker B. Phys.Rev.,1979, vol.D19, No 10, pp.2953-2960.

PARTICLE SOLUTIONS IN A UNIFIED FIELD THEORY

A numerical solution is obtained for the static electric spherically symmetric field in Bonnor's unified field theory. This solution can be interpreted as a distributed particle with a finite slef-energy. Important constants of the theory K and P are avaluated by assuming the particle carries the electron's charge and mass.

1577. Hughes R.J. Nucl.Phys.,1979, vol.B159, No 1-2,pp.67-76.

MAGNETIC MONOPOLES IN THE PRESENCE OF QUARK SOURCES

Physically static solutions of classical Yang-Mills theory with static external sources are examined. It is found that the system may contain magnetic monopoles of topological origin under certain conditions. Construction of new solutions of this type is shown to be particularly easy in temporal gauge. Equivalence with the system recently introduced by Kalb is demonstrated explicitly.

1578. Hughes R.J. Oxford Univ.,20-79,1979.

MAGNETIC MONOPOLE IN THE PRESENCE OF QUARK SOURCES

1579. Ichiyanagi M. J.Phys.Soc.Jap.,(Japan),1979, vol.47, pp.755-762.

SUPERFLUID FLOW AND ANALOGY TO DIRAC'S MONOPOLE

Taking the depletion effect into consideration in terms of the depletion velocity superfluid flow in an

annulus is disccused. It is shown that in annular regions superfluid flow is the gauge-invariant manifestation of a non-integral phase factor. The circulation is defined in terms of the depletion velocity which is essentially rotational. Arguments akin to Dirac's theory of magnetic monopole are used to obtain quantum mechanical vortex lines which have their ends in fluid.

1580. Jang Pong Soo, Soo Yang Park, Wali K.C. Phys.Rev.,1979, vol.18, No 2, pp.542-548.

INTERACTIONS BETWEEN 'T HOOFT-POLYAKOV MONOPOLES

The authors use the stress-energy tensor and the associated energy-momentum conservation to study the interactions between two widely separated monopoles (or monopole and antimonopole). By defining a set of minimal conditions to represent the above systems, the authors show how the problem reduced mathematically to a known electrostatic problem. The force between the monopoles (or monopole and antimonopole) is then, to the leading order the expected repulsive (attractive) Coulomb force. The authors also discuss how the Prasad-Sommerfield limit alters the problem, leading to twice the Coulomb force between a monopole and antimonopole and zero-force between two monopoles.

1581. Kalb M. Phys.Rev.,1979, vol.D18, No 8, pp.2909-2913.

TIME-INDEPENDENT YANG-MILLS STATICS

The author investigates classical Yang-Mills theory with sources in the limit of no time dependence and finds a class of "Abelian" solutions with nonvanishing magnetic field, even without spatial source-current density. The field is due to nontrivial point magnetic monopoles of topological origin.

1582. Kalb M. Massachusetts Institute of Technology,MIT CTP-778,Cambridge,1979.

A NOVEL HIERARCHIAL STRUCTURE FOR GAUGE FIELDS

1583. Kerner R. Phys.Lett.,1979, vol.B81, No 1,pp.21-24.

THE EXCITED STATES OF THE PRASAD-SOMMERFIELD SOLITON AND ITS SU(3) GENERALIZATION

The author investigates the asymptoric behaviour of the SU(3) magnetic monopole proposed by Sinha(1976) at $r \to 0$ and $r \to \infty$. He gets a series of asymptotic solutions at $r \to \infty$ which can be identified as radial excitations of the monopole. Then, by matching the asymptotic solutions in between athe first maximum of the function describing the excited state, he gets the global approximate solutions. The energy levels are obtained by feeding these solutions into the energy integral.

1584. Kerner R. Proc. Group Theor. Methods in Physics,Austin, 1978. Berlin,1979, pp.29-30.

THE EXCITED STATES OF THE PRASAD-SOMMERFIELD SOLITON AND ITS SU(3)-GENERALIZATION

1585. Kerner R. Phys.Rev.,1979, vol.19, No 4,pp.1243-1247.

ENERGY LEVELS OF THE MAGNETIC MONOPOLE IN THE PRASAD-SOMMERFIELD LIMIT

By analyzing the asymptotic behaviour of the 't Hooft magnetic monopole in the Prasad-Sommerfield limit it is seen that there is no uniqueness of the finite-energy solution due to one degree of freedom recorded. Moreover, this degree of freedom should be quantized in order to get a finite-energy solution. Having at one's dispolsal the asymptotic form of solutions at $r \to 0$ and $r \to \infty$, the author matches them up at some finite value $r = a$ in a C^0-class may, then inserts the result in the energy integral and finds the minimum with respect to the parameter a. Thus he finds the appropriate energy levels of the monopole in the Prasad-Sommerfield limit.

1586. Krolikowski W. Phys.Lett.,1979, vol.B85, No 4, pp.335-337.

CAN NEUTRINOS BE BOUND STATES OF MASSIVE SUPERSYMMETRIC PAIRS

A new relativistic two-body equation is conjectured for a system of one Dirac and one Klein-Gordon particle. It is exactly solved for a massive supersymmetric pair interacting through a Coulombic potential. Then, for the critical coupling constant 2 it leads to a massless stable bound state with spin 1/2.

1587. Kuz'michev V.E., Kharchenko V.F. Theor. and Math.Phys., 1979, vol.31, No 1, pp.328-337.

INTEGRAL EQUATIONS FOR THREE PARTICLES IN THE BOUNDARY CONDITION MODEL

Faddeev's equations for three-particles in a model with two- particle boundary conditions are reformulated so as to eliminate the singularities of the model and they are reduced to a system of one-dimensional integral equations whose kernel is in its turn determined by a different independent system of one-dimensional integral equations. The wave function of three particles with two-particle interaction in a finite number of partial-wave states is determined uniquely by the equations found here.

1588. Kyriakopoulos E. Nuovo Cim.,1979, vol. A52, No 1, pp.23-52.

EXACT DYON SOLUTION IN SU(3) GAUGE THEORY

1589. Kyria/kopoulos E. Athens Techn.Univ.preprint,Athens, 1979.

EXACT DYON SOLUTION IN SU(3) GAUGE THEORY

Two exact finite-energy monopole and dyon solutions are found in an SU_3 gauge theory broken down in the case

of one solution $U_1 \times U_1$ and in the case of the order to U_2 via Higgs scalar fields. One of them is an embedding of O_3 into SU_3 but the other is a genuine irreducible SU_3 solution. Both solutions are stable.

1590. Leznov A.N., Saveliev M.V. Lett.Math.Phys.,1979, vol.3, No 3, pp.207-211.

EXACT MONOPOLE SOLUTIONS IN GAUGE THEORIES FOR AN ARBITRARY SEMI-SIMPLE COMPACT GROUP

The authors construct an exact n-parametric monopole and dyon solutions for an arbitrary compact gauge group G of rank n by using the symmetry between cylindrically symmetric instanton equations in Euclidean space R_4 and monopole equations in Minkowski space $R_{3,1}$ (with Higgs scalar field in adjoint representation). The solutions are spherically symmetric with respect to the total momentum operator $-ir \times \mathrm{curl} + T$, where T represents the minimal embedding of SU(2) in G. Explicit expressions for the monopole magnetic charge and mass matrices are obtained. The remarkable aspect of these results is the existence of discrete series of the monopole solutions, which are labelled by n "quantum" numbers and degenerated in the latter ones at a field monopole mass matrix.

1591. Lohe M.A. Nucl.Phys.,1979, vol.B142, No 3, pp.236-252.

MAGNETIC MONOPOLES AND BACKLUND TRANSFORMATIONS

Backlund transformations are displayed for the equations which describe SU(2) magnetic monopoles in the limit of a vanishing potential. With these transformations a real exact solution describing a three-monopole system, possessing cylindrical symmetry is obtained. However, due to gauge-invariant singularities, the system has infinite energy.

1592. Mack G. and Petkova V.B. Inst. für Theoretische Phys., Univ.Hanburg, DESY 79/22, Hamburg,1979.

Z_2 MONOPOLES IN THE STANDARD SU(2) LATTICE GAUGE THEORY MODEL

The standard SU(2) lattice gauge theory model without fermions may be considered as a Z_2 model with monopoles and fluctuating coupling constants. At low temperatures; KA(=small bare coupling constant) the monopoles are confined

1593. Makagawa N. Tokyo,1979.

QUANTUM THEORY OF THE DIRAC FIELD IN THE PRESENCE OF THE STATIC TOPOLOGICAL MONOPOLE

1594. Mandelstam S. Phys.Rev.,1979, vol.19, No 8, pp.2391-2409.

CHARGE-MONOPOLE DUALITY AND THE PHASES OF NON-ABELIAN GAUGE THEORIES

1595. Marchildou L., Everett A.E., Antippa A.F. Nuovo Cim., 1979, vol.B53, pp.253-283.

ELECTRODYNAMICS AND TACHYONS

1596. Mc Keon G. Nucl.Phys.,1979, vol.B147, No 3-4, pp.299-316.

AN EXTENDED VECTOR THEORY

The possibility of coupling two conserved currents of opposite parity to a single vector field is investigated. The resulting theory has many, but not all, of the properties of the Dirac monopole. A brief discussion of the non-Abelian generalization of the Abelian theory is made.

1597. Mensky M.B. Lett.Math. Phys.,1979, vol.3, No 6,pp.513-520.

APPLICATION OF THE GROUP OF PATHS TO THE GAUGE

THEORY OF QUARKS

A desription is presented of a charged particle in an external gauge field with the help of a previously introduced group of paths. This desription exploits the group representation induced by known contour factors (ordered exponents, holonomy group). Them some novel class of representations is defined by integration of covariantly constant 2-forms. The representation from this class connected with the dual form *F for the strength of field F is shown to describe analogues of test magnetic monopoles and dyons in the gauge theory. The quarks are supposed to be gauge dyons, whose "magnetic" degrees of freedom are connected with a colour.

1598. Miglietta F., Ricci M. Nuovo Cim., 1979, vol. A49, No 1, pp. 93-100.

INFINITE CONSERVATION LAWS FOR THE ELECTROMAGNETIC AND THE ASYMPTOTIC GRAVITATIONAL FIELDS

We obtain two sets of infinite conservation laws for both the electromagnetic and the asymptotic gravitational field. The conservation laws hold for fields generated by insular sources embedded into an asymptotically flat-space-time background. For the electromagnetic field, the general structure of the conservation laws related the time variation of any multiple amplitude of the radial electric field to the outgoing flux of a corresponding multipole amplitude of the transverse magnetic field and vice versa. For l=0 we obtain conservation of the flux of the magnetic induction and of the electric charge. The conservation laws for the gravitational field hold in the asymptotic region only and have a similar structure. A connection to symmetry transformation is given for the c.m. conservation laws only. One set of them corresponds to local gauge invariance. A similar result for the second set of conservation laws requires the formal introduction of an axial c.m. potential, possibly coupled to a magnetic-monopole current.

1599. Mecklenburg W., O'Brien D.P. Phys.Rev.,1979, vol.D18, No 4, pp.1327-1328.

TIME-DEPENDENT PROPERTY OF THE PRASAD-SOMMERFIELD MONOPOLE

The authors show that the Prasad-Sommerfield solution for the 't Hooft monopole can be transformed to an exact time-dependent solution (which is singular on the light cone) of the SU(2) Yang-Mills-Higgs system.

1600. Mikhailov V.F. Alma-Ata Inst.High Energy Phys.,IFVE-AN Kazakhsk.SSR, preprint 74-79, Alma-Ata,1979.

GENESIS AND THE PHYSIC-CHEMICAL ASPECT OF THE SEARCH FOR THE RELIC MAGNETIC MONOPOLE(In Russian)

The negative results of experimental search of the free magnetic monopoles in the nature,its absence way be explained if to admit that the connected system monopole-heavy nucleus in process of nucleogenesis was formated. The probability of the formation of the connected system and the possible concentration of the relict systems at present is calculated in the framework of the flat Universe model.The relative concentration of the connected systems in less than 10^{-18}(Nucleon)$^{-1}$ id obtained. It is possible that the magnetic monopoles,the noticeable influence on the forming of the curve of the spread of the chemical elements in the Universe is exerted.

1601. Minami M. Research Inst. for Math.Sciences,Kyoto Univ., RIMS-286,1979.

DIRAC'S MONOPOLE AND THE HOPF MAP

1602. Minami M. Theor.Phys.,1979, vol.62, No 4, pp.1128-1142.

DIRAC'S MONOPOLE AND THE HOPF MAP

A regular electromagnetic potential $A_\mu(x)$ is found on a 3-sphere which may be regarded as describing the Dirac magnetic monopole in the sense that the field thensor derived from $A_\mu(x)$ gives the monopole strength tensor on a 2-sphere when pulled back by the Hopf map: $S^3 \rightarrow S^2$ .Relationship of $A_\mu(x)$ with the singular potentials is clarified. To represent the magnetic charge an integral formula over S^3 found by Whitehead is employed, which alternatively decomposes into consecutive integrals over S^2 and U(1).

An SO(3) gauge potential is also constructed from the viewpoint that the gauge group associated with $A_\mu(x)$ be little group U(1) to which SO(3) is spontaneously broken back by the "Higgs vacuum". The resulting SO(3)-field is the one on a 3-sphere and proves to be identified with the instanton field at large distances.No dynamical consideration and so no information near the origin are given, within the scope of this paper. It is shown nowever that the Whitehead integral which originally expresses the Hopf invariant as an integer turns out to be the surface integral which expresses the Pontrjagin index of the instanton.

1603. Moore S.M. Dept. de Fisica Univ. delos Andes, ANDES-16(P),Bogata,Colombia,1979.

SOLITONS AND INSTANTONS

1604. Mottola E. Phys.Rev.,1979, vol.19, No 10, pp.3170-3172.

NORMALIZABLE SOLUTIONS TO THE DIRAC EQUATION IN THE PRESENCE OF A MAGNETIC MONOPOLE

The zero-energy Dirac equation of a massless isovector particle in the back-ground field of the 't Hooft-Polyakov magnetic monopole is shown to have only two normalizable solutions.

1605. Mottola E. Phys.Lett., 1979, vol. B80, p.433. Erratum.

ZERO MODES OF THE 'T HOOFT-POLYAKOV MONOPOLE '

1606. Murzin V.S. INTRODUCTION TO COSMIC-RAY PHYSICS, Atomizdat, Moscow, 1979, pp.90-92.

DIRAC'S MONOPOLE

1607. Nahm W. Phys.Lett.,1979, vol.B79, No 4-5, pp.426-428.

THE INTERACTION ENERGY OF 'T HOOFT MONOPOLES IN THE PRASAD-SOMMERFIELD LIMIT

On the Prasad-Sommerfield limit of vanishing Higgs mass the size of 't Hooft monopoles increases when they interact with each other. For monopoles of like charges, their interaction energy decreases at least with the fourth power of the distance.

1608. Nahm W. Phys.Lett.,1979, vol.B85, No 4, pp.373-376.

INTERACTING MONOPOLES

The Bogomolny equation for interacting monopoles of like charge in the case of vanishing Higgs mass is fulfilled by an asymptotic expansion in powers of the inverse monopole distance. Consequently, the monopoles exert no long range forces on each other. However, the expansion is not summable. The degrees of freedom of the multi-monopole system are discussed.

1609. Nahm W. European Organization for Nuclear Research, CERN-TH-2796, Geneva,1979.

A SIMPLE FORMALISM FOR THE BPS MONOPOLE

A simple formalism for the BPS monopole is obtained by generalizing the ADHM construction of multi-instantons to a Hilbert space. Both the potential itself and the Green's functions for different isospin can be obtained with very little effort from the instanton formulae.

1610. Nahm W. Dept. of Applied Math. and Theor. Phys. Univ. of Cambridge, DAMTP 79/1, Cambridge, 1979

INTERACTING MONOPOLES

1611. Nahm W. European Organization for Nuclear Research, CERN-TH-2642, Geneva, 1979.

INTERACTING MONOPOLES

1612. Nakagawa N. Tokyo Univ., UT-329, Tokyo, 1979.

QUANTUM THEORY OF THE DIRAC FIELD IN THE PRESENCE OF THE STATIC TOPOLOGICAL MONOPOLE

The quantum field theories are investigated in the presence of the static 't Hooft-Polyakov monopole. Especially, a soluble model of the Dirac field around this monopole is found. There, the 5-dimensional form invariance apperaing in the Prasad-Sommerfield limit is generalized to the fermion sector. The propagator of the Dirac field is obtained with the help of this form invariance. Besides, the propagators of the fluctuation fields are proved to be replaced by their resolvents in the Feynman rule. These resolvents are also obtained.

1613. Nakagawa N. Tokyo Univ., UT-330, Tokyo, 1979.

QUANTUM THEORY OF FIELDS IN THE PRESENCE OF THE STATIC SOLITONS

The perturbation theoris around the static soliton solutions are constructed in two models. In the (1+1)-dimensional Goldstone model, the explicit forms of the propagator and ot its determinant are obtained around the static link-solution. There, the non-Gaussion zero-modes are proved to give no contributions. Therefore, the propagator is found to be replaced by a more convenient function, resolvent. This formulation is also applied to the (3+1)-dimensional SO(3) Higgs-Kibble model, coupled with Dirac fields. The 5-dimen-

sional form invariance raised by the Prasad-Sommerfield limit is generalized to the fermion sector. And the quantum theory of the Dirac fields around the 't Hooft-Polyakov monopole is found to be soluble in the presence of this invariance. The propagator and the resolvent are obtained by using the techniques of instantons.

1614. Nambu Y. Chicago Univ., EFI-79-26, Chicago, 1979.

QUARK CONFINEMENT: THE CASES FOR AND AGAINST
(Talk)

1615. Nambu Y. Ann. N. Y. Acad. Sci., 1979, vol. 294, pp. 74-79.

MONOPOLES, STRINGS AND INSTANTONS

1616. Narain K.S. Phys. Rev., 1979, vol. D20, No 10, pp. 2555-2565.

PATH INTEGRAL QUANTIZATION OF A DIRAC STRING LAGRANGIAN IN THE $A^o = 0$ GAUGE

It is shown that the path-integral quantization of a magnetic-monopole string Lagrangian can be carried out in the $A^o=0$ gauge without imposing constraints or fixing the gauge completely: longitudinal modes and the string variables associated with the gauge freedom are not eliminated, but the quantum fluctuations of these variables are integrated out in the Feynman path integral, and the electric Coulomb interaction potential and the charge-monopole interaction potential are obtained as effective potentials. The constraints are imposed on the state vectors. It is shown how to construct such state vectors obeying constraints at all times by using the path integral.

1617. Narain K.S. Syracuse Univ., SU-4213-135, New York, 1979.

PATH INTEGRAL QUANTIZATION OF DIRAC STRING LAGRANGIAN IN $A^o=0$ GAUGE

1618. Neinast R.A. Phys.Rev.,1979, vol.19, No 12, pp.,3785-3799.

GAUSSIAN FLUCTUATIONS: 'T HOOFT METHOD AND AN APPROXIMATE METHOD

1619. Nielsen H.B., Olesen P., Niels Bohr Inst.,Copenhagen Univ., NBI-HE-79-17, Copenhagen,1979.

A QUANTUM LIQUID MODEL FOR THE QCD VACUUM. GAUGE AND ROTATIONAL INVARIANCE OF DOMAINED AND QUANTIZED HOMOGENEOUS COLOR FIELDS

1620. Nielsen H.B., Olesen P. Nucl.Phys.,1979, vol.B160, No 2, pp.380-396.

A QUANTUM LIQUID MODEL FOR THE QCD VACUUM. GAUGE AND ROTATIONAL INVARIANCE OF DOMAINED AND QUANTIZED HOMOGENEOUS COLOR FIELDS

We show that domains are formed in a homogeneous SU(2) color magnetic field .Due to quantum fluctuations the domains have fluid properties. It is then argued that quantum mechanically, superpositions of such domains must be considered. The resulting state is gauge and rotational invariant, in spite of the fact that the original color magnetic field breaks these invariances .We point out that in our model for the QCD vacuum, color magnetic monopoles are not confined.

1621. Nikolskii S.I., Tukish E.I., Feinberg E.L., Amatuni A.Ts., Mamidzhanyan E.A., Matinyan S.G. Erevan Phys.Inst., EFI-358(16)-79, Erevan,1979.

INVESTIGATION OF INTERACTIONS OF COSMIC-RAY HADRONS AND NUCLEI AT ENERGIES 10^3-10^5 TEV
(In Russian)

1622. Oh C.H. Phys.Rev.,1979, vol.D18, No 12, pp.4817-4818.

NOTE ON A CLASSICAL SOLUTION FOR THE 'T HOOFT MONOPOLE AND THE JULIA-ZEE DYON

A real stable solution for the SU(2) Yang-Mills field coupled to the Higgs field is constructed from a complex sourceless solution of the Yang-Mills equation. It has the same properties as the Prasad-Sommerfield solution except for a singularity at the origin.

1623. Olive D. Symposium on Mathematical Methods in the Elementary Particles, Liblice, Czechoslovakia,1978. Czech.J.Phys.,Sept.8,1979, vol.B29, No 1,pp.73-80.

SUPERSYMMETRIC SOLITONS

The generalization of the two-dimensional soliton to four space-time dimensions is a magnetic monopole. If the Higgs field lies in the adjoint representation electric and magnetic charges q and g can be defined. If further the Higgs self-interaction vanishes all the particle states obey the universal, dual symmetric mass formula $M=a(q^2 + g^2)^{1/2}$. There is evidence that this is exact in quantum mechanics if the theory is made SO(2) supersymmetric.

1624. Olive D. US Houches Winter Advanced Study Institute. Les Houches,France,1978. Phys.Rev.,1979, vol.49, No 2, pp.165-172.

MAGNETIC MONOPOLES

There are two ways of associating "particles" with non-linear field equations: I. As a quantum excitations - this applies to all field equations and is familiar in text books on quantum field theory. II. As a soliton - this is more familiar in other branches of physics. Certain special non-linear field equations possess smooth classical solutions which resemble particles with structure in that the energy is localized in a small region and does not dissipate in time. There are the soliton solutions. Various questions

naturally pose themselves. Are the descriptions intrinsic or could the particles in nature be equally well described either way, so that the two theoretical descriptions are equivalent. These questions are considered in detail in this paper.

1625. Olive D. Proc. Int.Conf.Hig-Energy Phys., Geneva,1979, vol.1, pp.953-957.

MAGNETIC MONOPOLES

1626. Olive D.I. Proc. Mathematical Problems in Theoretical Physics, Lausanne,1979, pp.249-262.

MAGNETIC MONOPOLES AND NON-ABELIAN GAUGE THEORIES

1627. Olive D.I. Nucl.Phys.,1979, vol.B153, No 1-2,pp.1-12.

THE ELECTRIC AND MAGNETIC CHARGES AS EXTRA COMPONENTS OF FOUR-MOMENTUM

The Georgi-Glashow model leading to the 't Hooft-Polyakov monopole in the limit of vanishing Higgs self-interaction has a hidden symmetry. Whereby the Higgs field is the fifth component of the gauge potential and the electric charge the fifth component of four-momentum. The Higgs field can be gauged away at the expense of a dependence of gauge- dependent quantities upon x^5. This dependence is periodic in vacuo, a situation reminiscent at Kaluza-Klein theory. Suppersymmetrization of the model automatically introduces a sixth dimension whose conjugate momentum is the magnetic charge so that electromagnetic duality is generalized by the 56 rotation. The siedimensional formalism clarifies the universal mass formula generalizing the Englert-Brout-Higgs.-Kibble mechanism and applying to monopole solitons as well as gauge particles and other quantum excitations.

1628. Olive D. London Imperial Coll.,ICTP-78-79-5, London, 1979.

THE ELECTRIC AND MAGNETIC CHARGES AS EXTRA COMPONENTS OF FOUR-MOMENTUM

1629. O'Raifeartaigh L., Park S.Y., Wali K.C. Phys.Rev., 1979, vol.29, No 8, pp.1941-1950.

MAGNETIC MONOPOLE INTERACTIONS

We study the long-range interaction between an arbitrary number of finite-energy monopoles in non-Abelian gauge theories with spontaneous symmetry breakdown. The Higgs fields may belong to either the adjoint representation or to an arbitrary representation of the gauge group G with residual symmetry group U(1). We use the conservation properties of the stress-energy tensor to calculate the instantaneous force on monopoles starting from given initial field configurations. We show that when the Higgs fields belong to the adjoint representation of G, the stress-energy tensor vanishes everywhere in the Prasad-Sommerfield limit leading to a " W-interaction" result for a system of monopoles (or antimonopoles, but not both). When the monopoles are widely separated, one may picture each of them as consisting of a "core" outside which(the exterior region) the Yang-Mills gauge potential obey free-field Yang-Mills equations. We find exact solutions in the exterior region (exterior solutions) and show how they determine the desired long-range interactions through the stress-energy tensor. One is led to a very simple physical interpretation of the interactions as consisting of Coulomb-type attractive or repulsive forces due to magnetic charges and Newtonian or Yukawa-type attractive forces due to Higgs fields. We show how these forces differ when we have the same strength in general. From this result and also the mass spectrum, we find that the conjectured symmetry between gauge particles and finite-energy monopoles is limited to the case when the Higgs fields belong to the adjoint representation.

1630. O'Raifeartaigh L., Park S.Y., Wali K.C. Syracuse Univ., SU-4213-134, New York, 1979.

ON MAGNETIC MONOPOLE INTERACTIONS

1631. Osborn H. Phys.Lett., 1979, vol.B83, No 3-4, pp.321-326.

TOPOLOGICAL CHARGES FOR N=4 SUPERSYMMETRIC GAUGE THEORIES AND MONOPOLES OF SPIN 1

The central charges in the supersymmetry algebra of the N=4 supersymmetry gauge theory are obtained. When spontaneous symmetry breaking is imposed it is shown that the spins of the topological monopole states should be identical to those of the massive elementary particles.

1632. Osborn H. Dept. of Applied Math. and Theor. Phys., Cambridge Univ., DAMPT 79-4, Cambridge, 1979.

TOPOLOGICAL CHARGES FOR N=4 SUPERSYMMETRIC GAUGE THEORIES AND MONOPOLES OF SPIN 1

1633. Ozaki S. Preprint, 1979.

DERIVATION OF THE VARIOUS ADDITION THEOREMS FROM A GLOBAL METHOD FOR EVALUATING GREEN'S FUNCTIONS I (Revised version)

1634. Parsa Z. Am.J.Phys., 1979, vol.47, No 1, pp.56-62.

TOPOLOGICAL SOLITONS IN PHYSICS

The author presents an introduction to topological solitons. A broad definition of solitons and a discussion of their role in physics is given. To illustrate this concept, the author describes in some detail vortices and magnetic monopoles which are examples of topological soli-

tons in two and three spatial dimensions.

1635. Prasad M.K. New York State Univ., ITP-SB-79-99, Stony Brook, 1979.

INSTANTONS AND MONOPOLES IN YANG-MILLS GUAGE FIELD THEORIES

1636. Price P.B., Shirk K.E., Osborne W.Z., Pinsky L.S., Phys.Rev.,1979, vol.D18, No 5, pp.1382-1421.

FURTHER MEASUREMENTS AND REASSESSMENT OF THE MAGNETIC-MONOPOLE CANDIDATE

1637. Preskil J.P. Phys.Rev.Lett.,1979, vol.43, No 19, pp.1365-1366.

COSMOLOGICAL PRODUCTION OF SUPERHEAVY MAGNETIC MONOPOLES

Grand unified models of elementary particle interactions contain stable superheavy magnetic monopoles. The density of such monopoles in the early universe is estimated to be unacceptably large. Cosmological monopole production may be suppressed if the phase transition of the grand unification mass scale is strongly first order.

1638. Preskil J.P. Harvard Univ., Lyman Lab. of Phys.,HUTP-79/A028, Cambridge,1979.

COSMOLOGICAL PRODUCTION OF SUPERHEAVY MAGNETIC MONOPOLES

1639. Rebbi C. Sci.Am.,1979, vol.240, No 2, pp.76-91.

SOLITONS

1640. Rossi P. Nucl.Phys.,1979, vol.B149, No 1, pp.170-188.

PROPAGATION FUNCTIONS IN THE FIELD OF A MONOPOLE

The prasad-Sommerfield (1975) and Bogomolny(1976) (PSB) static monopole field is shown to be equivalent to an infinite sequence of Yang-Mills instantons, and the equivalence between the monopole sector of the PSB model and the static Euclidean Yang-Mills field is extended to the equations for the propagators. The explicit construction of the static propagation functions in the field of a monopole is then accomplished with the help of previous results in instanton theory. A purely geometrical interpretation of the classical effects of instantons and monopoles is given.

1641. Ruck H.M., Biedenharn L.C. Phys.Rev.,1979, vol.D20, No 8, pp.2089-2090.

COMMENT ON THE MOTION OF A SPIN-1/2 PARTICLE IN THE FIELD OF MAGNETIC MONOPOLE

We give an algebraic formulation of the theory of Kazama, Yang and Goldhaber and discuss the significance of the singular case of lowest angular momentum.

1642. Samuel S. Nucl.Phys.,1979, vol.B154, No 1, pp.62-110.

TOPOLOGICAL SYMMETRY BREAKDOWN AND QUARK CONFINEMENT

The manner by which topological symmetry breakdown leads to confinement in a non-Abelian gauge theory is discussed.

1643. Samuel S. Lawrence Berkeley Lab., LBL-8604, Berkeley, 1979.

TOPOLOGICAL SYMMETRY BREAKDOWN AND QUARK CONFINEMENT

1644. Samuel S.A. Thesis Lawrence Berkeley Lab.,LBL-9168, Berkeley, USA,1979.

STATISTICAL MECHANICS AND FIELD THEORY

1645. Satikov I.A., Strazhev V.I. Yad.Fiz.,1979, vol.30, No 5, pp.1379-1381.

ALLOWED VALUES OF THE QUARK MAGNETIC CHARGES IN DYONIC MODELS OF HADRONS(In Russian)

Restrictions are formulated for the possible magnetic charges of dyons, resulting from the Dirac charge quantization condition and with identification of the magnetic charge to the colour quantum number.

1646. Sawada T. Univ.Tsukubo, Inst. of Phys., UTHEP-42, Ibaraki,1979.

DISCREPANCIES IN PARTIAL WAVE DISPERSION RELATIONS AND A POSSIBLE STRONG VAN DER WAALS FORCE

1647. Sayed W.A. Phys.Rev.,1979, vol.20, No 6, pp.1465-1467.

MONOPOLE SOLUTIONS FOR STRONG GRAVITY COUPLED TO SO(3) GAUGE FIELDS

1648. Schoufeld J.F. Laboratoire de Physique Theoretique, Ecole Normale Superieure, LPTENS 79-25, Paris,1979.

DYNAMICAL SYMMETRY AND MAGNETIC CHARGE

1649. Scott D. Imperial Coll. ,Dept. of Theor.Phys.,ICTP-78-79-5A,London,1979.

ON THE EXISTENCE AND SMOOTHNESS OF SPHERICALLY SYMMETRIC MONOPOLE SOLUTIONS IN NON-ABELIAN GAUGE THEORIES
(Revised version)

1650. Scott D.M. Imperial Coll.,Dept. of Theor.Phys.,ICTP-78-79-32, London,1979.

MONOPOLES IN A GRAND UNIFIED THEORY BASED ON SU(5)

1651. Sivaram C.,Sinha K.P. Phys.Rep.,1979, vol.51, No 3, pp.111-187.

STRONG SPIN-TWO INTERACTION AND GENERAL RELATIVITY

The concept of short range strong spin-two (f) field (mediated by massive f -mesons) and interacting directly with hadrons was introduced along with the inifinite range (g) field in early seventies. In the present review of this grouwing area(often referred to as strong gravity) we give a general relativistic treatment in terms of Einstein-type (non-Abelian gauge) field equations with a coupling constant $G_f \simeq 10^{38} G_N$(G_N being the Newtonian constant) and a cosmological term $\Lambda_f f_{\mu\nu}$ ($f_{\mu\nu}$ is strong gravity metric and $\Lambda_f \approx 10^{28}$ cm^2 is related to the f -meson mass).The solutions of field equations linearized over de Sitter (uniformly curves) background are capable of having connections with internal symmetries of hadrons and yielding mass formulae of SU(3) or SU(6) type. The hadrons emerge as de Sitter "microuniverses" intensily curred within (radius of curvature 10^{-14}cm).

The study of spinor fields in the context of strong gravity has led to Heisenberg's nonlinear spinor equation with a fundamental length $\sim$ 2x 10^{-14}cm. Furthermore, one

finds repulsive spin-spin interaction when two-identical spin 1/2 particles are in parallel configuration and a connection between weak interaction and strong gravity.

Various other consequences of strong gravity embrace black hole(solitonic) solutions representing hadronic bags with possible quark confinement. Regge-like relations between spins and masses, connection with monopoles and dyons, quantum geons and friedmons, hadronic temperature, prevention of gravitational singularities, providing a physical basis for Dirac's two metric and large numbers hypothesis and projected unification with other basic interactions through extended supergravity.

1653. Staruszkiewicz A. Acta Phys.Pol.,1979, vol.B10, No 7, pp.601-606.

THE PARADOX OF A LORENTZ INVARIANT CURRENT AND CHARGE QUANTIZATION

It is argued that the electric charge $e'=4\pi/e$ where e is the charge of the electron, plays a distinguished role, similar to the role of Dirac's magnetic charge $g=1/2e$.

1654. Steinman O. Univ.Bielfeld, Dept.of Theor.Phys., BI-TP-79-38, Bielfeld,1979.

SOLITON QUANTIZATION IN GAUGE THEORIES

We study the quantization of the SO_3 gauge theory which possesses the 't Hooft-Polyakov monopole as a classical solution. The one-monopole sector of this model is constructed in lowest-order perturbation theory, with as expansion parameter. Explicit expressions for the fields are given and their properties discussed. We use a manifestly covariant formalism.

1655. Stump D.R. Indiana Univ. Bloomington,IUHET-42,Bloomington,Indiana,1979.

ANALOGUES OF MERONS AND MERON PAIRS IN THE XY MODEL

1656. Stump D.R. Phys.Dept.,Indiana Univ., Bloomington - IUHET-44, Bloomington,Indiana,1979.

THE INSTANTANEOUS COULOMB INTERACTION FOR A LONG-RANGE BACKGROUND FIELD IN QUANTUM CHROMODYNAMICS

1657. Stump D.R. Phys.Rev.,1979, vol.D20, No 8, pp.1965-1981.

INSTANTANEOUS COULOMB INTERACTION FOR A LONG-RANGE BACKGROUND FIELD IN QUANTUM CHROMODYNAMICS

The instantaneous Coulomb interaction is studied in the SU(2) Yang-Mills theory. The Coulomb -Green's function and instantaneous Coulomb potential of a static quark-antiquark pair are evaluated for a background gauge field $A_a^i(\vec{x})$ that is spherically symmetric and of long range, i.e., that is of order $|\vec{x}|^{-1}$ as $|\vec{x}| \to \infty$. The field $A_a^i(\vec{x})$ is of the same form as the Wu-Yang magnetic-monopole field. Expansion of the Coulomb Green's function in vector spherical harmonic functions reduces the problem to a radial problem. It is shown that the background field changes the asymptotic form of the instantaneous Coulomb interaction; specifically for the monopole field the correction term is of the same magnitude as the ordinary Coulomb interaction at large distances. In addition, the instanton contribution to the $q\bar{q}$ potential energy is calculated in the temporal-gauge formulatio of the theory, and compared to the instantaneous Coulomb interaction. This calculation illustrates the interpretation of instantons as tunneling field configurations. The possibility that long-range field fluctuations with the magnetic-monopole form occur in an ionized meron phase of quantum chromodynamics is discussed.

1658. Stump D.K. Phys.Rev.,1979, vol.20, No 10, pp.2592-2605.

ANALOGS OF MERONS AND MERON PAIRS IN THE XY MODEL

A path-integral formula for the vacuum wave functional is used to show that merons in quantum chromodynamics produce long-range vacuum fluctuations of the form of Wu-Yang monopoles, whereas meron pairs or instantons produce only short-range fluctuations. The existence of long-range vacuum fluctuations may be related to the problem of quark confinement. The XY model, which describes classical two-component spins on a two-dimensional lattice, is reviewed. Vortex spin-field configurations, which are responsible for the existence of a disordered phase in the XY model, are shown to be analogous to merons that they produce long range fluctuations of the spins doing a given axis. The analogy is emphasized by considering the analog of the vacuum wave functional in the XY model. It is argued that the vortex-antivortex pairs that occur in the ordered phase of the XY model are analogous to meron pairs or instantons in quantum chromodynamics.

1659. Tataru-Mihai P. Let. Math. Phys., 1979, vol. 3, No 5, pp. 437-444.

ON THE PRASAD-SOMMERFIELD DYON(MONOPOLE) SOLUTION

The author proves that the Prasad-Sommerfield dyon (monopole) solution for an SU(2) Yang-Mills field coupled with an SU(2) Higgs multiplet can be associated to a certain minimal immersion in S^3 ($\simeq$ SU(2)), i.e. it has a differential-geometric content similar to that of self-dual solutions for the pure SU(2) Yang-Mills field. Implications of this result as well as possibilities to extend it to higher gauge groups are discussed.

1660. Tataru-Mihai P. Starnberg MPI Lebensibedingungen, preprint, 1979.

ON THE PRASAD-SOMMERFIELD DYON(MONOPOLE) SOLUTION

1661. Tchrakian D.H. Dublin Inst. Adv. Studies, Kaiserslautern, DIAS-STP-79-12, Dublin, 1979.

AXIALLY SYMMETRIC PRASAD-SOMMERFIELD MONOPOLE

An axialty symmetric monopole solution expressed in terms of two parameters is found. It has unit magnetic charge and one of the parameters corresponds to a $\mathcal{L}$ - transition. At large distances from the origin, where the translational parameter is negligible, the solution is identical with the spherically symmetric Prasad-Sommerfield solution.

1662. Tchrakian D.H. Dublin Inst.Adv.Studies, DIAS-STP-79-28, Dublin,1979. Lectures given at the "Mathematical Physics Colloquium", Trapezon,Istanbul,1979.

SELF DUAL SOLUTIONS TO GAUGE FIELD EQUATIONS ON N DIMENSIONAL MANIFOLDS

1663. Tereshenkov V.I., Tomil'chik L.M. Vestsi Akad.Nauk Belorussk.SSR, ser. fiz.-mat.,No 3, pp.78-84,1979.

ON RETARDED POTENTIALS FOR THE DIRAC MONOPOLE

For a special parametrization of the Dirac string world surface the explicit expressions for retarded potential of an arbitrarily moving monopole have been found. In the static limit, the expressions obtained coincide with the Dirac potential for the monopole at rest.

1664. Ting-Chang H., Shuo-Hung K.,Hwa-Chung L. Sci.Sin.,1979, vol.22, No 2, pp.149-167.

ON THE PROBLEM OF DUAL CHARGE (MAGNETIC MONOPOLE) IN NON-ABELIAN GAUGE GROUPS

A connection of the spherical surface-gauge potential correspondence method is developed to obtain spherical symmetric solutions of sourceless gauge field with SU(2), SO(5) and SO(N) symmetry. The relation between gauge transformation and the rotation of the frame attached on the

spherical surface is presented. It is shown that only in the four dimensional case that the spherical symmetric solutions of sourceless gauge field with SO(N) symmetry can be a pseudo-particle solution with finite energy.

1665. Tolkachev E.A., Tomil'chik L.M. Phys.Lett.,1979, vol. B81, No 2, pp.173-174.

SPACE-REFLECTION OPERATION AND THE BOSON-FERMION PUZZLE IN A DYONIUM MODEL

The proof of the correct spin-statistics connection for a dyonium model is given by means of the definition of interchange of identical particles via the space-reflection operation in their center of mass system. The connection between the P-reflection operation and the singularity line rotations is discussed.

1666. Tomil'chik L.M. Doct.Thesis, Inst. of Phys.,Akad.Nauk Belorussk.SSR.

DUAL INVARIANCE AND MAGNETIC CHARGE IN ELECTRODYNAMICS

1667. Tomil'chik L.M. Inst. of Phys.,Akad.Nauk Belorussk. SSR, Preprint No 180,Minsk,1979.

VARIATIONAL PRINCIPLE IN ELECTRODYNAMICS WITH TWO-TYPES OF CHARGES AND RELATIVISTIC STRING MODEL

1668. Janeya T. Nucl.Phys.,1979, vol.B153, No 3-4, pp.365-401.

MONOPOLE CONDENSATION AND QUARK CONFINEMENT IN A WEAK COUPLING SU(N) LATTICE GAUGE MODEL

A model of SU(N) lattice Yang-Mills theory which

exhibits asymptotic freedom and permanent quark confinement simultaneously is presented. The author argues that in the limit of vanishing bare gauge-coupling constant, the model is approximately mapped by a duality transformation to the coupling phase of a Z(N) lattice gauge model. Existence of the continuum limit with the vanishingly small bare coupling constant (asymptotic freedom) requires one to make the duality map at the critical point of the Z(N) model. The mechanism of quark confinement is the condensation of magnetic monopoles and associated vortex strings which are topologically characterized by Z(N) group structure.

1669. Tsou Sheung Tsun Acta Phys.Pol.,1979, vol.B10, No 3, pp.219-227. Presented at the XVIII Cracow School of Theoretical Physics, Zakopane,1978.

A SHORT INTRODUCTION TO THE MATHEMATICAL FORMULATION OF GAUGE THEORY(Talk)

Some mathematical concepts in the formulation of gauge theory are gathered together with emphasis on their physical and geometric interpretation.

1670. Tsou S.T. CERN-TH-2535,1979.

1671. Troost W. Cargese Summer Inst.,1977 on Hadronic Structure and Lepton-Hadron Interactions. Plenum,New York,1979, pp.603-621.

MAGNETIC MONOPOLES IN CLASSICAL FIELD THEORIES

The subject of magnetic monopoles will be treated from a purely theoretical point of view. An exploration will be made into classical field theories to try and find solutions of classical field equations with a magnetic

charge, without introducing this charge as a quantum number of the fields at the start.

1672. Tu Tung-Sheng, Yang Cheng-Wing, Wu Tai-Tsun (China), Sci.Sin., 1979, vol.21, No 3, pp.317-326.

INTERACTION OF ELECTRONS, MAGNETIC MONOPOLES AND PHOTONS. I.

Using a method developed for treating monopole harmonics, the authors present in this series of papers a second quantized theory of interacting electrons magnetic monopoles, and photons. In this paper they discuss a system of interacting electrons, monopoles and the electromagnetic field. The electrons and monopoles are treated as spin 1/2 Dirac particles with the negative energy states not filled.

1673. Urrutia L.F. Phys.Rev., 1979, vol.D18, No 8, pp.3031-3034.

ZEROTH-ORDER EIKONAL APPROXIMATION IN RELATIVISTIC CHARGED-PARTICLE-MAGNETIC-MONOPOLE SCATTERING

The relativistic spin-1/2 charged-particle-magnetic-monopole scattering is considered in the high-energy, low-momentum-transfer limit. Under these circumstances the differential cross section is calculated in the zeroth-order eikonal approximation and shown to be independent of the choice of the singularity line. Out the same context the remote contribution to the variation of the action induced by a change in the singularity line is shown to be non-zero, contrary to what is usually assumed.

1674. Vecchia P.D., Ravndal F. Phys.Lett., 1979, vol.A73, No 5-6, pp.371-373.

SUPERSYMMETRIC DIRAC PARTICLES

Relaxing the requirement of parametrization invariance the authors present a supersymmetric Lagrangian for a

massive, spinning particle without having to use a five-dimensional formalism. The quantized theory describes a spin-1/2 Dirac particle whose propagator is calculated.

1675. Viswanathan K.S.,Yee J.H. Phys.Rev.,1979, vol.D19, No 6, pp.1906-1911.

FIRST-ORDER PHASE TRANSITIONS IN GAUGE THEORIES

The statistical mechanics of field theories with broken, global and local SU(3) gauge symmetries is studied in the one-loop approximation. The presence of a cubic term in the potential, when allowed by symmetry, is to restore the symmetry by a first-order phase transition rather than by a second-order transition. The transition teperatures are estimated to be too low for a finite density of magnetic monopoles to be excited.

1676. Wang Ke-Lin, Xsien Ting-Chang,Cheng Hsi-Teh. Phys.Energ.Fortis and Phys.Nucl.,1979, vol.2, No 5, pp.403 410.

ON THE SU(4) MONOPOLE AND DYON SOLUTIONS

A simple method is proposed to obtain the classical monopole and dyon solutions in the case of SU(4) symmetry, which can be systematically generalized to the general case of SU(N). The solutions obtained in the SU(4) case correspond to magnetic charges of $\pm g^{-1}$, $\pm$ 3/2g, $\pm$ 1/ 2g.

1677. Wang Pei, Hou Eo-Yu. Phys.Energ. Fort.Phys.Nucl., 1979, vol.3, pp.571-581.

THE MULTISYNCHRO-SPHERICAL SOLUTIONS OF THE SU(N) GAUGE THEORY (In Chinese)

1678. Weder R. Univ.Nacional Autonoma de Mexico,1979. Communicaciones Tecnicas,1979, vol.10,No 202.

EXISTENCE OF MONOPOLES IN SU(3) YANG-MILLS-

We give a vigorous proof of the existence of two time independent, finite energy, infinitely differentiable solutions to the Yang-Mills-Higgs equations of a SU(3) gauge theory. One of them is a unit monopole and the other has 1/2 unit of magnetic charge. We prove exponential decay of infinity. In this way we obtain a vigorous proof that the gauge fields have a massive part as is expected from the Higgs mechanism.

1679. Weinberg E.J. European Organization for Nuclear Research, CERN-TH-2779, Geneva, 1979.

FUNDAMENTAL MONOPOLES AND MULTIMONOPOLE SOLUTIONS FOR ARBITRARY SIMPLE GAUGE GROUPS

Magnetic monopole solutions for an arbitrary compact simple gauge group are considered in the Prasad-Sommerfield limit. For each group and choice of symmetry breaking there is a set of fundamental monopoles with minimal topological charges and possessing no internal degrees of freedom; the number of these is less than or equal to the rank of the gauge group. It is shown that if the unbroken gauge group is non-Abelian, all solutions with higher topological charges belong to parameter families, where p is the number of position and group orientation parameters needed to describe a set of non-interacting fundamental monopoles with the given topological charge. It is argued that these solutions, some examples of which are given, should therefore be interpreted as multimonopole configurations. An extension of these results to the case of a non-Abelian unbroken gauge symmetry is conjectured and shown to be valid for a number of examples.

1680. Weinberg E.J. Phys.Rev., 1979, vol.D20, No 4, pp.936-944.

PARAMETER COUNTING FOR MULTIMONOPOLE SOLUTIONS

SU(2) magnetic monopole solutions are considered in the Prasad-Sommerfield limit. It is shown that any solu-

tion with N units of magnetic charge belongs to a (4N-1)-parameter family of solutions. It is conjectured that these parameters correspond to the positions and relative U(1)-orientations of N non-interacting unit monopoles.

1681. Wilkinson D. ,Bais F.A. Phys.Rev.,1979, vol.19, No 8, pp.2410-2415.

EXACT SU(N) MONOPOLE SOLUTIONS WITH SPHERICAL SYMMETRY

Exact monopole solutions are constructed for an SU (N+1) gauge theory spontaneously broken by a single Higgs field in the adjoint representation. The solutions saturate the Bogomolny lower bound on the energy and are spherically symmetric with respect to the angular momentum operator J =-ir x NABLA + T, where T generates the maximal SU(2) subalgebra of SU(N+1). The authors solutions are the most general ones with the above symmetry and contain N real parameters which may be thought of as specifying the nature of symmetry breaking. When this symmetry breaking is such that the scalar field matrix has repeated eigenvalues, it is found that only one of the possible point monopoles has a corresponding finite-energy solution saturating the Bogomolny bound.

1682. Wilson W., Swamy N.U.U.J., Phys.Lett.,1979, vol.72A, No 2, pp.188-190.

POSSIBILITY OF DETECTING MAGNETIC CHARGES USING PULSAR EMISSION

Modification of well-known plasma-wave dispersion relations due to particles breaking magnetic charge is presented. If these charges exist in the interstellar medium the effects of the new modes they allow way be detectable in pulsar emission.

1683. Witten E. Phys.Lett.,1979, vol.86B,No 3-4, pp.283-287.

DYONS OF CHARGE $e\theta/2\pi$

It is shown that in CP non-conserving theories the electric charge of a't Hooft-Polyakov magnetic monopole will not ordinarily be integral or even rational in units of the fundamental charge e. If a non-zero vacuum angle θ is the only mechanism for CP violation, the electric charge of the monopole is exactly calculable and is $-e\theta/2\pi$ plus an integer. If there are additional CP violating interactions, the monopole charge must ne computed as a power series in the coupling constant. These results apply in realistic theories such as SU(5).

1684. Witten E. European Organization for Nuclear Research, CERN-TH-2724, Geneva,1979.

DYONS OF CHARGE $e\theta/2\pi$

1685. Witten E. Harward Univ.,Cambridge,HUTP-79-A007, Cambridge,1979.

BARYONS IN THE 1/N EXPANSION

1686. Witten E. Nucl.Phys.,1979, vol.B160, No 1, pp.57-115.

BARYON IN THE 1/N EXPANSION

In this paper the existing results concerning mesons and glue states in the large-N limit of QCD are reviewed and it is shown how to fit baryons into this picture.

1687. Wu Yong-Shi,Chen Shih,Kuo Han-Ying. Sci.Sin.,1979, vol.21, No 2, pp.193-206.

$U_2 \simeq SU_2 \times U_1$ INVARIANCE OF PRINCIPLE BUNDLES FOR MAGNETIC MONOPOLES AND ITS PHYSICAL IMPLICATIONS

1688. Xia Dao-Xing Fudan J.(China),1979, No 2, pp.8-13.

ON THE COMMUTATIONAL RELATION IN THE GLOBAL GAUGE THEORY FOR GROUP U(1)

Weyl type commutational relations for the Dirac monopole without singularity strings in global gauge theory for group U(1) is discussed and a unique Van Neumann type theorem is established for this type of commutational relation.

1689. Yang C.N. Acta Sci.Nat.Univ.Sunyatseni,1979,No 2, pp.129-139.

MAGNETIC MONOPOLES FIBRE BUNDLES AND GAUGE FIELDS

1690. Yang C.N. Proc. 19-th International Conference on High Energy Physics, Tokyo, 1978.Tokyo,1979,pp.497-500.

DEVELOPMENT IN THE THEORY OF MAGNETIC MONOPOLES

A brief review of works dedicated to the Dirac magnetic monopole theory which includes the following items: topological reasons for the appearance of singularities; electron interaction with a universaly heavy static monopole; building of cosmic Lagrangian which describes electron and monopole interaction; and a method of secondary quantization for this system.

1691. Yang C.N. European Organization for Nuclear Research, CERN-TH 2725, Geneva,1979.

FIBRE BUNDLES AND THE PHYSICS OF THE MAGNETIC MONOPOLE

1692. Yang C.N. Ann.N.Y.Acad. Sci.,1979, vol.294, pp.86-97.

MAGNETIC MONOPOLES,FIBRE BUNDLES AND GAUGE FIELDS

1693. Yang C.N. J.Math.Phys.,1979, vol.19, No 12, pp.2622-2627.

SU_2 MONOPOLE HARMONICS

For a particle of I-spin I in an SU_2 monopole field in five-dimensional Euclidean space, the monopole harmonics are found. They belong to the irreducible representation $(p,q)_5$ where $p = q + 2I$. They form a complete set of wave sections.

1694. Yoneya T. Nucl.Phys.,1979, vol.B153, No 3-4,pp.431-444.

MONOPOLE CONDENSATION AND QUARK CONFINEMENT IN A WEAK COUPLING SU(N) LATTICE GAUGE MODEL

A model of SU(N) lattice Yang-Mills theory which exhibits asymptotic freedom and permanent quark confinement simultaneously is presented.It is argued that in the limit of vanishing have gauge-coupling constant,the model is approximately mapped by a duality transformation to the confining phase of a Z(N) lattice gauge model. Existence of the continuum limit with the vanishingly small bare coupling constant (asymptoting freedom) requires one to make the duality map at the critical point of the Z(N) model. The mechanism of quark confinement is the condensation of magnetic monopoles and associated strings which are topologically characterized by Z(N) group structre.

1695. Yoneya T. Sapporo Hokkaido Univ.,preprint,1979.

MONOPOLE CONDENSATION AND QUARK CONFINEMENT IN A WEAK COUPLING SU(N) LATTICE GAUGE MODEL

1696. Zadoo T.K., Ahmad M., Handoo B.B. Indian J. Pure and Appl. Phys.,1979, vol.17, No 8, pp.535-537.

MAGNETIC DIPOLE MOMENTS OF CHARMED BARYONS AND THE MAGNETIC QUARKS

The theory that Dirac's magnetic monopoles have aspects similar to the conventional quarks is used for studying the magnetic dipole moments of charmed baryons.

1697. Zadoo T.K., Ahmad M. Indian J. Pure and Appl.Phys., 1979, vol.17, No 3, pp.152-157.

CHARMED HADRONS, ELECTRIC QUARKS AND MAGNETIC QUARKS

The theory that Dirac's magnetic monopoles have aspects similar to the conventional quarks is sued for studying charmed baryons. Mass relations between charmed and uncharmed baryons are derived.

1698. Zeldovich B.Ya., Khlopov M.Yu. Phys.Lett.,1979,vol.B79, No 3, pp.239-241.

ON THE CONCENTRATION OF RELIC MAGNETIC MONOPOLES IN THE UNIVERSE

The modern concentration of relic 't Hooft-Polyakov monopoles is shown to amount to $\sim 10^{-19}$ cm^{-3}, being determined by the diffusion annihilation rate at $t < 10^{-5}$s. To eliminate the contradiction with experimental upper limits some mechanism similar to quark confinement should forbid free monopole existence.

1699. Zia R.K.R. Amer.J.Phys.,1979, vol.47, No 8, pp.700-703.

CLASSICAL ORBITS OF A CHARGED PARTICLE IN A MAGNETIC MONOPOLE FIELD

The orbits of a charged particle in the magnetic field due to a magnetic monopole are reexamined and interpreted intuitively: they are straight lines (geodesis) on a cone. The general case in which an arbitrary central force is superimposed is analyzed. It is shown that bound orbits in the central force which do not ordinarily chose may be closed by the addition of a monopole of suitable strength

1700. Zin Sun Fudan J. 1979, No 4, pp.52-58(China).

BOUND STATES COMPOSED OF THE BARYON AND THE MONOPOLE

1701. Zrelov V.P. Joint Inst,for Nuclear Research,JINR-12289, Dubna,1979,

ON A HYPOTHETICAL POSSIBILITY OF THE SEARCH FOR DIRAC'S MONOPOLE

The present investigation for the magnetic charges "g" introduces the independent equations of Maxwell where $div\,\vec{B} = 4\pi\rho_m$ and $div\,\vec{D} = 0$,i.e. the equations describing electromagnetic phenomena in the world consisting of only magnetic matter (the "g" world). It is postulated that magnetic matter should consist of atoms similar to Bohr's ones, and the fine structure constant should be universal for our world (the world "e") and world "g", i.e. $\frac{e^2}{\hbar_e c} = \frac{g^2}{\hbar_g c} = \alpha$. As a result, with $e \neq g$, the Planch constant $\hbar_g$ and $\hbar_e$ of the "g" and "e" worl are not equal ($\hbar_g \neq \hbar_e$). With the relationship of "g" and "e" predicted by Dirac $(g = \frac{e \cdot n}{2\alpha})$ it is possible to obtain the relation for $\hbar_g$ and $\hbar_e$ as $\hbar_g = n^2/4\alpha^2 \cdot \hbar_e$ .Some possible displays of magnetic matter in-space and at accelerators are discussed.

1980

1702. Ahlen S.P. Rev.Mod.Phys.,1980, vol.52, No 1, pp.121-175.

THEORETICAL AND EXPERIMENTAL ASPECTS OF THE ENERGY LOSS OF RELATIVISTIC HEAVILY IONIZING PARTICLES

We review the theory of the electromagnetic interactions between rapidly moving charged particles and the matter T-H Rough which they pass. The emphasis will be on very massive electric ($-100 \leq Z_1 \leq 100$) and magnetic ($|g| = 137$ E and 137 E/2) particle moving with relativistic velocities ($\beta > 0.2$, $\gamma < 100$). Consideration will be given to both the stopping power of the projectile and to the response of the absorbing medium to the exitation caused by the projectile.

1703. Akhoury R., Goldhaber A.S. Phys.Rev.,1980, vol.D21, No 2, pp.454-465.

LINEAR DEFORMATIONS OF THE PRASAD-SOMMERFIELD MONOPOLE

The Bogomolny equation for linear perturbations of the Prasad-Sommerfield monopole is solved exactly. Explicit expressions for all the normalizable and unnormalizable nongauge modes are obtained, and previous results of Mottola on the normalizable modes are confirmed. A new choice of gauge facilitates the solution. Open questions and possible applications are mentioned.

1704. Bais F.A., Rudaz S. Geneva,1980.

ON THE SUPPRESSION OF MONOPOLE PRODUCTION IN THE VERY EARLY UNIVERSE

1705. Balachandran A.P., Stern A. Nucl.Phys.,1980, vol.B162, No 3, pp.385-396.

MAGNETIC MONOPOLES WITH NO STRINGS

Previous treatments of the charge-monopole system have used either a Lagrangian singular along the Dirac string or a multiple valued action integral. Here we formulate an action principle for this system which involves no strings and is single valued. This is achieved by writing the Lagrangian directly in terms of the variables of a suitable fibre bundle. Canonical quantization is carried out in a simple way and known results are recovered.

1706. Balachndran A.P., Marmo G., Skagerstam B.S. Nucl.Phys.,1980, vol.B164, No 3, pp.427-444.

SUPPERSYMMETRIC POINT PARTICLES AND MONOPOLES WITH NO STRINGS

In previous work, an action principle for the charge monopole system was developed and it was canonically quantized. The action was single valued and free of string singularities. In this work, we supersymmetrize the preceeding action and canonically quantize this new action. It describes a charged spin-half particle of gyromagnetic ratio 2 in a magnetic monopole field. It is shown that if a system admits only local Lagrangians for a configuration space Q, then under certain conditions, it admits a global Lagrangian when Q is enlarged to a suitable U1 bundle over Q. The charge monopole system is an example of such a system. Conditions under which a symplectic form is derivable from a Lagrangian are also found.

1707. Banks T., Horn D. Phys.Rev.,1980, vol.D21, No 8, pp.2423-2424.

COMMENT ON PHASE TRANSITIONS IN Z(N) GAUGE THEORIES

We present an intuitive explanation of the first-order nature of the phase transitions in the four-dimensional Z(N) gauge theories for $N \leqslant 4$ in terms of the effective potential for electric and magnetic monopoles.

1708. Boratav M. European Organization for Nuclear Research, CERN-EP, 80-77, Geneva, 1980.

FROM QUARKS TO TACHYONS: A REVIEW OF FUNDAMENTAL PARTICLE HUNTING

1709. Borbiellini G., Bonnecud G., Coshmare R.L., Coignet G., Ellis J., Giallard M.K., Grivaz J.F., Matteuzzi C., Peccei R.D., Wiik B.H. Deutsches Elektronen-Synchrotron, DESY 8/42, Hamburg, 1980.

QUARKS AND MONOPOLES AT LEP

1710. Brandt R.A., Young K. Nucl.Phys., 1980, vol. B162, No 1, pp.168-188.

ELECTRIC-MAGNETIC DUALITY AS A SECONDARY SYMMETRY

1711. Brandt R.A, Neri F. New York Univ., NYU/TR4/80, New York, 1980.

SINGULAR GAUGE TRANSFORMATIONS AND MAGNETIC MONOPOLES

In theories of magnetic monopoles, the invariance group must be enlarged to include singular local gauge transformations. A conventional classical non-Abelian gauge theory is invariant only to gauge transformations U(x) which are non-singular in the sense that $(\partial_\mu \partial_\nu - \partial_\nu \partial_\mu) \underline{U}(x) = 0$; but it magnetic charge is introduced, additional gauge transformations $\underline{V}(x)$ for which $(\partial_\mu \partial_\nu - \partial_\nu \partial_\mu) \underline{V}(x)$ [illegible] and must be included. This

paper is devoted to the study and application of such singular gauge transformations. It is seen that physical observables in monopole theories must be invariant under both non-singular and singular transformations. The latter are necessary to move the unphysical singular strings and thus establish the Lorentz invariance of monopole theories provided that the magnetic charge is quantized. Previously Lorentz invariance was proved only in simple special cases. Singular transformations are also necessary to remove the strings and thus lead to the construction of non-singular monopoles provided that the quantized magnetic charge is suitably chosen. The string removing gauge transformation is seen to map the magnetic charge matrix to zero. Also discussed are the nature of singularities in $\underline{V}(x)$, the effect of these singularities on the non-Abelian equations of motion (e.g. the failure of the Bianchi identity), and the representation of $\underline{V}(x)$ as a path-ordered exponential of a line integral.

1712. Brandt R.A., Neri F. MAGNETIC MONOPOLES IN SU(N) GAUGE THEORIES., New York Univ., NYU/TR1/80, New York, 1980.

The potential $\vec{\underline{A}}(\vec{r}) \equiv \underline{M}\,(\hat{r} \times \hat{n})(r - \vec{r}\cdot\hat{n})^{-1}$ is a static solution to the classical theory of non-Abelian gauge fields coupled to a point magnetic source, for any matrix $\underline{M}$ in the Lie algebra of the gauge group G. This solution is rotationally invariant if the eigenvalues of M in the adjoint representation of G are quantized in half-integer units, but is stable to small perturbations only if all non-vanishing eigenvalues are $\pm$ 1/2. In this paper for the gauge groups G=SU(N), it is shown which sets of eigenvalues of $\underline{M}$ are consistent with the group structure, which consistent sets are gauge inequivalent, and which consistent gauge inequivalent sets correspond to stable monopoles. It is found that there are N inequivalent stable monopoles, including the trivial case $\underline{M}=\underline{0}$. Equivalence here is with respect to non-singular gauge transformations — — — the symmetry transformations of

the classical theory. Singular gauge transformations are, in contrast, not symmetries but they are nevertheless useful for classifying solutions, and for relating the above concept of local stability to the global or topological, stability associated with the Dirac strings. In thi context, it is shown that there are N distinct topological classes of monopoles, with the group structure of the center $Z_N \cong \Pi_1(SU(N)/Z_N)$ of SU(N), that each class contains exactly one stable monopole, and that any other monopole in the same class has a strictly larger value of the magnetic charge magnitude for $\underline{M}^2$. This leads to an integrating physical picture of local stability as a consequence of the minimazation of magnetic energy. The paper concludes with some comments on related topics: the empirical absence of magnetic charge, 't Hooft's calculation of magnetic energy, magnetic confinement, and spontaneously broken theories.

1713. Burzlaff J. Univ. Kaiserslautern, Kaiserlautern, 1980.

ON THE SU(3) MONOPOLE WITH MAGNETIC QUANTUM NUMBERS (0,2)

We prove the existence of a spherically symmetric finite energy SU(3) solution with magnetic charge 0 and isomagnetic charge 2. Because of the special ansatz this solution cannot satisfy the Bogomolny equations in the Prasad-Sommerfield limit. At the origin the solution is given in the form of a convergent asymptotic series. At infinity we give convergent asymptotic expansions in the Prasad-Sommerfield limit.

1714. Byzov N.N. Candidate thesis, Inst. of Nucl. Phys., Akad. Nauk Uzbeksk. SSR, Tashkent, 1980.

DYNAMICS AND IRRADIATION OF CHARGED MAGNETON

1715. Cardy J.L. Calif.Univ.,UCSB-TH-35-80, Stony Brook, 1980.

UNIVERSAL PROPERTIES OF U(1) GAUGE THEORIES

1716. Carrigan R.A.,Jr. Batavia,1980,19 p.(EFI 80/04).

DOWN TO EARTH SPECULATIONS ON GRAND UNIFICATION MAGNETIC MONOPOLES

1717. Cho Y.M. Phys.Rev.,1980, vol.D21, No 4, pp.1080-1088.

RESTRICTED GAUGE THEORY

A restricted gauge theory is obtained as a self-consistent subset of a non-Abelian gauge theory by imposing an extra magnetic symmetry to the gauge symmetry. The theory describes the dual dynamics between the colar isocharges (i.e. the electric charges) and the topological charges (i.e. the magnetic charges) of the non-Abelian symmetry, and contains two potentials, the electric and the magnetic potentials, in a dual-symmetric way. The topological charge is identified as the dual of the Noether charge of the magnetic symmetry of the theory. A possible role of the restricted chromodynamics for quark confinement in quantum chromodynamics is speculated.

1718. Cho Y.M. Max-Planck-Institute für Physik und Astrophysik, MPI-PAE/PTH 1/80, München,1980.

COLOURED MONOPOLES

A complete set of the point-like monopole solutions for the group SU(3) is presented which can describe arbitrary allowed magnetic charges. The method adopted to construct the solutions makes use of the topological structure of the non-Abelian symmetry and could be applied to an arbitrary gauge group G.

1719. Christ N., Jackiw R. Phys.Lett.,1980, vol.B91, No 2, pp.228-232.

EQUALITY OF MAGNETIC CHARGE AND PONTRYAGIN INDEX FOR YANG-MILLS DYONS

A description of Yang-Mills dyons is given solely in terms of Yang-Mills fields. For an SU(2) gauge group the magnetic pole strength is shown to coincide with the Pontryagin index of the dyon configuration, treated as periodic in time and hence defined on $S^1 \otimes R^3$.

1720. Clement G. Université de Constantine,PUC-80-02, Constantine, Algeria,1980.

EINSTEIN-YANG-MILLS-HIGGS SOLITONS

The classical theory of the gravitational field coupled to an SO(3) gauge field and to a ghost Higgs field in (3+1) dimensions is found to admit regular localized solutions of the electric or magnetic type.These solutions, which generalize solutions previously found for the Abelian case, are characterized by a non-Euclidean spatial topology, with two points at infinity.

1721. Deans W.S. Nucl.Phys.,1980, vol.B164, No 3, pp.509-527.

STRINGS IN GAUGE THEORIES

A theory of charged particles coupled to gauge fields by flux lines quantized as string variables is developed. In the absence of magnetic charge this is equivalent to the usual gauge theory. In the presence of magnetic charge the flux lines can form the nuclei of physical observable finite-energy strings, leading to a confining potential between charges.

1722. Degrand T.A., Torissaint D. Calif.Univ.,UCSB-TH-22-80 (80 Rec.Jul) 51p.

TOPOLOGICAL EXCITATIONS AND MONTE CARLO SIMULATION OF ABELIAN GAUGE THEORY

1723. Prokoshkin Yu.D., Diddens A.N., Diebold R., Gaillard J.M. Galaktionov Yu.U., Gershtein S.S., Filcher J. Serpukhov Inst. of High Energy Physics, IHEP,80-3,Serpukhov,1980.

HADRON AND PHOTON EXPERIMENTS IN 10 TEV RANGE AT FIXED-TARGET ACCELERATORS

Possible hadron and photon experiments at 20 TeV stationary-target proton accelerator have been considered in order to see typical limitations and possibilities of the experiments in this new energy domain.

1724. Felsager B., Leinaas J.M. Nucl.Phys.,1980, vol.B166, No 1, pp.162-188.

GEOMETRIC INTERPRETATION OF MAGNETIC FIELDS AND THE MOTION OF CHARGED PARTICLES

A geometric representation of magnetic fields in terms of plane bundles in R^3 is examined, and for two examples, the magnetic flux string and the monopole, it is shown how the field configurations can be related to the geometry of cones and spheres. Using the normal vector of the planes as a dynamical variable we treat the structure of the magnetic field in a way similar ti that of an ordered medium. We especially compare it with the structure of the O(3) non-linear O-model. Finally a geometric interpretation of electric charge is introduced by associating with charged particles a rotating, body-fixed frame which is constrained to rotate around the normal vector of the planes. The close connection with the Kaluza-Klein model is discussed.

1725. Forgacs P., Horvath Z., Palla L. Kozp.Fiz.Kut.Intez., KFKI-1980-17, Budapest,1980.

GENERATING THE BPS ONE MONOPOLE BY A BACKLUNG TRANSFORMATION

1726. Forgacs P., Horvath Z., Palla L. Phys.Rev.Lett.,1980, vol.45, No 7, pp.505-508.

GENERATING THE BOGOMOLNY-PRASAD-SOMMERFIELD ONE-MONOPOLE SOLUTION BY A BACKLUNG TRANSFORMATION

1727. Friedman J.L., Sarkin R.D. Comun.Math.Phys.,1980, vol. 73, No 2, pp.161-190.

A SPIN-STATISTICS THEOREM FOR COMPOSITES CONTAINING BOTH ELECTRIC AND MAGNETIC CHARGES

1728. Fryberger D. Stanford Linear Accelerator Center, SLAC-PUB-2474, Stanford,1980.

A SEMICLASSICAL MONOPOLE CONFIGURATION FOR ELECTROMAGNETISM

A semiclassical monopole configuration of generalized electromagnetic that satisfies Maxwell's equations and a criterion of conformal invariance is explicitly constructed. This configuration has no singularities, carries quanta of two different kinds of angular momenta and is called varton. It also carries topological charge. It is shown that the rotation associated with the angular momenta leads to a minimum energy for the configuration. Setting the energy to this minimum and quantizing the angular momenta of rotation yields a quantization condition for the magnitude of the electromagnetic charge. The smallest allowable nonzero electromagnetic charge carried by a configuration which has a nonzero topological charge equals 25.8e.

1729. Fryberger D. Stanford Accelerator Center, SLAC-PUB-2497, Stanford, California, 1980.

ON THE MAGNETICALLY BOUND MONOPOLE PAIR, A POSSIBLE STRUCTURE FOR FERMIONS

Arguments are presented that two magnetically bound monopoles will fall into a ground state characterized by an orbital angular momentum quantum number $\ell = 1/2$. That such a state forms a suitable structure for point-like fermions is proposed.

1730. Fryberger D. Lett. Nuovo Cim., 1980, vol. 28, No 9, pp. 313-320.

ON THE MAGNETICALLY BOUND MONOPOLE PAIR, A POSSIBLE STRUCTURE FOR FERMIONS

1731. Gambini R., Trias A. J. Math. Phys., 1980, vol. 21, No 6, pp. 1539-1545.

PATH DEPENDENT QUANTUM FORMULATION OF ELECTROMAGNETISM WITH MAGNETIC CHARGES

A path-dependent quantum formulation of electromagnetism with magnetic charges is proposed. One starts from a path-dependent non-singular potential which generalizes the Wu-Yang potential. Then a Lagrangian formulation is proposed manifestly self-dual and without singular terms or kinematical constraints. The quantization of this Lagrangian leads to linear space of path-dependent wave-functions where the dynamical equations are stated. The angular momentum usually considered in the field of a static monopole is identified with the generation of spatial rotations in the space of the path-dependent wave-functions.

1732. Gambini R., Salamo S., Trias A. Lett.Nuovo Cim., 1980, vol.27, No 12, pp.385-388.

SELF-DUAL COVARIANT LAGRANGIAN FORMULATION OF ELECTROMAGNETISM WITH MAGNETIC CHARGES

1733. GIANT MAGNETIC MONOPOLES, CERN Cour.,1980, vol.20, No 3, p.114.

1734. Gliozzi F. In: Proceedings of the Workshop on Hadronic Matter at Extreme Energy Density, held at the Ettore Majorana Center,Erice,Italy,1978. Plenum Press, New York, 1980, pp.29-48.

DUALITY TRANSFORMATION AND CONFINEMENT

1735. Greensite J.P. Nucl.Phys.,1980, vol.B166, No 1,pp.113-124.

LARGE-SCALE VACUUM STRUCTURE AND NEW CALCULATIONAL TECHNIQUES IN LATTICE SU(N) GAUGE THEORY

By exponentiating infinite series of vacuum diagrams in strong-coupling lattice gauge theory, an expression for the ground state is obtained containing new information about long-wavelength, large-scale vacuum fluctuations. It is found that lattice vacuum fluctuations are dominated by monopole configurations, on scales large compared to the lattice spacing. An efficient alternative to the standard Kogut-Susskind perturbative expansion is developed, which avoids the use of group integrations. A possible non-perturbative extension of this technique applicable to intermediate couplings, is discussed.

1736. Guth A.H., Tye S.H.H. Phys.Rev.Lett.,1980, vol.44, No 10, pp.631-635.

PHASE TRANSITIONS AND MAGNETIC MONOPOLE PRODUCTION IN THE VERY EARLY UNIVERSE

In grand unified models, the abundance of superheavy magnetic monopoles in the universe can be suppressed if (1) the phase transition which creates the monopoles occurs after much supercooling; and (2) immediately after the phase transition, the effective monopole mass is large compared with temperature. These requirements impose constraints on the history of the early universe. The Georgi-Glashow SU(5) group probably breaks to SU(4) ⊠ U(1) befor it reaches SU(3) ⊠ SU(2) ⊠ U(1).

1737. Hajiček P. Preprint,1980.

I. CHOICE OF THE CLASSICAL SOLUTION

1738. Hirata K. Nucl.Phys.,1980, vol.B169, No 1-2, pp.165-188.

DIRAC'S MONOPOLES AND ACTION-AT-A-DISTANCE THEORY: CLASSICAL DYNAMICS

We redefine Dirac's action for charge-monopole systems as a certain limit of Wu-Yang's action in a way which is similar to, but different from the work of Brandt and Primack. The lagrangian theory thus obtained reproduces, in a simple and straightforward manner, all of the Maxwell-Lorentz equations without recourse to Dirac's veto. It also becomes clear that the action-at-a-distance formalism is especially suited for the description of such systems. An action equations of motion and conserved linear and angular momenta are explicitly given, which do not depend on the string. The existence of a charge-monopole bound state is suggested.

1739. Houston P., O'Raifeartaigh L. Phys.Lett.,1980, vol.B94, No 2, pp.153-156.

ON THE CHARGE DISTRIBUTION OF STATIC AXIAL AND MIRROR SYMMETRIC MONOPOLE SYSTEMS

1740. Hruby J. Nucl.Phys.,1980, vol.B162, No 3, pp.449-460.

ON THE SUPERSYMMETRIC SOLITONS ON MONOPOLES

The basic results in a new trend in supersymmetry and soliton theory are presented. It is shown that the soliton expectation value of the energy operator is the mass of the soliton without quantum corrections. A new supersymmetric monopole model in three-dimenisons is constructed by generalization of the supersymmetric Gordon model in one space dimension.

1741. Hosotani Y. The Enrico Fermi Institute, Univ.of Chicago, EFI 80/14, Chicago,1980 .

MAGNETIC SUPERCONDUCTIVITY AND A LINEAR RESPONSE THEORY FOR NON-ABELIAN GAUGE FIELDS

We investigate properties of magnetic superconductivity as a mechanism for quark confinement. There are two kinds of magnetic permiability, μ^{el} and μ^{mag}, in non-Abelian gauge theory. Necessary conditions for the electric and magnetic superconductivity are given by $\mu^{el} \sim 0$ and $\mu^{mag} \sim 0$, respectively. Employing a linear response theory, we find that μ^{mag} is related to a two-point correlation function of field strengths and that the condition $\mu^{mag} \sim 0$ can be satisfied in non-Abelian gauge theory.

1742. Houston P., O'Raifeartaigh L. Dublin Inst. for Adv. Studies, DIAS -STP-80-16, Dublin,1980.

ON THE CHARGE DISTRIBUTION OF STATIC AXIAL AND MIRROR SYMMETRIC MONOPOLE SYSTEMS

It has been shown that the imposition of axial and mirror symmetry on the static magnetic SU(2) Yang-Mills-Higgs system reduces the usual first order (self-dual) Bogomolny euqations to five equations for five unknown (gague-invariant) functions. In this note we show that for a differentiable Higgs field, the five field equations and the topology rule out all charge distributions along the axis of symmetry except a single-point distribution, and the boundary conditions at the single-point distribution are discussed.

1743. Houston P., O'Raifeartaigh L. Phys.Lett.,1980, vol. B93, No 1-2, pp.151-154.

ON THE ZEROS OF THE HIGGS FIELD FOR AXIALLY SYMMETRIC MULTI-MONOPOLE CONFIGURATIONS

It is shown that a continuous axially symmetric isovector Higgs field cannot have discrete topological charge of the same sign on the axis of symmetry unless it vanishes along the axis between the charges. The implications of this result for the existence of multimonopole field configuration is briefly discussed.

1744. Houston P., O'Raifeartaigh L. Dublin Inst. for Adv. Studies, Dublin, 1980.

ON THE ZEROS OF THE HIGGS FIELD FOR AXIALLY SYMMETRIC MULTI-MONOPOLE CONFIGURATIONS

1745. Horvathy P.A. Centre National de la Recherche Scientifique, CNRS 80/p.1190, Marseille,1980.

ROTATIONAL SYMMETRY AND DIRAC'S MONOPOLE

Dirac's monopol's field is constructed in the framework of symmetric mechanics by imposing rotational and time-translation invariance on the motion of a test particle. Qunatization is achieved by the geometric method of Kostand and Sourian, which allows for an elegant solu-

tion of the quantum symmetry problem. Space-reflection symmetry is studied in addition.

1746. Chan Hong-Mo, Tsou Sang Tsun. ON THE CHARACTERIZATION OF MONOPOLES IN NON-ABELIAN GAUGE THEORIES. Geneva,1980, 11p.

1747. Chan Hong-Mo, Tsou S.T. European Organization for Nucl.Research, CERN Ref.TH 2883, Geneva,1980.

ON THE CHARACTERIZATION OF MONOPOLES IN NON-ABELIAN GAUGE THEORIES

We attempt to help clarify some confusion in the literature on what characterizes monopoles in non-Abelian gauge theories. There is no meaningful classification of monopoles as "magnetic charge multiplets" belonging to representations of a "magnetic gauge group" as suggested by some authors, the "magnetic charge" defined there not being in general conserved. We found no physically meaningful classification other than the topological quantum number or gauge type of bundles over spheres. For a pure SU(n) Yang-Mills theory, this can be characterized by the nth roots of unity.

1748. Jackiv R. Institute for Theor.Phys.,Univ. of California CTP-849, Santa Barbara,1980.

DYNAMICAL SYMMETRY OF THE MAGNETIC MONOPOLE

It is demonstrated that the interaction of a charged particle with a magnetic monopole possesses a large invariance:time can be arbitrarily reparametrized.When the interaction occurs within conventional,nonrelativistic dynamics, the entire theory admits an O(2,1) conformal group of symmetry transformations, which seems to have escape notice. Combining this invariance group with the O(3) group of spatial rotations shows that the problem admits an O(2,1) x O(3)=O(3,1) group of invariances, in analogy with the Kepler/ Coulomb problem. Furtheremore, at fixed angular momentum, the dynamical system is described by a single,

irreducible, unitary representation of °(2,1), whose Casimir eigenvalue is determined by the monopole strength. Some similar properties of the isotropic harmonic oscillator are also mentioned.

1749. Jackiv R. In XX-th International Conference on High Energy Physics, Madison, 1980.

COMMENT ABOUT MAGNETIC MONOPOLES

1750. Jackiv R. Institute for Theor. Phys., Univ. of California, CTP-84, Santa Barbara, 1980.

INVARIANCE SYMMETRY AND PERIODICITY IN GAUGE FIELDS

1751. Kibble T.W.E. London Imperial Coll., ICTP-79-80-23, London, 1980.

SOME IMPLICATIONS OF A COSMOLOGICAL PHASE TRANSITIONS

I discuss the reason for believing that phase transitions occurred in the very early history of the universe and the topological structures that may have been generated thereby - in particular, the strings and monopoles. The aim is mainly pedagogical with special emphasis on unsolved problems.

1752. Kovacs E. SLAC, Stanford Linear Accelerator Center, SLAC-PUB-2465, Stanford, 1980.

ANSATZ FOR SOLUTIONS WITH HIGHER TOPOLOGICAL CHARGE

The correspondence between topologically stable kinds of scalar ϕ^4 theory, vortices of the Abelian -Higgs model, monopoles of the 'T Hooft-Polyakov model and instantons of SU(2) Euclidean gauge theories is exhibited. The use of multi-instanton ansatze for finding multi-monopole and multivortex configurations is then investigated. A partial

solution of the N-vortex configuration for the Abelian-Higgs model is obtained.

1753. Kruglov S.I., Strazhev V.I. J.Phys.,1980, vol.A13, No 4, pp.L85-L87.

NEW APPROACH TO THE THEORY OF MAGNETIC MONOPOLES

A,P,T-invariant theory of massive dually-charged particles is proposed. This theory is based on the idea that a particle with multi-spin described by the Dirac-like equation is a magnetically charged particle. The concept of magnetic charge has, in this approach, a pure quantum mechanical nature.

1754. Langacker P.,PI S.-Y. Phys.Rev.Lett.,1980, vol.45, No 1, pp.1-4.

MAGNETIC MONOPOLES IN GRAND UNIFIED THEORIES

It is suggested that the magnetic monopoles predicted by grand unified theories would not be produced in significant numbers if electromagnetic gauge invariance is spontaneously broken when the temperature T is greater than $T_c \gtrsim 1$ T eV. A model possessing this behaviour is displayed and the cosmological implications are discussed.

1755. Lazarides G., Magg M., Shafi Q. European Organization for Nuclear Research, CERN-TH-2856, Geneva,1980.

PHASE TRANSITIONS AND MAGNETIC MONOPOLES IN SO(10)

In a unified gauge theory based on SO(10), the combination of a strongly first order phase transition and a magnetic confinement mechanism can suppress the density of magnetic monopoles at the time of nucleosynthesis. However, this only occurs if SO(10) breaks down to $SU(3)_c \otimes U(1)_{EM}$ via $SU(4)_c \otimes (SU(2)_R)$. For the other symmetry breaking patterns of SO(10) obtained with

a minimal Higgs system, the potential conflict with the standard big-bang cosmology is not naturally avoided.

1756. Lazarides G., Shafi G. European Organization for Nuclea Research, CERN TH-2811, Geneva,1980.

THE FATE OF PRIMORDIAL MAGNETIC MONOPOLES

1757. Lazarides G., Shafi G. Phys.Lett.,1980, vol. B94, No 2, pp.149-152.

THE FATE OF PRIMORDIAL MAGNETIC MONOPOLES

Unified gauge theories, in which the $SU(2)_L$ and $U(1)_Y$ subgroups do not have non-trivial intersections, possess an inbuilt mechanism for a complete extinction of the primordial magnetic monopoles. The potential conflict with the standard hot big-bang cosmology is therefore avoided in such theories. The usual gauge theories, based on SU(5), SO(10) and E_6 do not have this property.

1758. Leznov A.N., Savelev M.V. Fiz. El. Chastits i Atomn. Yadra (Russ.), 1980, vol.11, pp.40-91.

EXACT CYLINDRICALLY SYMMETRIC SOLUTIONS OF THE CLASSICAL EQUATIONS IN GAUGE THEORIES WITH THE ARBITRARY COMPACT LIE GROUPS

The main results in the field of exact cylindrically symmetric solutions of the classical equations in gauge theories with an arbitrary simple compact Lie group are expounded compactly.

1759. Lykken J.D., Strominger A. Phys.Rev.Lett.,1980,vol.44, No 18, pp.1175-1178.

SPIN FROM ISOSPIN IN SU(5)

The possibility of the charge-monopole systems with half-integer spin in the grand unified SU(5) model is

investigated and found to occur.

1760. Maison D. Max-Planck-Institut für Physik und Astrophysik, MPI-PAE/PTh 11/80, München, 1980.

UNIQUENESS OF THE PRASAD-SOMMERFIELD MONOPOLE SOLUTION

1761. Matsui T. Tokyo Univ., UT-KOMABA 80-06, Tokyo, 1980.

DUALITY TRANSFORMATIONS FOR O(3) AND O(4) SPIN SYSTEMS IN TWO DIMENSIONS

Duality transformations of Kramers and Wannier are applied to two-dimensional lattice spin systems having O(3) and O(4) global symmetries. Dual spin variables on dual lattice are introduced by employing the graphical method of Levinson et al. for SU(2) recoupling coefficients. By evaluating the dual systems approximately the original systems at low temperatures are shown to be described in terms of "spin-wave modes and discrete excitations specified by integers. In the O(3) case some of the leading contributions to tge latter excitations are similar in structures to sets of meron excitations in the continuum (i.e. constituents of instanton excitations). There appears also a sequence of multipole configurations, each monopole bearing fractional "topological "charge. Throu Throughout the duality method the infrared difficulties in the simeclassical approximations of dilute instanton gas disappear because all configurations of spin variables are now taken into account. Possible roles of the dual excitations in the O(3) system are briefly discussed.

1762. Mignani R. Nuovo Cim., 1980, vol.B56, No 2, pp.201-209.

PATH-DEPENDENT APPROACH TO GRAVITATIONAL MONOPOLES

We discuss the possibility of introducing gravitational analogues of magnetic monopoles (i.e. sources of

the dual Riemann tensor) into Einstein's equations in the framework of Mandelstam's path-dependent formulation of the gravitational field. It is shown that, by this approach gravitational monopoles arise straightforwardly from a consistency requirement for the theory. Moreover, their existence implies a local violation of the energy-momentum conservation law. Possible consequences and developments of the theory are considered.

1763. Minami M. Progr.Theor.Phys.,1980, vol.63, No 1, pp.303-321.

QUATERNIONIC GAUGE FIELDS ON S^7 AND YANG'S SU(2) MONOPOLE

A regular connection 1-from is introduced on a 7-sphere and gauge transformations are applied to it to produce two specific singular connections. The gauge potentials which these singular connections embody are shown to be identical with Yang's SU(2) monopole solutions as shown by pulling back the latter by a Hopf map $\eta_2: S^7 \rightarrow S^4$. The study is a genuine generalization of a previous work where Dirac's U(1) monopole was discussed within the realm of the Hopf fibre-map $S^3 \rightarrow S^2$. The present discussion hence parallels the previous one; a major difference being only that the quaternions are used in place of the complex numbers.

1764. Nahm W. European Organization for Nuclear Research, CERN TH-2835, Geneva,1980.

ON ABELIAN SELF DUAL MULTIMONOPOLES

1765. Nahm W. Phys.Lett.,1980, vol.B93, No 1-2, pp.42-46.

ON ABELIAN SELF-DUAL MULTIMONOPOLES

Abelian self-dual monopoles are Dirac monopoles which also act as the source of a scalar field equal in strength to the potential of the magnetic field. The static field generated by several such monopoles with arbitrary

positions can be described by adapting the ADHM formalism developed for instantons. In particular one obtains an exact expression for the Green function of the covariant Laplace operator.

1766. Nahm W. Phys. Lett., 1980, vol. B90, pp. 413-414.

A SIMPLE FORMALISM FOR THE BPS MONOPOLE

A simple formalism for the BPS monopole is obtained by generalizing the ADHM construction of multi-instantons to a Hilbert space. Both the potential itself and the Green's functions for different isospin can be obtained with very little effort from the instanton formulae.

1767. Oh C.H., Rosy Tch. Phys. Rev., 1980, vol. D21, No 2, pp. 531-534.

NON-SELF-DUAL STATIC GAUGE FIELDS

We exhibit exact non-self-dual statistic solutions to the SU(2) Yang-Mills field equations by solving the equation $\nabla^2 \nu + \lambda \nu^3 = 0$ using cylindrical and spherical coordinates. The resulting gauge fields are complex and have singularities. For the cylindrically symmetric solution we convert it into a real gauge field coupled to the Higgs field in the limit in which the self-interaction potential of the Higgs field vanishes.

1768. Pi S.Y. In: XX-th International Conference on High Energy Physics, Madison, 1980.

SUPPRESSION OF SUPERHEAVY MONOPOLES IN GUTS

1769. Ryder L.H. J. Phys., 1980, vol. 13, No 2, pp. 437-447.

DIRAC MONOPOLES AND THE HOPF MAP $S^3 \rightarrow S^2$

It is shown that the presence of point magnetic monopoles necessitates a fibre-bundle formulation of electro-

dynamics. The Hopf "fibring" of S^3 over a base space S^2 with fibre S^1 yields the Wu-Yang potentials which describe the Dirac monopole. The Gauss- Bonnet-Chern theorem yields the Schwinger quantization condition.

1770. Sawada T. Progr.Theor.Phys., 1980, vol.63, No 6, pp.2016-2031.

DISCREPANCIES IN PARTIAL WAVE DISPERSION RELATION AND A POSSIBLE STRONG VAN DER WAALS FORCE

1771. Scott D.M. Department of Applied Mathematics and Theoretical Physics, Univ. of Cambridge, DAMTP 80/7, Cambridge,1980.

ON THE POSSIBILITY OF MAGNETIC MONOPOLES LIGHTER THAN $\frac{1}{\alpha} M_x$ IN GRAND UNIFIED THEORIES

It is argued that in special cases monopoles may have masses significantly less than $\frac{1}{\alpha} M_x$ where M_x is the mass of the heaviest vector boson in the grand unified theory under consideration.

1772. Scott D.M. Department of Applied Mathematics and Theoretical Physics, Univ. of Cambridge, DAMTP 80-2, Cambridge,1980.

THE MASSES OF MONOPOLES IN GRAND UNIFIED THEORIES

The form the Bogomolny bound takes in grand unified theories is considered. In the context of certain approximations, which are detailed, the ratio of the mass of a monopole to that of a superheavy vector boson is calculated. Lower bounds on the masses of these particles are given in terms of the mixing angles of the theory. The results are applied to the spin (10) theory.

1773. Shepard H.K. Preprint,1980.

COMMENTS ON THE HIGH TEMPERATURE YANG-MILLS GAS

1774. Schechter M., Weder R. Universidad Nacional Autonoma de Mexico, Communicaciones Tècnicas, No 227, Mexico,1980.

A THEOREM ON THE EXISTENCE OF DYON SOLUTIONS

We prove the existence of finite energy dyon solutions to Yang-Mills-Higgs equations satisfying the Julia-Zee Ansatz, and the generalization to SU(N) gauge groups. This vigorously established the existence of a model for the particles having electric and magnetic charge conjectured by Schwinger. We also prove that the solutions are real analytic on (0, ∞) and C^{∞} at r =0. To establish our result we prove a new abstract theorem that allows to study singular constrained variational problems without the introduction Lagrange multiplies.

1775. Schechter M., Weder R.Y. Phys.Rev.Lett.,1980, vol.44, No 20, pp.1303-1305.

RIGOROUS RESULTS ON THE EXISTENCE OF DYON SOLUTIONS

The existence of finite-energy dyon solutions satisfying the Julia-Zee Ansatz and the generalization to SU(N) gauge groups is rigorously established. It is also proved that the solutions are real analytic on (0, ∞) and infinitely differentiable at 0. The proof is based on an abstract theorem that allows one to study constrained variational problems without introducing Lagrange multipliers.

1776. Smalyakov N.V. Serpukhov Inst. High En.Phys., IHEP, 80-11, Serpukhov,1980.

ELECTRON SCATTERING ON DIRAC-SCHWINGER MONOPOLE AT SMALL ANGLES

A correction for the scattering amplitude of electron on monopole at small angles has been obtained in the framework of quantum theory of Dirac-Schwinger magnetic monopole. After redefinition of the S matrix the amplitude satisfies the requirements or relativistic invariance.

1777. Soares I. J.Math.Phys.,1980, vol.21, No 3, pp.521-525.

INHOMOGENEOUS ROTATING UNIVERSES WITH CLOSED TIME-LIKE GEODESICS OF MATTER

We present a new class of inhomogeneous stationary cosmological solutions of Einstein-Maxwell equations,with rotating dust and electromagnetic fields. For a subclass of these models, the topology of the space-time manifold is S'C X R, and the time-like geodesic lines of dust are closed; electromagnetic fields are necessary only to avoid matter singularity S. While in the completely homogeneous limit they are essential for consistency of field equations these electomagnetic fields have the structure of magnetic monopole fields since the total magnetic flux across the unit 2-sphere is different from zero that is magnetic monopoles must be present as a source of the fields.

1778. Strazhev V.I., Shkolnukov P.L. Acta.Phys.Pol.,1980, vol. B11, No 3, pp.209-220.

ON TWO-POTENTIAL FORMULATION OF ELECTRODYNAMICS WITH MAGNETIC MONOPOLES

The two-potential Lagrange formulation of the theory of magnetic charge is developed. The connection with the Dirac and Cabibbo-Ferrari formulations of electrodynamics with magnetic monopoles is ststed.

1779. Tataru-Mihai P. Preprint,1980.

MONOPOLES AND THE SYMMETRY BREAKING PATTERN OF A SO(10)-BASED GUT. A TOPOLOGICAL ARGUMENT.

1800. Thomas G.H. Riv.Nuovo Cim.,1980, vol. 3, No 4, pp.1-119.

INTRODUCTORY LECTURES ON FIBRE BUNDLES AND TOPOLOGY FOR PHYSICISTS

1801. Tchrakian D.H. J.Math.Phys.,1980, vol.21, No 1, pp.166-169.

N-DIMENSIONAL INSTANTONS AND MONOPOLES

The possibility of finding solutions of the instanton and monopole types to gauge field theories on arbitrary even and odd dimensional Euclidean manifolds respectively is investigated. Suitable boundary conditions for both types are given and new self-duality criteria are developed, for gauge field theories an N-dimensional manifolds ($N \geqslant 5$) which are also endowed with new action and Lagrangian densities.

1802. Tye S.-H.H. Lab. of Nucl.Studies Cornell Univ., CLNS-80/448, Ithaco,1980.

MONOPOLES,PHASE TRANSITIONS AND THE EARLY UNIVERSE

The non-observation of magnetic monopoles imposes stringent constraints on the structure of grand unified theories and their phase transition properties in the early (i.e. $\sim 10^{-36}$ second after the big bang) stages of the universe. We discuss this in the context of the Georgi-Glashow SU(5) model.We also give the explicit forms of the exact monopole solutions. in this model.

1803. Weinberg E.J. Nucl.Phys.,1980, vol.B167, No 3, pp.500-524.

FUNDAMENTAL MONOPOLES AND MULTIMONOPOLE SOLUTIONS FOR ARBITRARY SIMPLE GAUGE GROUPS

Magnetic monopole solutions for an arbitrary compact simple gauge group are considered in the Prasad-Sommerfield

limit. For each group and choice of symmetry breaking there is a set of fundamental monopoles with minimal topological charges and possessing no internal degrees of freedom, the number of these is less than or equal to the rank of the gauge group. It is shown that if the unbroken gauge group is Abelian, all solutions with higher topological charges belong to p-parameter families, where p is the number of position and group orientation parameters needed to describe a set of non-interacting fundamental monopoles with the given topological charge. It is argued that these solutions, some examples of which are given, should therefore be interpreted as multipole configurations. An extension of these results to the case of a non-Abelian unbroken gauge symmetry is conjecture and shown to be valid for a number of examples.

1804. Yaffe L.G. Preprint, 1980.

CONFINEMENT IN SU(N) LATTICE GAUGE THEORIES

1805. Yaffe L.G. Phys.Rev., 1980, vol. D21, No 6, pp.1574-1590.

CONFINEMENT IN SU(N) LATTICE GAUGE

1806. Yang Chen Ning European Organization for Nuclear Research, CERN Ref. TH-2886, Geneva, 1980.

MAGNETIC MONOPOLES AND FIBRE BUNDLES

Talk given at a Conference at the Academy of Science, Rome, 1980.

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