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Intra-Nuclear Cascade Produced by 200-GeV Protons

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A Proposal for Experimental Study

at The University of Tennessee

Utilizing the 200-Gev Proton Beam Developed

at the National Acceleration Laboratory, Batavia, Ill.

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Introduction.

The Monte-Carlo method of calculating the consequences of an intra-nuclear cascade has been reasonably successful in describing proton-nucleus collisions at energies below 3 GeV[1], although not so satisfactory for the corresponding pion-nucleus collisions[2]. A basic feature of the method is the assumption of successive interactions by the incoming particle with individual nucleons of the target nucleus. However, it is an old suggestion of Cocconi[3] that at cosmic-ray energies this assumption might not be valid, and that the interaction should perhaps be regarded as an m-M collision, where m is the nucleon mass and M is the mass of 4 or 5 nucleons which lie in the "path" of the incident nucleon through a Ag or Br nucleus. Considered thus, the c-m γ-factor of the collision will be only about one half of the c-m γ-factor for the corresponding nucleon-nucleon collision. Since the angular distribution of the shower particles can be interpreted in terms of the c-m velocity[4] and since such measurements have up to now lacked significance

[1]The paper of H. W. Bertini, Phys. Rev. 188, 1711 (1969) summarizes the extensive foregoing work at Brookhaven and Oak Ridge.

[2]Continuing work in this laboratory.

[3]G. Cocconi, Phys. Rev. 93, 1107 (1954).

[4]See for example U. Haber-Schaim, Supp. al Nuovo Cimento, 12, 344 (1954) or C. Castagnoli et al, Nuovo Cimento 10, 1539 (1953).

because the incident energy was not known[5], new observations on the angular distribution of shower particles from 200-GeV protons with Ag and Br in nuclear emulsions make possible a test of the Cocconi suggestion.

An alternative interpretation of the shower particle angular distributions might be sought from the hypothesis of limiting fragmentation in particle-nucleon collisions[6], provided the intra-nuclear cascade method can be applied to the products of the initial fragmentations in a complex target nucleus.

Proposed Experiment

It is proposed that a small stack of Ilford K5 nuclear emulsions 600 microns thick be exposed to $5.0 \times 10^4/cm^2$ 200 GeV protons, with the proton beam parallel to the emulsion plane. The emulsions will be processed at U.T. The procedures by which collisions in Ag, Br, are identified have been described in a foregoing paper on high energy collisions in complex nuclei.[7] The emergent angles of shower particles from these collisions will be measured, where "shower particles" are those collision products showing ionization levels equal to or less than the

[5] Emulsion Chamber Group, Can. Jour. Phys. 46, S660 (1969)

[6] J. Benecke et al, Phys. Rev. 188, 2159 (1969).

[7] D. T. King, Phys. Rev. 188, 1731 (1969).

plateau value for the emulsion. For beam-induced collisions showing 7 or more nuclear evaporation products, the shower particle angular distributions will be studied as a function of shower-particle multiplicity.

There are two low-noise microscopes at U.T. for the measurement of multiple coulomb scattering on tracks in emulsions. It is possible that the shower-particle momentum spectrum at angles $\gtrsim 30^{\circ}$ can be extracted for comparison with the predictions of the intra-nuclear cascade.

With the principal investigator in this study there will be associated W. M. Bugg, G. T. Condo, E. L. Hart, and R. W. Childers. Initial support will come from U.T. Physics Department.