NAL PROPOSAL No. 232

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400-GeV Protons on Complex Nuclei

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July 1, 1973

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ABSTRACT

Collisions of 200-GeV protons in complex nuclei have displayed some surprising features. An emulsion experiment is proposed to extend this study to 400-GeV proton-nucleus collisions.

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1 July 73

Proton-Nucleus Collisions at 200 GeV

A beam-follow study along the tracks of 200-GeV protons in emulsion (NAL Expt. #103) has accumulated preliminary data on 200-GeV p-nucleus collisions in Ag, Br, (73%); C,N,O, (23%) and H (4%). Multiplcity and emission-angle information on the meson jets is being tabulated, together with the nuclear-evaporation characteristics of each collision.

(a) A surprising 21±3% of the collisions show no visible nuclear evaporation, where ∿10% might be expected.

(b) The frequency of odd multiplicities (p-n) among these "white" collisions is ∿20% larger than expected.

(c) Electromagnetic interactions of the protons in the coulomb fields of target nuclei are identified (proton tridents) but the cross section is ∿20 times smaller than expected.

Theoretical Background: The Monte Carlo intranuclear Cascade analysis for p-nucleus collisions at energies <3 GeV has led to a modified treatment (P. M. Fishbane, J. S. Trefil, Phys. Rev. C, in press) which might be appropriate in the 200-400 GeV region. This theory should account for the large proportion of collisions in complex nuclei which result in such low nuclear excitation as to produce no visible nuclear evaporation. The differences in multiplicity-and angle-distributions between (a) evaporation jets, (b) white stars, and (c) free-hydrogen collisions, should also be predictable.

The different parton compositions of neutrons and protons may become distinguishable in comparisons between p-n (odd multiplicity) and p-p (even multiplicity) white stars. For such a comparison to be meaningful, the number of white-star observations would have to be $\gtrsim$ 1000.

The Proposed Experiment: It is intended to expose two emulsion stacks each to an integrated 400-GeV proton beam intensity $3 \times 10^4/cm^2$. This is $\sim 6 \times 10^5$ protons on each stack, where a stack occupies $\sim$25% of a 4-inch diameter beam, so that the experiment requests two successive shots of 2.5×10^6 protons. If 400-GeV protons are not available for the emulsion exposures, the experiment can proceed with 300-GeV protons.

Beam-follow methods will be employed to accumulate $\sim$5000 collisions of beam protons. Elimination of beam contamination will be achieved by parallelism criteria on beam doublets, as outlined in our publications. Characteristics of beam-particle collisions will be recorded in three broad categories of resultant nuclear excitation: large evaporations, small evaporations, and white stars. Multiplicities and emission angles for the $\sim$1000 expected events in this last group will be independently checked by at least two physicists. Electromagnetic interactions of beam protons will be separately compiled, and analysis of these observations will be carried out on collaboration with Dr. A. S. Cary, of Harvey Mudd College.