Brief Reports

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On the electromagnetic contribution to inclusive production in proton-air collisions in the regime of projectile fragmentation

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(Received 17 July 1986)

We calculate the inclusive charged-particle differential cross section in p-^{14}N collisions expected on the basis of the inelastic p-^{14}N electromagnetic interaction at high energy.

In a recent paper,[1] Ferbel and Zielinski discussed the possible impact of electromagnetic production on tests of the validity of the hypothesis of limiting fragmentation[2] for the projectile-fragmentation regime in proton-air collisions at cosmic-ray energies. Although the calculated total inelastic cross section that could be attributed to production in the Coulomb field of ^{14}N nuclei (Primakoff mechanism[3]) corresponded to only $\sim 0.5\%$ of the inelastic p-^{14}N cross section, it was conjectured that the electromagnetic yield would be restricted to a rather narrow region of phase space (of forward rapidities), and could consequently have an anomalously large effect on the inclusive differential cross section in the region of proton fragmentation.

In this paper we present the results of the more detailed calculation of the differential inclusive yield of charged particles in the rest frame of the incident proton, for interactions in the nuclear Coulomb field. As in the original work,[1] we have included atomic screening effects, which are important for incident proton energies of $\gtrsim 10^3$ TeV.

The present calculation is based on the formulation given in Ref. 1, and on data for inclusive production of charged particles in γ-p photoproduction reactions of the kind

$$\gamma + p \rightarrow \text{charged particle} + \text{anything} . \quad (1)$$

The inclusive inelastic differential cross sections for reaction (1), as a function of energy of the incident photon,[4] were folded in with the Primakoff formula to provide the inclusive yield of charged particles in p-^{14}N collisions, shown in Fig. 1. [The pseudorapidity (η) is defined relative to the rest frame of the proton.]

The bands in Fig. 1 reflect approximately one-standard-deviation uncertainties in the cross sections for reaction (1). As anticipated, the inclusive yield from the Coulomb contribution to hadron production grows with incident proton energies. To gauge the effect of this contribution, we must compare the value of $d\sigma/d\eta \approx 0.5$ mb, for $\eta \approx 0$, to that expected from purely hadronic production. Results from the colliders indicate that, for pp collisions, $d\sigma_{pp}/d\eta$, near $\eta \simeq 0$, is ~ 25 mb (Ref. 5). If the inclusive yield (differential multiplicity) for pseudorapidities near $\eta \simeq 0$ is independent of target material,[6] then the yield from hadroproduction in p-^{14}N collisions at $\eta \simeq 0$ is expected to be $d\sigma/d\eta \approx 200$ mb. Consequently, it appears that the effect of the Coulomb contribution on the dif-

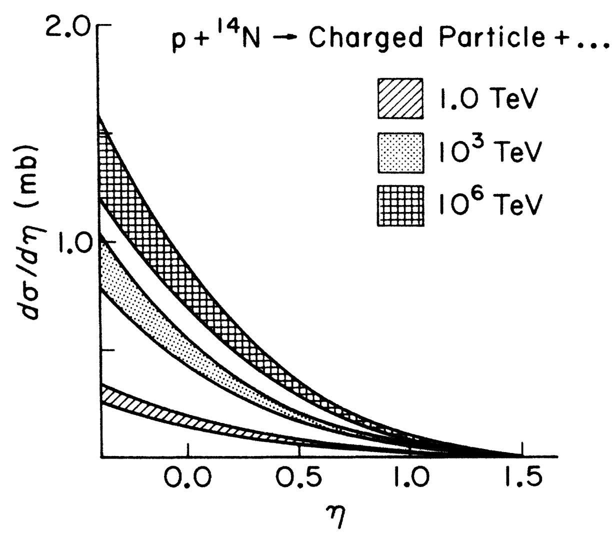

FIG. 1. Calculated inclusive yield of charged particles produced in inelastic Coulomb interactions in p-^{14}N collisions. The results are shown as a function of incident proton energies for pseudorapidities (η) defined relative to the incident proton.

ferential cross section is just as small as that on the total cross section. The most likely reason for this is that, although the electromagnetic contribution is in fact more localized near $\eta = 0$, the average multiplicity for these interactions is far lower than for diffractive hadronic sources. Consequently, we conclude that the effect of the Coulomb contribution to the inelastic inclusive spectrum can be ignored for cosmic-ray energies of order $\lesssim 10^6$ TeV.

We thank the Department of Energy for support of this work.

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