JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN Vol. 17, SUPPLEMENT A-III, 1962
INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part III

III-6-5. A Study of Nuclear Interactions at 20 to 150 Gev in Carbon*

SIDDHESWAR LAL, YASH PAL, and R. RAGHAVAN
Tata Institute of Fundamental Research, Bombay, India

Nuclear interactions produced in Carbon by Cosmic ray particles of energy 20 to 150 Gev have been studied using a multiplate cloud chamber at an altitude of 2.2 kms. The experimental set up is shown in Fig. 1. The production layer consisted of a slab (c) of graphite 10 cms. thick mounted inside the chamber. Carbon was selected as the lightest easily available material, to ensure that one was studying Nucleon-Nucleon collisions. Starting about 10 cms. below the graphite block, there were 8 plates of glass each 1/4" thick. All events were accepted in which (i) a charged particle was recorded in the counter tray (G_1), mounted immediately below the graphite block, (ii) a certain minimum pulse height was observed in the liquid scintillator (s) and (iii) at least one of the secondaries penetrated an additional 10 cms. of lead below the scintillator to register in the counter tray G_2. Two Geiger trays placed by the side of the chamber and in level with its top were used in anti-coincidence to cut out air showers. The triggering mechanism could select interactions made by neutral and charged primaries with equal efficiency.

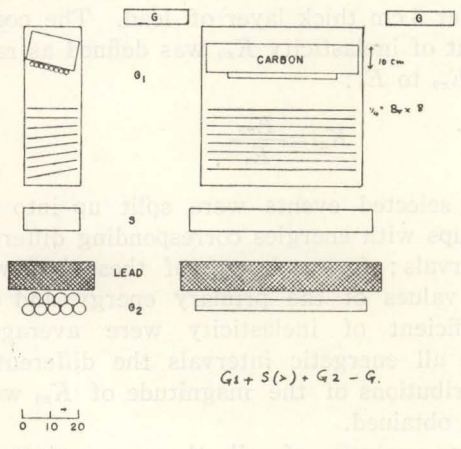

Fig. 1. Experimental Arrangement.

A total of 122 events were selected for detailed analysis. The angular distribution of all shower particles was measured using a mechanical analog. The primary energy was determined by using the procedure of Castagnoli *et al*, which assumes symmetry in the c.m. system of the emitted particles. The experiment was particularly designed to measure the secondary γ-ray energies by studying the development of the cascades made by them. The disposition of matter in the cloud chamber was such that most of the γ-ray separate far enough before materialising, so that they can be recognised individually and their cascades do not mix with each other seriously. Energy determination was based essentially on the track length method.

The main results of this investigation at 2.2 kms, may be summarized as follows.

1. The integral energy spectrum of nucleons at an altitude of 2.2 kms may be expressed by a power low having a negative exponent $1.3^{+0.26}_{-0.29}$

2. The ratio of neutral to charged particles amongst the interacting particles of energy 20–150 Gev at this altitude is 0.69 ± 0.13. This combined with similar results from other experiments leads, under some assumptions, to an upper limit of 0.53 for the average inelasticity for collisions in air.

3. The average multiplicity of charged shower particles is 5.6 ± 0.2 for events whose multiplicity is equal to or greater than 3.

4. The inelasticity for production of π-mesons with a Carbon target is $K_\pi=0.24\pm0.04$ (in the c.m. system).

5. The average total energy of a π-meson in the c.m. system is found to be 430 ± 50 Mev. This value is the same as found for interactions of widely differing energies.

6. The angular distribution of *created* particles in the c.m. system is isotropic.

* This paper was read by M. G. K. Menon.

7. The average value of the transverse momentum for neutral π-mesons is 390 ± 25 Mev/c; the most probable value is 290 Mev/c, with an assymmetric spread $p_T=290^{+160}_{-90}$ Mev/c.

8. The ratio of $\pi^0 s$ to charged shower particles amongst the created particles is 0.4 ± 0.04, the same as determined at energies of $\approx$1000 Gev in nuclear emlsions, indicating that the fraction of $X^{\pm}$ particles (*i.e.* nonpions) amongst the created particles does not change significantly from an energy of 20 Gev to 1000 Gev, and is

$$\frac{N_{X^{\pm}}}{N_{X^{\pm}}+N_{\pi^{\pm}}}=0.2\pm.08$$

9. The interaction mean free path in brass for charged secondary particles is 133 ± 14 gms/cm^2.

JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN Vol. 17, SUPPLEMENT A-III, 1962
INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part III

III-6-6. Investigation of a Dependence of the Average Fraction of Energy Imparted to the Neutral Pions on the Primary Energy*,**

S. A. AZIMOV, A. M. ABDULLAEV, V. M. MJALKOVSKIJ and T. S. JULDAŠBAEV

Physical-Technical Institute of the Academy of Sciences of the Uzbek SSR, Tashkent, USSR

The aim of this work was to investigate a dependence of the average value of the coefficient of inelasticity on the primary energy (within the interval $E_0=10^{11}\sim10^{12}$ ev) by means of the Cerenkov counters system.

For evaluating of the primary energy "Calorimetrical method" was employed, which has been suggested by N. L. Grigorov. But the arrangement here used, is in distinction from the well-known types of the "ionization calorimeter", including seven Cerenkov counters that allowed to measure the number of relativistic particles under different layers of an absorber.

The experiments were conducted by the authors at the high-mountain scientific station of the Physics Institute of the Academy of Sciences of the Uzbek SSR (the Coom-Bel Pass, altitude of 3200 m above sea level).

During 850 hours of running of the arrangement, 550 showers were registered which have been created in the carbon block (with a thickness that corresponded to 20 g/cm^2) by single particles with $E_0>50$ Gev.

With the Cerenkov counter placed under the graphite block the multiplicity of the secondary particles n_s was measured.

The energy transfered to π^0-mesons in the first act of an interaction $E_{\pi 0}$ was estimated by measuring of the number of relativistic particles in the eletron-photon cascade shower under 3 cm thick layer of lead. The coefficient of inelasticity $K_{\pi 0}$ was defined as ratio of $E_{\pi 0}$ to E_0:

$$K_{\pi 0}=\frac{E_{\pi 0}}{E_0}\ .$$

All selected events were split up into the groups with energies corresponding different intervals; for each one of these intervals the values of the primary energy and the coefficient of inelasticity were averaged. For all energetic intervals the differential distributions of the magnitude of $K_{\pi 0}$ were also obtained.

An analysis of all these experimental results leads to the following conclusions:

1. The fraction of the primary energy transfered to the secondary π-mesons in

* This paper was read by N. A. Dobrotin.

** No manuscript has been received and the preprint is reprinted.