absolute values will come from the intensity measurements made at these points of average maximum development. Certainly the question of kinks and fine structure in the primary energy spectrum can best be answered from such data.

Discussion

Wataghin, G.: I would like to raise the question whether one could derive some conclusions concerning the interaction mean free path of the primary particle and on the inelasticity for particles of highest energy, starting from the analysis of the data on the development of the generated showers in the atmosphere.

Clark, G. W.: I think that extremely small values of inelasticity for very high energy interactions are ruled out by the observation that showers can attain the size of 10^{10} particles at sea level. More precise limits on inelasticity can undoubtedly be obtained by a careful analysis of the data I discussed.

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III-4-30. Tokyo Air Shower Project

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Studies on the structure of EAS by Tokyo Air Shower Project were summarized.*

First, energy partition among various components of EAS was discussed and various quantities were related each other: such as the energy flow carried by electron-photon component as well as nuclear active component, nuclear mean free path at extremely high energy and the attenuation length of EAS. And the implication of the value of the attenuation length of EAS in the atmosphere was discussed.

Consistency among experimentally estimated values of various quantities suggests rather modest picture of EAS which is essentially consistent with what was postulated in calculations by N. Ogita. However this does not yet mean to reject such an abrupt change of the nature of nuclear interaction of the existence of radical deviation of the nature of EAS from the average, as discussed by Ueda and McCusker before, Miyake, Kameda and others in this conference. In fact we saw an indication of the necessity of some radical explanation in the study of the structure of individual core.

We should not forget that Kameda and Toyoda have given somewhat less importance to the role of nuclear active component than we did based upon their analysis of cloud chamber pictures..

N-n_μ diagram was often used in this study. The basic idea is that by this diagram we may essentially avoid the confusion because of the fluctuation of the starting point of EAS in the atmosphere. There was an argument by Sreekantan. The argument is based upon his observation of fluctuation of nuclear active particles and mu-mesons. The both appeared to be related each other showing similar magnitude of fluctuation. The implication of this fact is that, since attenuation of the both must be different, only the fluctuation of the starting point of the shower can not show this sort of related fluctuation.

High energy nuclear active particles and high energy gamma rays were observed in

* The contents of most part of this article are in III-4-1 and III-4-28 and only the part which is related to other contributions will be presented here.

the core and the structure of the nuclear cascade was studied. Fluctuation of the lateral structure within 3 meters from the shower axis was interpreted in terms of the superposition of steep core on the ordinary core. This steep core, existence of which is also suggested by S. Miyake and W. Hazen, looks hard to be interpreted by either a single gamma ray or multiple gamma rays according to the conventional energy spectrum of mesons at production. And this suggests an appearance of entirely different sort of energy spectrum such as that the majority of the energy may be concentrated into a small number of mesons.

There is an indication (III-4-28) that the appearance of steep superposed core might be related to high transverse momentum in meson production or, in other words, some unusual energy partition at the collison may be related to high transverse momentum.

The differential energy spectrum of nuclear active particles in EAS was presented up to 10^{13} ev. There seems to be a break of the spectrum around 10^{12} ev, although its existence may still be subject to experimental reason or nuclear physical reason. This question may have to be discussed in relation to the size spectrum, the spectrum of number of mu-mesons of EAS discussed in the session of Primary and the energy spectrum of gamma rays in the atmosphere discussed in the session of Jet as the whole.

Discussion

Peters, B.: (1) Can the 10% occurrence of very much narrower and more energetic cores superimposed on to ordinary shower cores be explained if there existed a nuclear process in which in cases of 10% of the cores a nucleon gives a large fraction of its energy to a single π^0-meson?

(2) Can the occurrence of two such cores separated from each other be interpreted as due to parallel nuclear cascades initiated by a heavy primary, thereby eliminating the necessity for assuming very large momentum transfers?

Oda, M.: (1) Yes.

(2) I cannot rule out this possibility.

Yamaguchi, Y.: (1) Could you tell me zenith angles of your multicore events? Did they come almost vertically?

(2) If so, it seems to me that Peter's explanation is best.

Oda: (1) Yes, the quoted cases were essentially vertical.

(2) I personally agree.

Sreekantan, B. V.: About these multi-core events, is it not true that you will pick it up with the present arrangement only if there is a distinct difference in the lateral distribution of the separate cores?

Oda: Yes. Unless at least one of the separate cores has a steep lateral distribution, you would not notice the multi-core event.

Pinkau, K.: You quote an interaction mean free path for the primary particles of $\sim 100\ g/cm^2$. Is this not difficult to reconcile with heavy primaries?

Oda: Accounting for an admixture of heavy primaries the interaction m.f.p. for proton should be larger than $100\ g/cm^2$.