FEATURES OF THE HIGH ENERGY ELECTRON SPECTRUM

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Recent studies of the spectrum of high energy primary electrons using emulsion chambers have been made with an exposure factor some 10 to 100 times larger than those obtained by other experimental devices. (Taira et al., 1979, Nishimura et al., 1980). The total exposure is now almost 6 m^2-day-str., including the recent exposure at Palestine, Texas in May 1980, and it is now quite possible to extend observations of the electron spectrum into the TeV region with reliable accuracy in the next few years.

Because high energy electrons lose their energy rapidly through synchrotron radiation and inverse Compton processes, an observed high energy electron could not have traversed far from its origin. Regarding this point, several works were presented at the time of Kyoto Conference in 1979. (Giler et al., 1978, 1979, Nishimura et al., 1979, Webber et al., 1979).

One is the effect of a small number of discrete sources which could contribute to the high energy electrons, assuming that supernovae are the sources of cosmic-rays. Assuming that supernovae occur in the Galaxy at a rate of one per 30-100 years, one would expect only several supernovae to be the sources of observed electrons in the TeV energy range. Thus the electron intensity above 1 TeV will show large fluctuations from a smooth power law behaviour due to the small number of discrete sources which are capable of contributing to the observed flux. We would therefore expect to observe humps in the spectrum correlating to the individual sources. Results of some detailed calculations assuming the random occurrence of supernovae and taking the frequency mentioned above are shown in Ref. I.

Other aspects of the analysis of features of the high energy electron spectrum is the effect of the deficiency of short path lengths which was obtained by an analysis of the composition of heavy primaries in cosmic-rays. The results have demonstrated that the spectrum is depressed quite appreciably beyond 100 GeV. Such results

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seem to be difficult to reconcile with the data near 1 TeV observed by our group, and throw doubts on the likelihood of electrons and heavy primaries being produced in the same sources.

The path length distribution is known to be energy dependent. These works have been carried out by assuming that the path length distribution is the same at all energies. Here we mention that the effect is highly dependent on the model of propagation. As an example, in the case of double leaky box model (nested leaky box model), the deficiency of short path lengths is caused near the source, and the corresponding energy is higher than that of the observed electrons. This causes the depression to be smaller than that calculated by the previous authors. Furthermore, the leakage probability from the source region is higher for higher energy electrons, and this also increases the flux of electrons at high energies.

The results of calculation taking account of these factors are shown in Fig. 1. This demonstrates that the effect of the deficiency of the short path lengths is highly dependent on the propagation model, and could yield agreement with the observed data in the several hundred GeV region for a certain model of propagation of cosmic-rays.

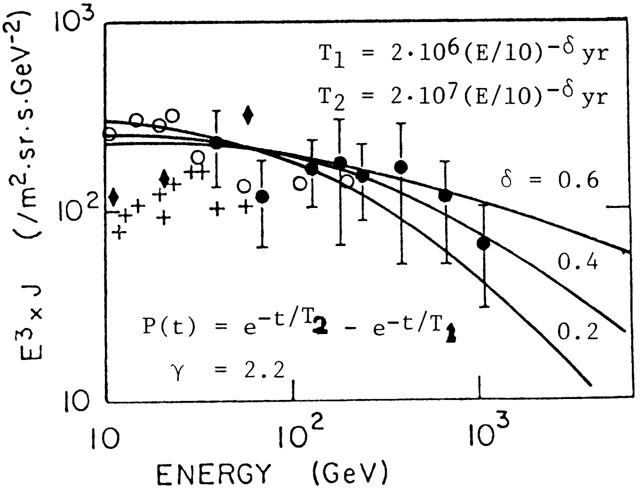

Fig. 1. Calculation with double leaky box model

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