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MULTIPARTICLE INTERACTIONS IN THE HIGH-AND SUPERHIGH-ENERGY REGION

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Up to the present time, only such types of elementary particle interactions have been studied in accelerator experiments and in cosmic rays, in which the initial state contains only one or two particles. At the same time, elastic and inelastic processes, described by Feynman's diagrams with 3,4 or a greater number of initial particles, are of great theoretical importance.

Unique possibilities for studying such type of interactions are provided by experiments on inelastic collisions of high-energy particles with atomic nuclei, when secondary particles, generated during a π-N or N-N interaction inside the nucleus as a result of the Lorentz compression effect, escape into a very narrow solid cone and the next intranuclear nucleon captures (or scatters) with a high probability several such particles at once [I,2]

Although present experimental data on nuclear interactions for energies $T > 30$ Gev are quite inaccurate and experimental and theoretical data can be correlated for each fixed T- value within a broad range of assumptions concerning the properties of multiparticle ineteractions, an examination of the overall (aggregate) experimental data presently availabe makes it possible, however, to draw a number of sufficiently specific conclusions.

These conclusions are based upon the comparison of experimental data with a series of step-by-step (Monte-Carlo) calculations, using consecutively more precisely defined assumptions on the nature of multiparticle interactions. In this connection, the simplest and most general assumptions were used at first, such as the independence of angular and energetic characteristics of produced particles on the type of such particles, the isotropy of angular distributions in digital computers, etc., which were examined in detail only as it became absolutely necessary to correlate the results of calculations with those of the experiment. Such an approach provides specific guarantees against the incorporation into the theory of some unsubstantiated and speculative factor.

The calculations could be performed only by using high-speed computers; the large volume of input information required the development of special programs with the view of maximum economy of computer storage facilities.

The experimental data available at the present time do not allow us to obtain as yet isolated (separate) information on interactions with particle number π = 3,4 etc. At present, conclusions can be reached only on the characteristics of multiparticle interactions, which are averaged with respect to the number and type of colliding particles. Since, when T>> I Gev, numerous π -mesons are produced, this means, basically, that these are interactions with several mesons in the initial state. The properties of such interactions are quite similar to the corresponding properties of inelastic π - N interactions, namely, there exists a released particle carrying away about 50% of the total energy, the angular distributions are sharply asymmetric with a characteristic dependence of the asymmetry on the type of particle generated the mean energy and the mean multiplicity of these particles increases approximately as $T^{1}/_{4}$, and an average of I0-20% heavy particles are generated at very high energies.

Figures I and 2 show unstandardized energetic and angular distributions of particles from inelastic multiparticle interactions for several energy values. Of course, no serious significance can be attributed to details of these distributions, since within the limits of experimental errors agreement with test data can be obtained both in the case of somewhat smoother and somewhat steeper curves. However, the main features of the distributions remain invariable.

To arrive at more detailed conclusions, precession measurements are of great importance, which can be carried at 60-70 Gev with the Serpukhov accelerator.

It should be noted that the contribution of multiparticle interactions is found to be greater in the case of light nuclei. For example, at T=I00 Gev, the ratio of multiparticle interactions inside light, medium and heavy nuclei of a photoemulsion is respectively to 38, 30 and 28%.

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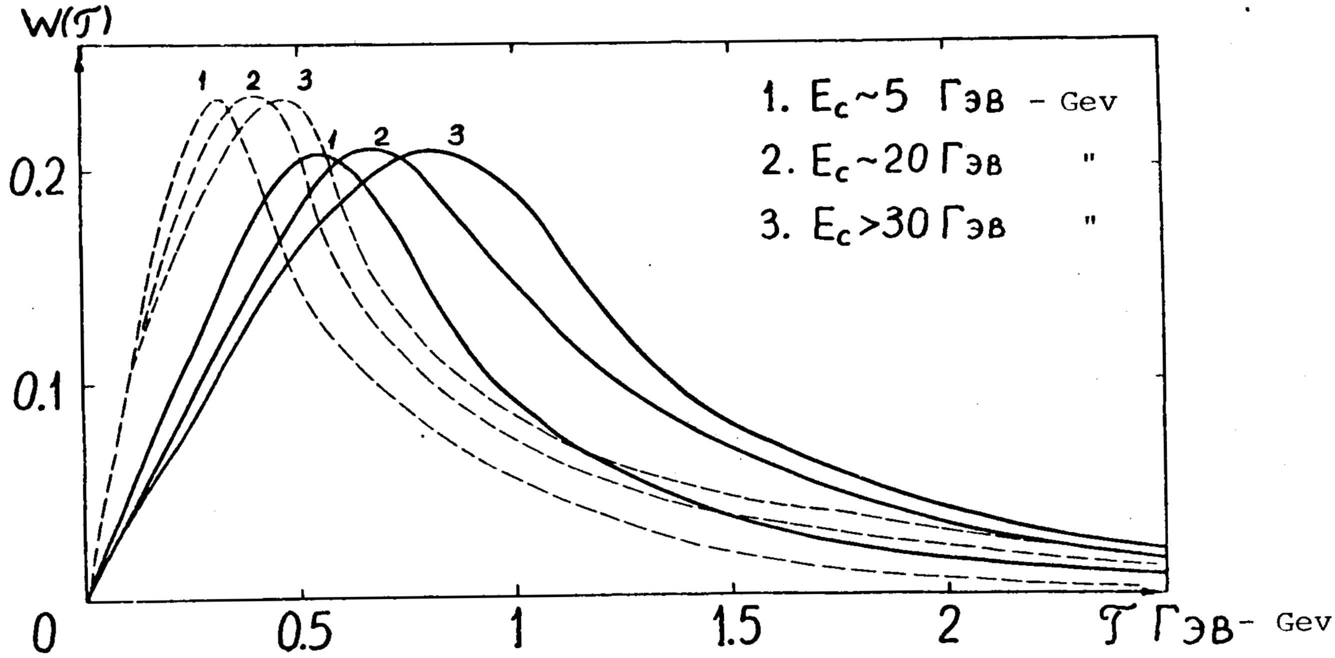

Fig. I. Energy distribution in a digital computer of particles generated during an inelastic multiparticle interaction. E_c is the toatl (overall) energy of the multiparticle system which can be used for the formation of new particles.
Solid-line curves correspond to nucleons, broken-line curves to π -mesons.

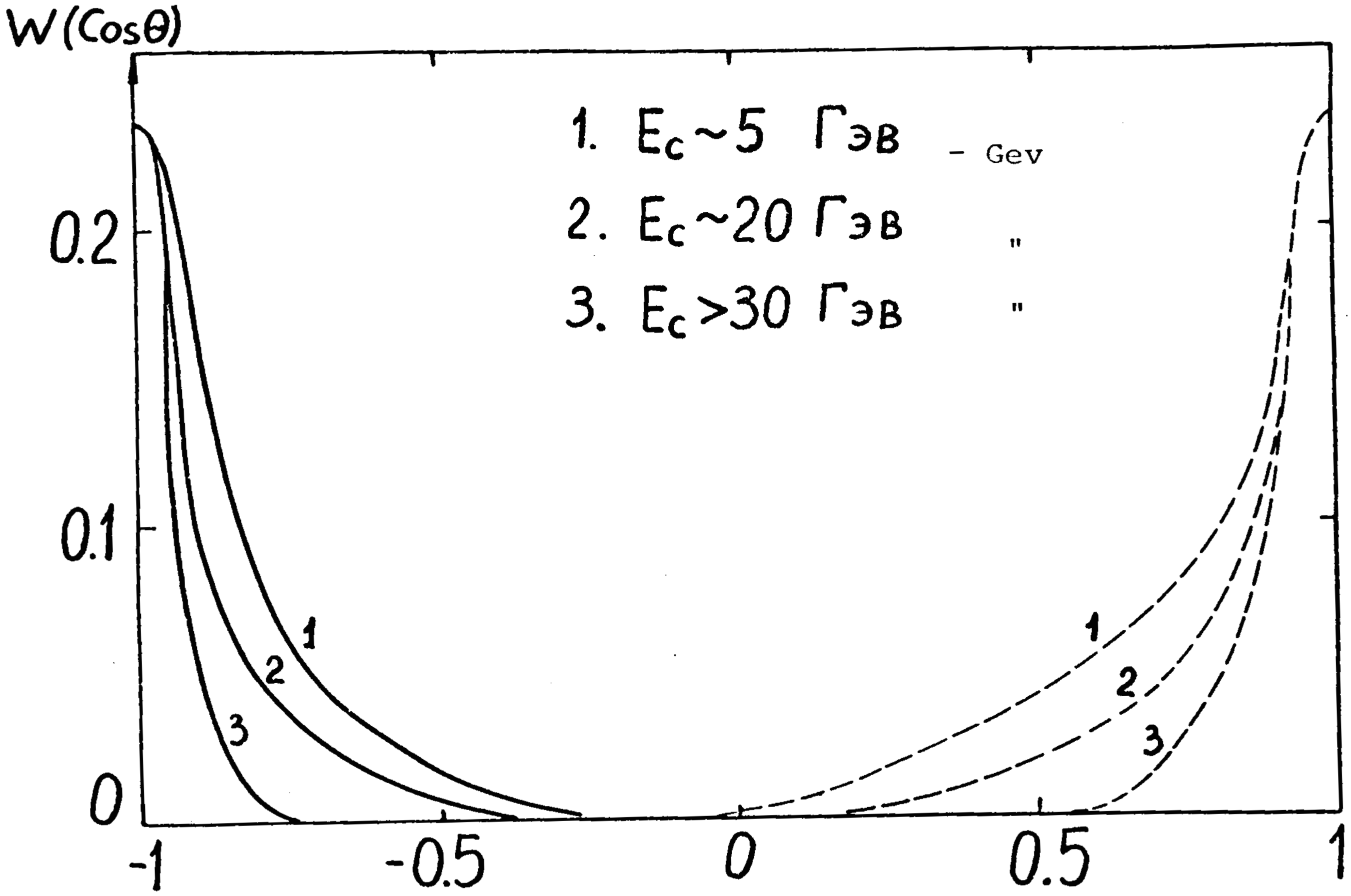

Fig. 2. Angular distributions in a digital computer of particles generated during an inelastic multiparticle interactions. Symbols are the same as those in Fig. I.

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