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NUMERICAL ANALYSIS OF ELECTROMAGNETIC CASCADES DEVELOPMENT IN EMULSION CHAMBERS

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1. Introduction. A new calculational scheme of the Monte-Carlo method assigned for the investigation of the development of high and extremely high energy electromagnetic cascades (EMC) in the matter was elaborated in the work [1] . In the works [2] the scheme [1] was applied to the analysis of angular and radial distributions of EMC electrons in the atmosphere. In the work [3] by means of this scheme the EMC development in dense medium is investigated and some preliminary data are presented on the behavior of EMC in emulsion chambers. In the present article the results of more detailed theoretical analysis of the EMC development in emulsion chambers are discussed.

2. Method. The calculational scheme used here consists in the combination of the usual Monte-Carlo method (the transport of the low energy part of the cascade ($E \leq 5\,GeV$)is calculated by this method) and a method of numerical solution of adjoint cascade equations (to calculate the development of the high energy cascade part).

Our calculations were carried out for the cascade energy region (10^2 - 10^5) Gev, the Landau-Pomeranchuk- Migdal effect was taken into account in a number of calculations. Some improvement was made in the computational code [1,3] concerning the electron multiple scattering sampling quality.

This improvement allowed us to get better agreement with experimental data [4] .

3. Results. Our calculational data are compared in fig.1 with the experimental data of FNAL [4] and some results of other Monte-Carlo method calculations. As can be seen from

fig.1 our data are in good agreement with experimental results [4] and calculations of Okamoto and Shibata [5] (for R = 50, 100 μm and the upper side of emulsion our results and data [5] practically coincide). At the same time there exists considerable difference of all results presented in fig.1 from the Monte-Carlo method data [6]. To our opinion this difference may be explained by the not quite correct account of the multiple scattering of cascade electrons in [6].

A comparison of our data for homogeneous medium with analytical data [7] evaluated in the core approximation is given in fig.2. As can be seen, our data for R = 200 μm are in a rather good agreement with analitical results corresponding to the simple saddle point method condition, but there exists considerable disagreement with the data using complicated condition of this method.

It is well known that core approximation data on average number of EMC electrons in a small radius circle are invariant with respect to production E_0R of primary energy E_0 and radius R. Fig.3 shows that such invariance takes place only approximately and only for relatively small values of E_0R.

Fig.4 illustrates the difference in the development of EMC in homogeneous medium of lead and a real emulsion chamber. Analytical data [8] taking into account only single emulsion layer are given there too. A qualitative agreement between numerical and analytical data is observed.

References:

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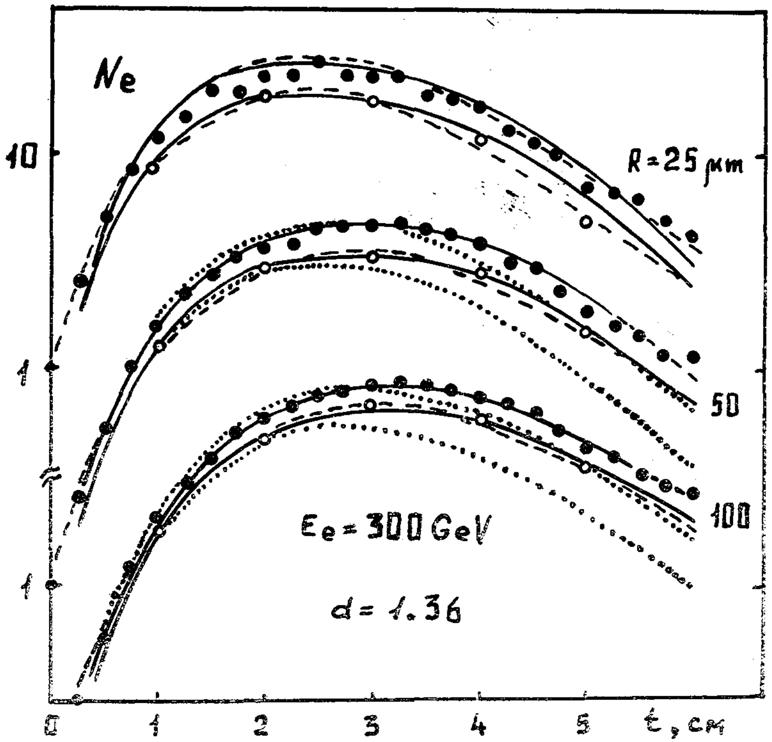

Fig. 1. The average number of electrons N_e within 25,50 and 100 μm for the chamber of the structure described in [4]. ●,○ - experimental data [4] corresponding to the upper (●) and lower (○) emulsion sides, —— - our data, ---- data [5], ... - data [6]

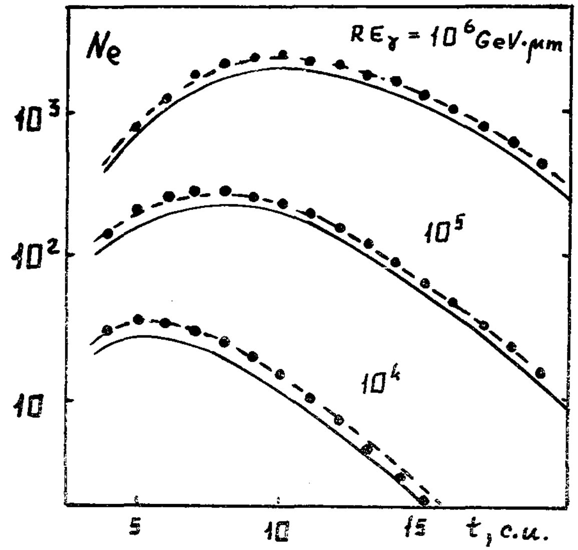

Fig.2. The average number of cascade electrons N_e within radius R=200 μm for the homogeneous lead absorber. ● - our calculation, curves are the core approximation data [7] corresponding to usual (----) and complicated (——) saddle point method conditions.

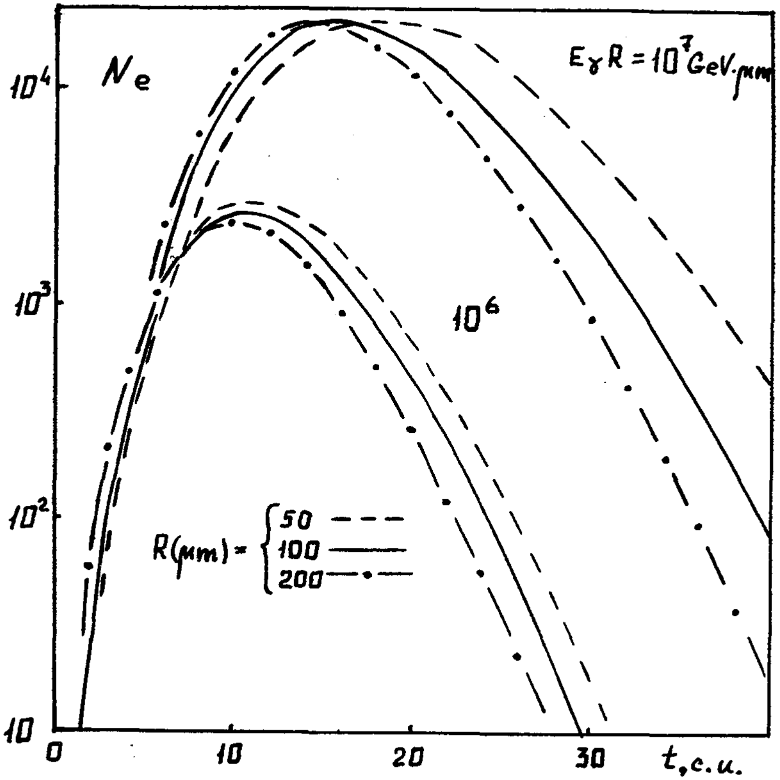

Fig.3. The average number of cascade electrons N_e in the homogeneous lead absorber. The LPM effect is taken into account.

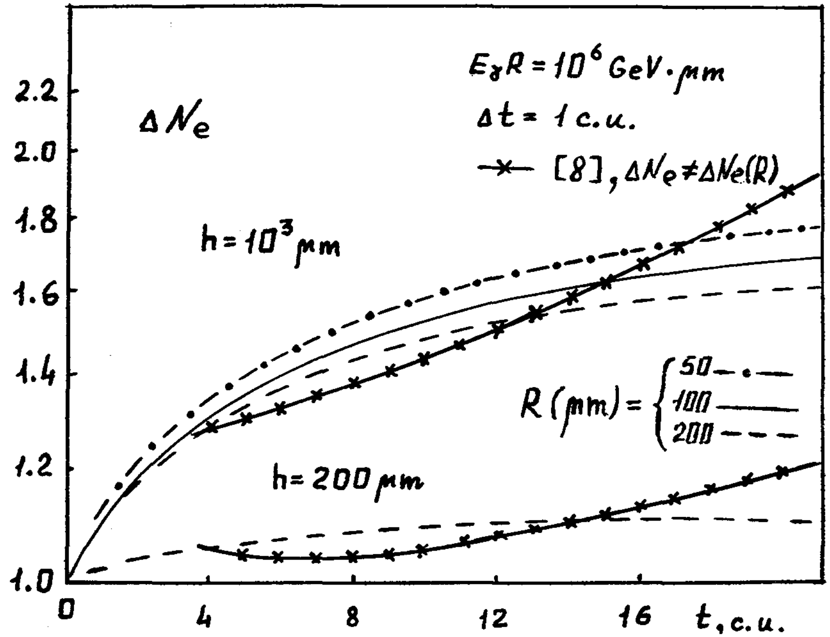

Fig.4. The ratio ΔN_e of average number of electron tracks for homogeneous medium of lead and the lower emulsion side of the chamber having the lead layers thickness $\Delta t = 1$c.u. and emulsion (or film) layers thickness h.