CONSEQUENCES FOR EAS PHENOMENA OF ADOPTING A VERY LARGE PHOTONUCLEAR CROSS SECTION

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Abstract. It has been suggested tha the apparent normality in the muon number for the excess showers from the direction of Cyg X-3 is due to the γ-p cross-section being near nuclear at high energies. We examine the consequencies for EAS the adopting this hypothesis. No experimental objection to the validity of the hypothesis seems to appears. In fact it is found that some data appear to be better described when the allovance for the rising photoproduction cross-section is made.

Introduction. It has been shown by Kiel group [Samorski and Stamm 1983] that the muon content at the excess showers from the dirrection of Cyg X-3 is close to that in the normal showers. Similar conclusions have been reached by the Lodz group for the excess showers from Crab [Dzikowski et al 1983] and by the Los Alamos group [Dingus et al 1988] for the Hercules X-1.

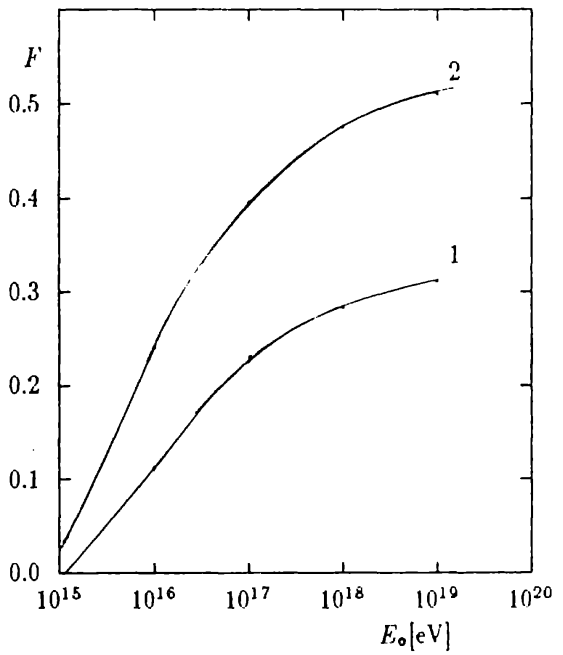

Fig.1 Fraction of the electromagnetic cascade energy transfered back to hadron component. 1 – scaling breaking according W-W, 2 – scaling parametrized at $\sqrt{s}$=200

The most likely explanation of that phenomenon would be that the cross-section for hadronic interaction of photons is increasing with their energy. A possible mechanism for that has ben given recently by Halzen and Drees (1988). According to that paper, at certain conditions the cross-section for the photoproduction can reach the hadronic cross-section at energies around $E_\gamma = 2 \cdot 10^6$ GeV. It should be however stressed that such increase is not sufficient for explaining the high muon content in the photon imtiated showers. In that case hadronic cross-section should be reached at least one order of magnifide lower. Moreover it has been demonstrated by us [Szabelski et al 1989] that if the hadronic cross-section for photoprooduction is reached at energies around 10^{14} eV certain cosmic ray phenomen can be understood better.

Assumptions of the calculations. For the present calculations it has been assumed that the photoproduction cross-section remains small until $E_\gamma = 10^{14}$ eV and increases to the value of 40% of the total cross-section above that threshold (remaing 60% being the normal cross-section for pair creation). The photoproduction interaction is simular to the Π-Nucleus interaction except that there is no leading

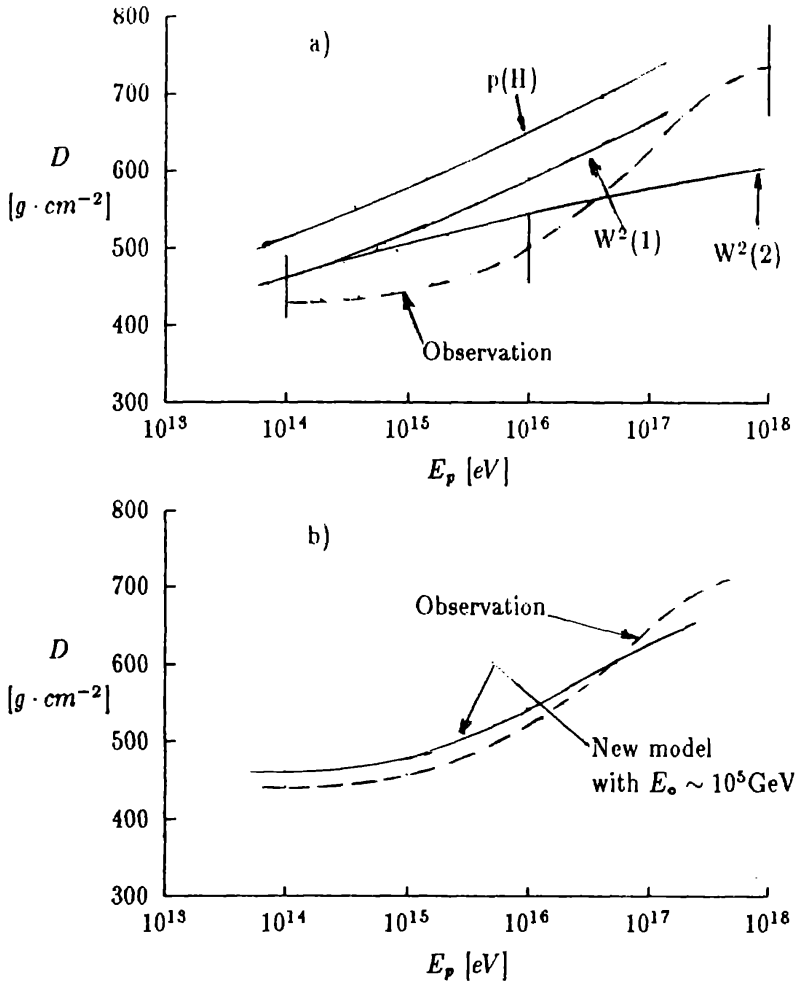

Fig.2 Depth of the shower maxima

pion production. The net result is that the photoproduction interactions are slightly move efficient in production of muons (approximately by the factor of 1.5).

Results of calculations. The rsults of calculations are summarised in figures 1–3. In figure 1 there is shown fraction of the energy of the photons which is transformed back to the hadronic casdade as the result of photoproduction process as a function of the primary photon energy. The lower courve is for scaling breaking model of Wdowczyk and Wolfendale an the upper for scaling parametrized at $\sqrt{s}$=200 GeV. In figure 2 the standart predictions for the depth of the shover maximum (a) and predictions of the present model (b) are compared with experimental data. It is scen that the present model predictions well represent the data removing the long standing difficulty with explainig the shower maxima position. Finally in figure 3 there is shown N_μ vers N_e dependence also with and without the effect of the rising photoproduction cross–section. The model of high energy interaction is taken according the W–W scaling breaking formula.

Conclusion. It appears that the basic properties of the EAS are consistent with the predictions based on the assumption about the rising cross–section of the photoproduction and in certain cases (longitudinal EAS development) the description is even better. The hypothesis gives a chance of good description of the longitudinal development of EAS without invoking very dramatic changes in high energy interaction model. The hypothesis would also explain the suprisingly low rate of the γ-ray families observed in emulsions chambers. It should be also poined out on the basis of the fig 3 that muon to electron ratio in EAS in the considered case would become less dependent on the mass of the primary particles.

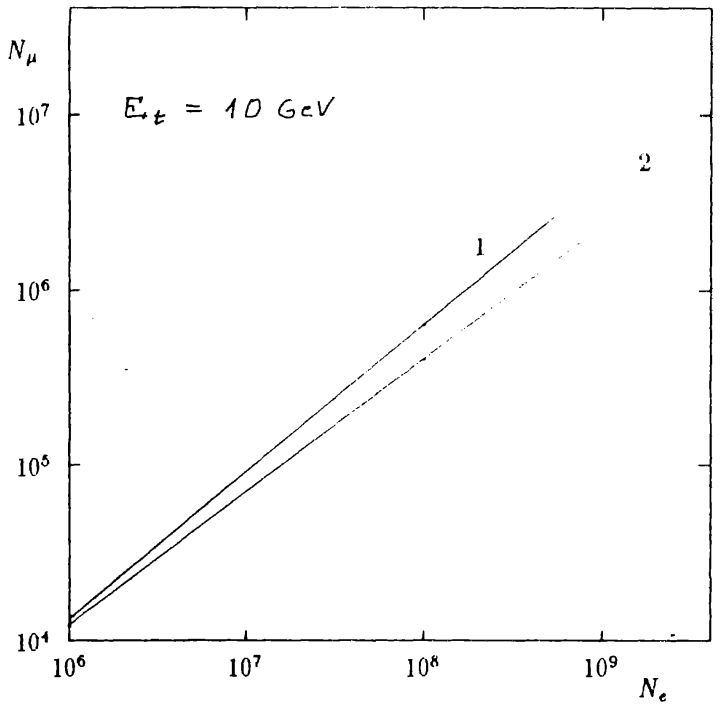

Fig.3 N_μ vers N_e relation.
1 – rising cross–section of photoproduction,
2 – no photoproduction

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