SEARCH FOR EXCESS SHOWERS FROM CRAB NEBULA

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ABSTRACT

There are analyzed the arrival directions of muon poor showers registrated in the Tien Shan experiment during an effective running time about $1,8 \cdot 10^4$ h. It is shown that there is a significant excess of these showers from the direction of Crab Nebula.

I. Introduction

Recently there are some papers about the search of gamma-quanta flux from Crab Nebula, based on the Extensive air showers data. Only the Lodz group /1/ found a significant excess (5.5σ) from Crab and the estimated flux is

$$F(>10^{16}\ \mathrm{eV}) = 2 \cdot 10^{-13}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$$

but the energy spectrum $F(>E_{o\gamma}) \sim E_{o\gamma}^{-\alpha}$ becomes very flat- $\alpha=0,4$. The Akeno array /2/ didn't find a shower excess from Crab and gave only the upper limits flux $\sim 10^{-14}-10^{-15}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ for $E_{o\gamma} \sim 10^{15}-10^{16}$ eV corresponding. Haverah Park gave also a negative result and put the upper limits of the Crab flux $I(>10^{15}\ \mathrm{eV}) = 2,6 \cdot 10^{-13}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ and $I(>10^{16}\ \mathrm{eV}) = 1,2 \cdot 10^{-15}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ /3/. The search was carried out by means of total intensity distribution analysis of showers. The analysis of muon-electron number relation, carried out by AKENO, has shown that there is no significant muon number increase in showers from Crab region.It seems that this result is already regular if we take into account that the primary gamma-quanta flux is 10^2-10^3 times smaller than the isotropic flux of the primary charged particles.The search of primary gamma-quanta flux /4/ carried out with help of muon and hadron poor shower selection registrated in the Tien Shan experiment has shown that the relative contribution of the gamma-initiated showers is $(n_\gamma/n_{p,A}) = (2,53 \pm 0,83).10^{-3}$ by $E_0 \gtrsim 10^{15}$ eV and the absolute flux intensity is

$$I_\gamma = (3,4 \pm 1,2).10^{-13}\ cm^{-2}s^{-1} \quad /4/.$$

The correspondent criteria for muon and hadron poorness of showers were $(N_\mu/\bar{N}_\mu) \leq 0.11$ and $(E_h/E_e) \leq 0,02$.

However, the geometry of the ionization calorimeter makes the statistical ensemble too small, because the real solid angle becomes smaller. If we take into account the muon criterion only, we can apply a much bigger sensitive area for the shower selection. This selection condition gives the possibility to reduce the background noise $\sim 10^2$ times, though there is no possibility for a full elimination of normal showers.

2. Experiment and method

In this analysis we set experimental data registrated by Tien Shan array since February 1974 till October 1982, for an effective running time $1,75.10^4$h. $7,5.10^5$ showers with sizes $N_e > 1,3.10^5$ and axis, localyzed in the central part $|X,Y| < 7$m of the installation are selected. The accuracy of the shower parameters estimation are /5/:

$$[\sigma_x, \sigma_y] \leq 0,5m;\ \sigma_\theta < 3^\circ;\ \sigma_\varphi \leq 10^\circ;\ (\sigma_{N_e}/\bar{N}_e) < 15\%;\ (\sigma_{N_\mu}/\bar{N}_\mu) < 30\%;$$

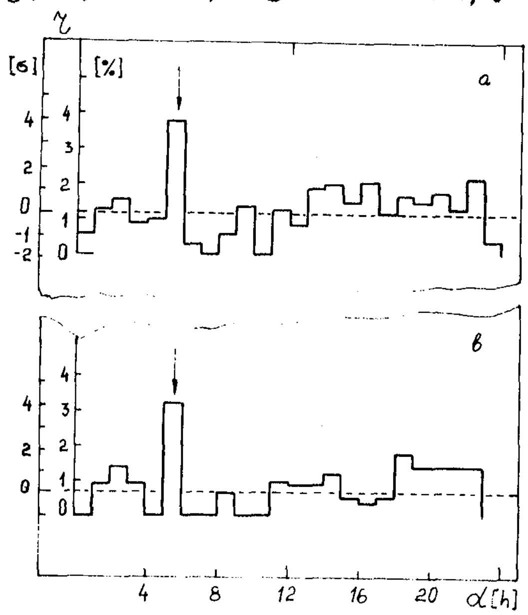
$\Delta t = 1$ min.

The coordinates (α, δ) are calculated for each shower. A further declination band of 15° width arround the Crab was considered. The 15° right ascension were chosen so that the Crab position remains in the middle of the interval.

Two distribution types are analyzed: I) all showers distribution $n_t(\alpha)$, and 2) muon poor shower distribution $n_\mu(\alpha)$. Assuming a good isotropy of "all showers" distribution there was analyzed the relation $\tau = [n_\mu(\alpha)/n_t(\alpha)]$. This method gives a possibility to eliminate the influence of exposition differences in the right ascension interval. The criterion $(N_{\mu\gamma}/N_\mu) \leq 0{,}II$ for muon poor showers /4/ was used in the form $m_\mu \leq I$, where m_μ is the number of the real registrated muons with $E_\mu > 5$ GeV by the detector with sensitive area about 45 m^2.

3. Results and discussions

Two groups of EAS with sizes $N_e \geq I{,}78.IO^5$ and with $N_e \geq 3{,}2.IO^5$ were selected. The "all showers" distribution shows no significant excess in the region of the Crab Nebula. However, the muon poor showers selection leads a significant anisotropy from the Crab direction for the two these intervals: $\tau_{Crab} \approx 4\sigma$ for $N_e \geq I{,}8.IO^5$ and $\tau_{Crab} = 4{,}2\sigma$ for $N_e \geq 3{,}2.IO^5$ /fig. Ia and Ib/.



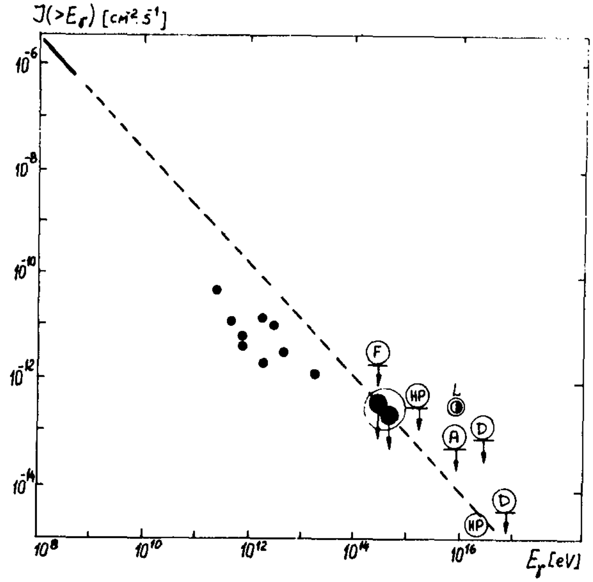
The correspondent estimated energy thresholds are: $E_{01} = (2{,}5 \div 5).IO^{I4}$ eV and $E_{02} = (4 \div 8).IO^{I4}$ eV. The lower limits were obtained for pure electromagnetic cascades, the upper limits - for normal showers from primaries with $\bar{A}$=IO. The obtained gamma-fluxes from the Crab Nebula are:

$I_\gamma(>3{,}5.IO^{I4}\ \text{eV}) = (2{,}8 \pm 0{,}8) \times IO^{-I3}\ \text{cm}^{-2}\text{s}^{-I}$ and

$I_\gamma(>5{,}5.IO^{I4}\ \text{eV}) = (I{,}9 \pm 0{,}7).IO^{-I3}\ \text{cm}^{-2}\text{s}^{-I}$

As it is shown in /4/, the muon poorness criterion only gives a possibility to estimate the upper limit of the gamma-flux intensity from the source.

If we extrapolate the gamma-flux energy spectrum from the Crab obtained in low energy experiments /6/ /fig.2/



(black points:small-results from optical Cerenkov Light experiments /7/;big-our results;A-/2/; HP-/3/; L-/I/; F-/7/; D-/8/),it is seen that the obtained absolute intensity of gamma-flux from the Crab Nebula in the energy region IO^{I4}-IO^{I5} eV is in good agreement with the results of direct measurements.

References

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