Extra-galactic Sources 1739+522, 3c454.3, NGC1275, Mkn501, Mkn421 - Spectra and Images

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Abstract

A new metagalactic source of gamma-quanta with energies > 0.8 TeV with flux $(0.78 \pm 0.13) \bullet 10^{-12} cm^{-2} s^{-1}$- seyfert galaxy NGC1275 was detected. Active galactic nuclei 3c454.3 and 1739+522 (z=0.859 and z= 1.375) with flux accordingly $(0.43 \pm 0.17) \bullet 10^{-12} cm^{-2} s^{-1}$ and $(0.47 \pm 0.18) \bullet 10^{-12} cm^{-2} s^{-1}$ were also detected. The observed gamma-quanta energy spectra of four galactic and five metagalactic sources doesn't contradict with average energy spectra of this sources in energy rage 1 - 50 TeV - $f(E_\gamma) dE_\gamma \sim E_\gamma^{-2.35 \pm 0.16} dE_\gamma$. The differential spectrum of protons and cosmic ray nuclei at energy interval $1 - 3 \bullet 10^7$eV is $f(E) dE \sim E^{-2.72 \pm 0.1} dE$.

The investigation of extra-high energy gamma-quanta sources by any methods including mirror Cherenkov astronomy touches the problem of cosmic ray nature and correspondingly the role of Galaxy and Metagalaxy in their generation. Created at the Lebedev Physical Institute and stated at the Alatoo mountains 3338 m high above the sea level SHALON-1 mirror telescope with mirrors square 11.2 m^2 and image-matrix consisting of 144 photomultipliers with the full angle of $> 8^o$ was used for observations of galactic and metagalactic very-high energy gamma-quanta at the energy range 1-50 TeV sources. From Fig.1 (these proc.) of used in SHALON experiment gamma-quanta and proton with energy 1 TeV image-parameters Monte-Carlo simulations and of experimental gamma-quanta from local sources and cosmic rays protons image-parameters distributions observed by SHALON telescope one can see that selection criteria used in SHALON-1 experiment extracts gamma from the proton background which confirms correctness of chosen in SHALON experiment gamma selection criteria.

The SHALON-1 observations at Tien-Shan high-mountainous station were carried out since 1992 during this period 12 metagalactic and galactic sources were observed. Among them are galactic sources Crab Nebula (the supernova remnant), Cygnus X-3 (binar), Tycho Brage (supernova remnant), Geminga (radio-weak pulsar) and metagalactic ones Markarian 501 (blazar), Markarian 421(blazar),

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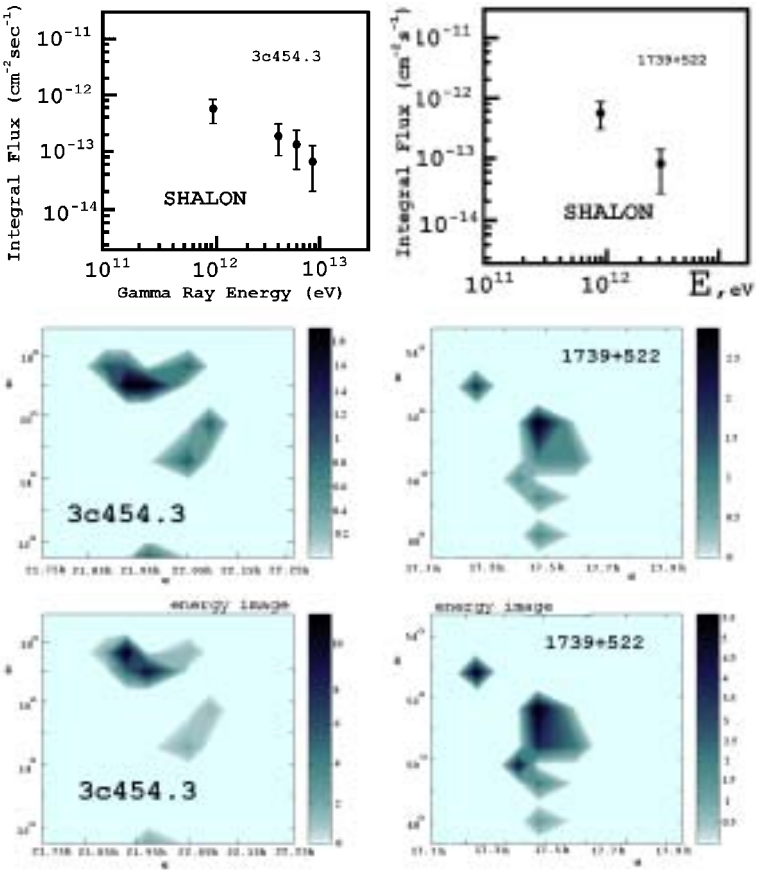

Fig. 1. Gamma-quanta integral spectra by SHALON-1 of: left - 3c454.3 (z=0.859); right - 1739+522 (z=1.375) and Images at energy range of more than 0.8 TeV and energy image (in TeV) of 3c454.3 and 1739+522

NGC1275 (Seyfert galaxy), 3c454.3 (quasar) and 1739+522 (quasar). For the each source the observation data results analysis are integral spectrum, time analysis of events from the source and background ones observed simultaneously and the sources images (Fig. 1 - 3). The observation data of previously known gamma-quanta sources (Markarian 421, Markarian 501 and Crab Nebula) observed by both SHALON and other experiments are approximately equal. At 1998 at SHALON observation there was a new metagalactic gamma-quanta with energies > 0.8 TeV source with flux $(0.78 \pm 0.13) \bullet 10^{-12}$ detected. This source coincides by its coordinates with the active nucleus galaxy NGC 1275. The energy spectrum of active galactic nuclei NGC 1275 was measured at energy interval of 0.8 to 50 TeV, $k_\gamma = -1.19 \pm 0.19$ (Fig. 2), time analysis was performed and the source image is presented at Fig. 2. The observable energy distribution of gamma-quanta from local sources of NGC 1275 is $dF/dE_\gamma \sim E^{-2.19 \pm 0.19}$. The observed

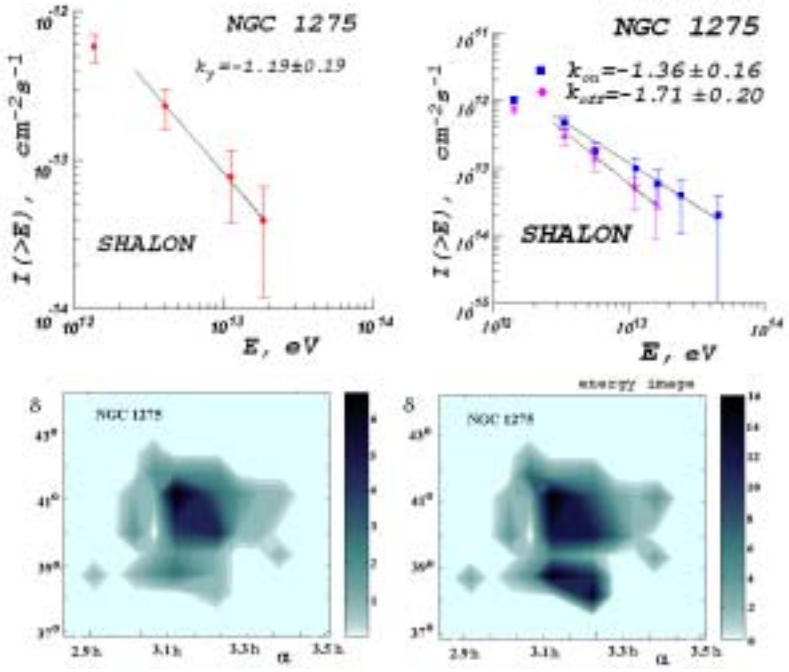

Fig. 2. Above: Gamma-spectra of the gamma radiation from NGC 1275. The observable energy distribution of gamma quanta from local sources NGC 1275 $dF/dE_\gamma \sim E_\gamma^{-2.19\pm0.19}$. The observed spectra of the gamma-quanta including the 10%-15% contribution of the proton showers is $dF/dE \sim E^{-2.36\pm0.16}$. It also differs from observed energy spectrum for cosmic rays $dF/dE \sim E^{-2.71\pm0.19}$ Below: Image at energy range of more than 0.8 TeV and energy image (in TeV) of NGC 1275

spectrum of the gamma-quanta including the 10%-15% contribution of the proton showers is for NGC 1275 $dF/dE_{on} \sim E^{-2.36\pm0.16}$. It is differs from observed simultaneously spectrum for cosmic rays $dF/dE \sim E^{-2.71\pm0.19}$. Firstly detected by SHALON telescope extragalactic source NGC1275 also was observed at Tibet installation. At the energy region from 0.8 to 10 TeV there were detected new metagalactic sources 1739+522, z=1.375 and 3c454.3, z=0.859 with fluxes $(0.43 \pm 0.17) \bullet 10^{-12}$ and $(0.47 \pm 0.18) \bullet 10^{-12}$ accordingly. The energy spectra at energy region from 0.8 to 10 TeV were measured and the source images are presented (Fig. 1). The galactic source Cygnus X-3 known more than for 10 years as a variable intensity $\leq 10^{-11} - 5 \bullet 10^{-12} cm^{-2} s^{-1}$ source was observed with gamma-quanta flux $F(E_o > 0,8 TeV) = (4.2 \pm 0.7) \bullet 10^{-13} cm^{-2} s^{-1}$. For Cygnus X-3 the integral spectrum indexes are accordingly: $k_\gamma = -1.20 \pm 0.14$, $k_{on} = -1.51 \pm 0.22$, $k_{off} = -1.77 \pm 0.21$. The observed energy gamma-quanta spectrum from 4 sources in our Galaxy and 5 Metagalaxy sources do not contradict with the averaged energy gamma-quanta spectrum of all this sources at energy region 0.8-50 TeV $f(E_o)dE_o \sim E_o^{-2.35\pm0.16} dE_o$. The differential spectrum of protons and nucleus of

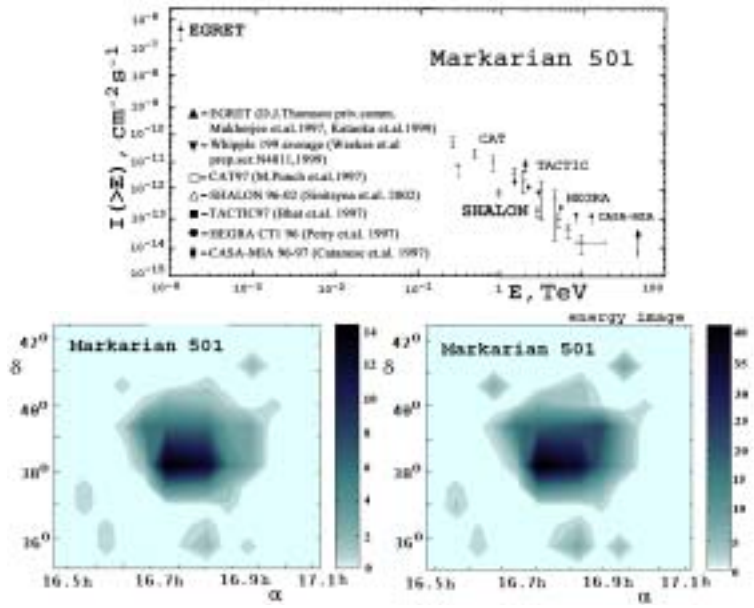

Fig. 3. Gamma-quanta integral spectra by SHALON-1 of Markarian 501 and Image at energy range of more than 0.8 TeV and energy image (in TeV) of Markarian 501

cosmic radiation $f(E)dE \sim E^{-2.72\pm0.1}dE$ at energy interval of 1 - 3 • 10^7 TeV. So the energy spectrum at interval $10^{12} - 10^{14}$ eV of almost all detected gamma-sources in the power plot ~ 0.5 times harder the protons and nuclei of cosmic rays one. This intensifies the problem - what are the processes in Universe forming the unified cosmic rays spectrum on many orders of energy magnitude. The new problem arose in comparing the power of sources of gamma-quanta generated in our Galaxy (the supernova remnants) and power of metagalactic sources (active galactic nuclei). The powers of metagalactic sources in 10^6 times exceeds the power of gamma-sources in our galaxy, and the most far from our Galaxy currently known source 1739+522 is in 10^{11} times more powerful than the total gamma-radiation of all known gamma-sources of our Galaxy. Among the ten observed by different researchers studying gamma-radiating objects there are some sources from with sporadical or periodical changes of gamma-radiation intensity (Markarian 421, Markarian 501, Crab Nebula). Radiation variability can be a helpful information about the object's nature, if it's not connected with the equipment instability or conditions of Cherenkov radiation observation in atmosphere. It is undoubt, that the synchronous gamma-quanta flux intensity changing observations by two spaced far one from another gamma-telescopes SHALON-1 and SHALON-2 is the best provement of radiation variability of gamma-quanta source itself.

1. Sinitsyna V.G., Nikolsky S.I. et.al. 2001, Nucl.Phys. B. 97, 215 and 219.