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The comparison of metagalactic sources NGC 1275, 3C454.3 and 1739+522 with the early known galactic and metagalactic sources

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Abstract. The comparison of the observed by Tien Shan gamma-telescope SHALON metagalactic sources NGC 1275, Markarian 421, Markarian 501, 3c454.3 and 1739+522 with the earlier investigated galactic sources Crab Nebula, Cygnus X-3, Geminga, Tycho Brahe exposed that all extragalactic sources mentioned above have 10^6-10^8 times higher intensity of the gamma-radiation than galactic sources. The differences of the energy spectrum of the cosmic rays, the gamma-quanta spectra from NGC 1275 and Markarian 501 including 10-15 percentage of the cosmic rays particles and the gamma-quanta only ($F(E_\gamma)/dE_\gamma \sim E_\gamma^{-2.19\pm0.19}$ for NGC 1275, $F(E_\gamma)/dE_\gamma \sim E_\gamma^{-2.28\pm0.26}$ for Markarian 501) are discussed.

The research of extragalactic and galactic sources of very-high energy gamma-quanta by methods, including ones using mirror Cherenkov telescopes (TABLE 1) concerns, rather than delicate problem of the nature of cosmic rays and accordingly the role of our galaxy and extragalaxy in their generation. It is generally accepted, but may not be proved enough that the cosmic rays before the break in their spectrum have a galactic origin (energy $<10^{15}$-10^{16}eV) and only at energies of $> 10^{16}$eV the role of the extragalaxy probably grows.

Experimental data on a very high energy gamma - ray astronomy which are still not numerous (at present gamma-ray astronomy is behind from the cosmic rays at relict cutoff energy on observable gamma-quanta energy) completely denies mainly galactic origin of cosmic rays. All at present detected extragalactic sources of gamma - quanta with the energies higher than 10^{12}eV (Fig 1-4) have the radiation intensity 10^6 - 10^8 times larger than Crab Nebula. But we know, that among all galactic sources the Crab Nebula is the brightest one by an observable gamma-quanta flux, that is definitely connected with it's nearness to Solar system The figure 4 illustrates the reliability of the background extraction at the gamma-sources observations by the Cherenkov radiation of the electron - photon cascades in atmosphere by means of the mirror telescope. An out - of -

TABLE 1. ***The catalogue of observing by SHALON telescope in TeV energies since 1994.***

Source	Type	Flux $cm^{-2}s^{-1}$ E>0.8TeV	Distance	
	Galactic		Kpc	
Crab Nebula	Plerion	$(1.10\pm0.13)\bullet10^{-12}$	2.0	
Cygnus X-3	Binary	$(4.20\pm0.70)\bullet10^{-13}$	1.1	
Geminga	Supernova Remnant	$(0.48\pm0.17)\bullet10^{-12}$	0.25	
Tycho Brahe	Supernova Remnant	$(1.89\pm0.09)\bullet10^{-13}$	2.0 - 5.1	
	Extragalactic		mpc	z
Mkn 421	Blazar	$(0.63\pm0.14)\bullet10^{-12}$	124	0.031
Mkn 501	Blazar	$(0.86\pm0.13)\bullet10^{-12}$	135	0.034
NGC 1275	Seyfert Galaxy	$(0.78\pm0.13)\bullet10^{-12}$	71	0.013
3c454.3	Quazar	$(0.43\pm0.17)\bullet10^{-12}$	4685	0.859
1739+522	AGN	$(0.47\pm0.18)\bullet10^{-12}$	7500	1.375

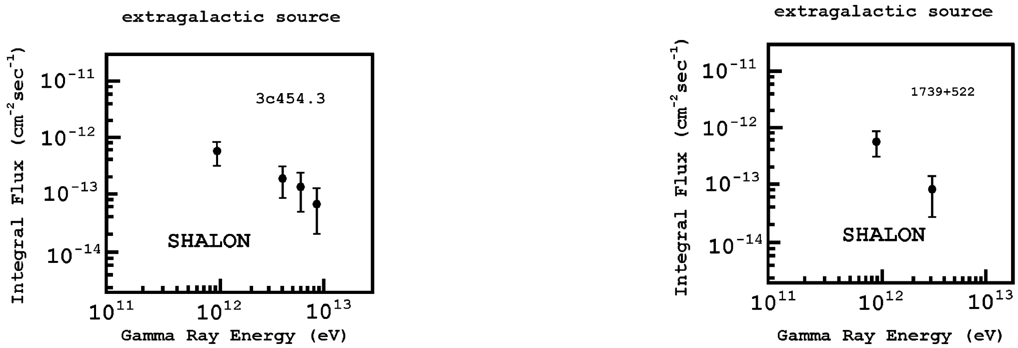

Fig. 1. *The spectra of gamma-radiation from 3c454.3 and 1739+522*

atmosphere gamma - astronomy has detected a lot of gamma – quanta sources with energies of 10^8-10^9 eV, which are various by their nature. At observed extensive air showers, with the primary particles energies of 10^{14}-10^{15} eV the "no muons" or "no hadrons" flux was estimated, but the accuracy of the determination of stellar coordinates of gamma - quanta arrival direction does not allow unambiguously connect such a shower with the coordinates of probable sources. As one can see from figure 3 the experimental data, obtained by means of the SHALON telescope conforms to other observed fluxes data of the gamma-quanta in the energy interval of 10^{11}-10^{13} eV and form the united spectrum with the gamma-quanta data in the energy interval of 10^8-10^9 eV. Fig. 1-4 represent the spectra of gamma-radiation from extragalactic sources, which was revealed at the observations with SHALON.

The Table 1 presents the catalogue of the gamma-quanta sources have been observed by the SHALON telescope since 1994. One can see that the observing intensity of the galactic and extragalactic sources differentiate a little, that is connected with the statistic observation of sources and with the necessity to have the sufficient informing image about the distribution of the Cherenkov radiation in atmosphere. However the approximate equality of the photon fluxes from the galactic and extragalactic sources means 10^6-10^8 times higher intensities of the extragalactic sources because of its more significant remoteness. The extragalactic sources 1739+522 and 3c454.3 are the extremely distant ones with the significant red shift (Fig. 1).

Very high energy gamma - astronomy is an essential source of information about processes in various, as a rule, active galactic and extragalactic objects. However, cosmological processes, connected with nature of a substance structure, with its superdense quasistable state in active galactic nuclei, will be observable only by an energy spectrum of their electromagnetic radiation and probably in future, by a high energy neutrino flux. Occasionally or not a regular observation of gamma - radiation of extragalactic sources in many countries were started when mirror telescopes were designed, which allows to detect extensive air showers by Cherenkov radiation in a rather small solid angle.

The gamma-telescope SHALON of a high-mountain observatory of Lebedev Physical Institute at Tien Shan, located on the height 3338m above a sea level, is destined for gamma – astronomical observation in the energy range 0.8 - 50 TeV. The telescope has a matrix of photomultipliers with full angle > 8° and an angular resolution ~ 0,5°. It is necessary to note, that matrix with large full angle allows to carry out the observation of the supposed source (**ON** data) and background of cosmic ray EAS **(OFF** data) see simultaneously, i.e. at a practically the same thickness of

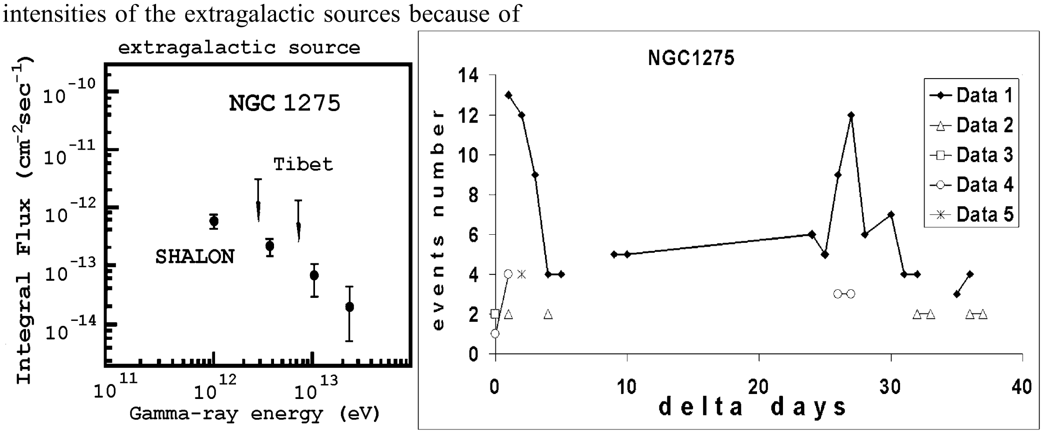

Fig. 2. *The spectrum of gamma-radiation from AGN NGC 1275 and NGC 1275 time diagram 1996-1999: DATA 1 - gamma-quanta events sum 1996, 1997, 1998 and 1999; DATA 2,3,4,5 - background events of showers produced by cosmic ray protons (large full angle of observations gives an opportunity to carry out* ***ON*** *and* ***OFF*** *observations simultaneously) 1996, 1997, 1998 and 1999 accordingly (see text).*

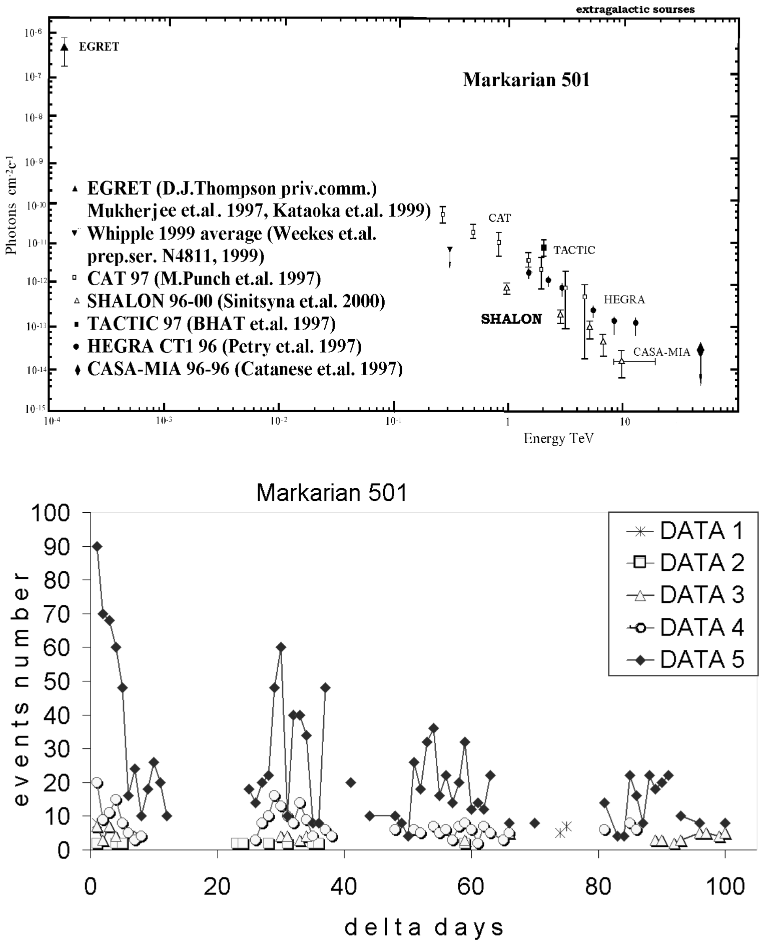

Fig 3. *Spectrum of the gamma-radiation of AGN Markarian 501 and its time diagram 1996-1999. DATA 5 - gamma-quanta events sum 1996, 1997, 1998 and 1999 SHALON; DATA 1,2,3,4 - background events of showers produced by cosmic ray protons (large full angle of observations gives an opportunity to carry out **ON** and **OFF** observations simultaneously) 1996, 1997, 1998 and 1999 accordingly (see text).*

an atmosphere, its transparency and other conditions of experiment. An additional selection of electron-photon showers among extensive air showers of cosmic rays can be carried out by the analysis of a light image (generally of an elliptic spot in a lightreciever matrix) in comparison with developed characteristic parameters of distributions for both showers from gamma - quanta and showers from protons and nuclei.

The Fig. 2, 3 presents the results of the time analysis. The time analysis shows number of event (gamma or background), coming with the certain time interval (delta days). At On data in all sources groups of peaks with common average 5-10 days width were detected with the period to multiple 24-26 days. These peaks can be interpreted as periods connected with the fact that observations are being carried out only by moonless nights. As one can see from presented at Fig. 2-3 the contribution of cosmic rays background into observable gamma-quanta with energies > 0.8 TeV doesn't exceed 10% - 15%.

Among different search methods of gamma-quanta local sources the most important is observations of Cherenkov radiation from electron - photon cascades generated in atmosphere by very high energy gamma - quanta. Thus the direction of Cherenkov radiation coincides with the direction on the source. An approximate equality of observed intensity of the sources is connected with a limited tune of observation of a proposed point source. Probably Crab Nebula is a typical source of Galactic cosmic rays (Fig. 4) and NGC 1275, Markarian 421 and Markarian 501 (Fig. 3-4) are typical sources of extragalactic cosmic rays. Being the brightest and most unvaring source at TeV energies, Crab has been observed by most experiments mainly as a test source and do we are. The average year flux from Crab Nebula on SHALON data is $(1.10\pm0.13)\bullet10^{-12}cm^{-2}c^{-1}$. because we have an additional selection criteria int_0 ant int_1. This value is less then meaning in other Cherenkov experiments, mentioned above. Other galactic source is Geminga observed with $(0.48\pm0.17)\bullet10^{-13}cm^{-2}s^{-1}$ flux. Fig.

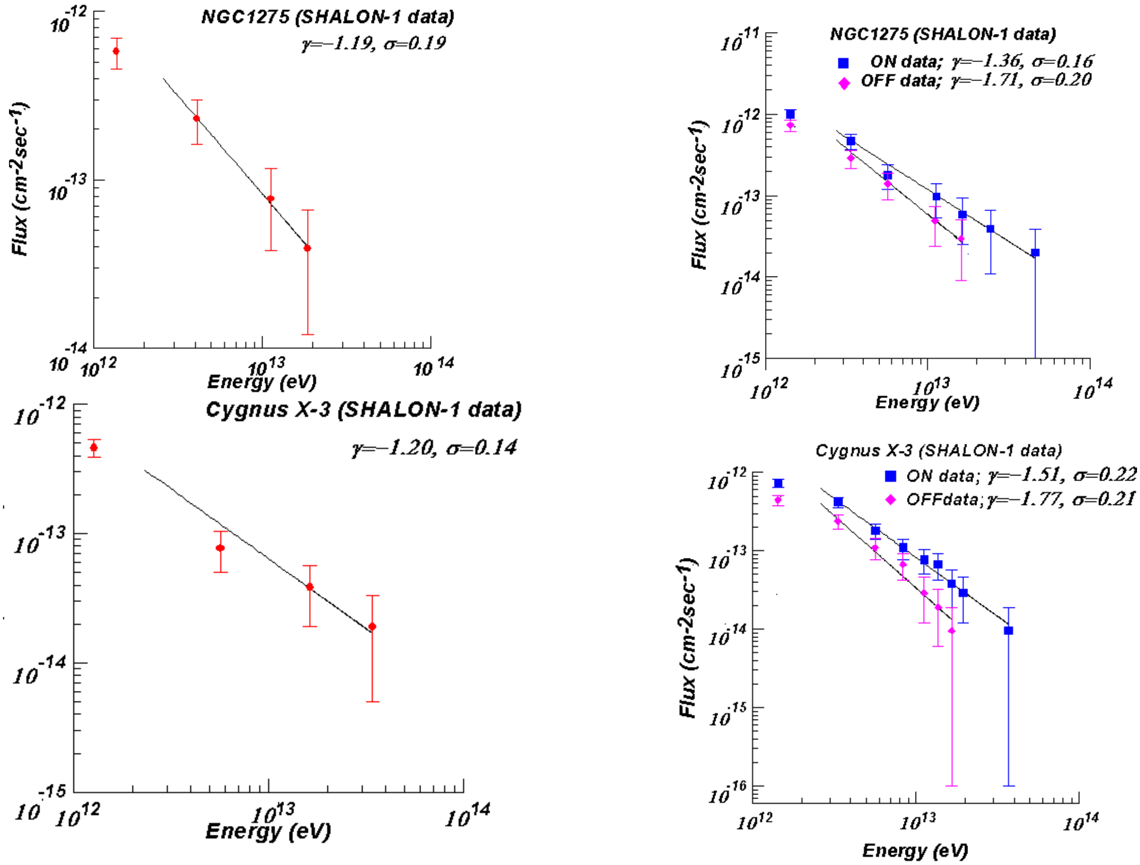

Fig. 4. *Spectra of the gamma radiation from Seyfert AGN NGC 1275 and Cygnus X-3. The observable energy distribution of gamma quanta from local sources of NGC1275* $dF/dE_\gamma \sim E_\gamma^{-2.19\pm0.19}$*, of Cygnus X-3* $dF/dE_\gamma \sim E_\gamma^{-2.20\pm0.14}$ *. The observed spectra of the gamma-quanta including the 10%-15% contribution of the proton showers is of NGC1275* $dF/dE \sim E^{-2.36\pm0.16}$*, of Cygnus X-3* $dF/dE \sim E^{-2.51\pm0.22}$*. It also differs from observed energy spectrum for cosmic rays* $dF/dE \sim E^{-2.71\pm0.19}$ *and* $dF/dE \sim E^{-2.77\pm0.21}$ *accordingly.*

3 and fig. 3-6 (report OG2.1, this conference) shows the spectra of this sources in comparison with the data of other experiments. The Cygnus X-3 is known to be weak source with $(4.20\pm0.70)\bullet10^{-13}cm^{-2}s^{-1}$ flux. The weaker than previous is Tycho Brahe with $(1.89\pm0.90)\bullet10^{-13}cm^{-2}s^{-1}$ flux (Table 1). This flux is extremely low and the addition confirming of Tycho's SNR in TeV region is necessary. The observable energy distribution of gamma quanta in an interval of energy 10^{12} - $5\bullet10^{13}$ from the local sources in our Galaxy do not contradict with the spectrum of Crab Nebula $dF/dE_\gamma \sim E_\gamma^{-2.08\pm0.12}$, of Cygnus X-3 $dF/dE_\gamma \sim E_\gamma^{-2.20\pm0.14}$. The observed spectra of the gamma-quanta including the 10%-15% contribution of the proton showers is for Crab Nebula $dF/dE \sim E^{-2.35\pm0.12}$, for Cygnus $dF/dE \sim E^{-2.51\pm0.22}$, energy spectrum of cosmic rays $dF/dE \sim E^{-2.7}$. The fluxes of metagalactic and galactic sources observed both SHALON and other experiments are approximately equal, but the difference of distance is 10^4. It means that radiating power of extragalactic sources is 10^8 times higher. Taking into account limited number of sources in our Galaxy in comparison with Metagalaxy, one can expect that cosmic rays with energy more than 1 TeV are mainly of extragalactic origin.

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