ACTIVE GALACTIC NUCLEI TEV RESULTS FROM THE SHALON-ALATOO OBSERVATORY

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ABSTRACT.

The TeV catalogue of extragalactic sources contains three objects investigated by the SHALON-ALATOO Observatory at energy above 0.8 TeV: Markarian 421, Markarian 501 and NGC 1275, which was detected in TeV energy range by the observation on the telescope SHALON-1. Observatory have just announced the TeV discovered of NGC 1275.

More than forty years ago, when Cherenkov light from cascades of cosmic rays in the atmosphere on the background of a night sky had been detected, attention was paid to the possibility of observation gamma-astronomy in the energy range 10^{12}-10^{15} eV. In 1961-1963 A. Chudakov and his collaborators were the first who made the attempts to search gamma rays from the Galaxy center by means of an optical device with a resolution 1°-2° . From that time and till 1990 various sources detected in many experiments were mainly with variable sources, that reasoned that sources detected by some observers weren't detected by others. From 1981 more precise methods were being developed in order to select electron-photon cascades in the atmosphere on the background of 10^3 more intensive flux of extensive air showers produced by protons and cosmic ray nuclei.

At the present time in north hemisphere a few telescopic devices for Cherenkov radiation with angular resolution ~0.1° (observatory Whipple in Arizona, CAT in French Pyrennees, Russian observatory SHALON in ALATOO et al., Table 1) allow to have stable results concerning to several galactic and extragalactic the sources of gamma-quanta in energy interval 10^{12}-$5\cdot10^{13}$ eV at fluxes less 10^{-12} cm^{-2} sec^{-1}. In the field energies above 10^{14} eV is shown , that observations of extensive air showers (EAS) generated by primary gamma-quanta is possible by other methods: as that EAS without muon , EAS without hadron, and even as to profile ionization light of atmosphere from the satellite. However at the primary energies below 10^{14} eV the observations of directed Cherenkov radiation from atmosphere for the present time is the most effective. One singles out the electron-photon showers in the EAS, which generated by protons and nuclei, you may improve by means of the increasing of the angular accuracy of direction, in which develops shower, that correspondences of the direction of primary gamma-quanta. Such improving of the gamma-astronomical observations is possible at the large area of mirror telescopes, like telescopes CAT and WHIPPLE. That is possible for the telescope SHALON by means of the increasing of the number of telescopes, placed into one group with the parallel axes of observation (it is possible so this will be done into Indian observatory Abu). At ALATOO observatory SHALON high-mountain station of Lebedev Physical Institute of Russian Academy of Science in Kazakhstan the development of gamma-astronomical observations is connected with the assemblage of the second telescope SHLAON. SHALON-2 will be set up at a distance 260m from telescope SHALON-1, and the propagation of EAS between the both gamma-telescopes (~10^4m^2) will be the subject of stereoscopic analysis of the of cascade development , which is different for the gamma and proton-nuclei showers.

For the present time it is known very finite number of the gamma-quanta sources with energy above 10^{12}eV. It is connected with the small intensity of observing fluxes and by large observation time that is greatly restricted by the weather and moon-less night periods. It is possible that this fact explain approximate equality of observing fluxes from different gamma-quanta sources both galactic OG 2.1.31

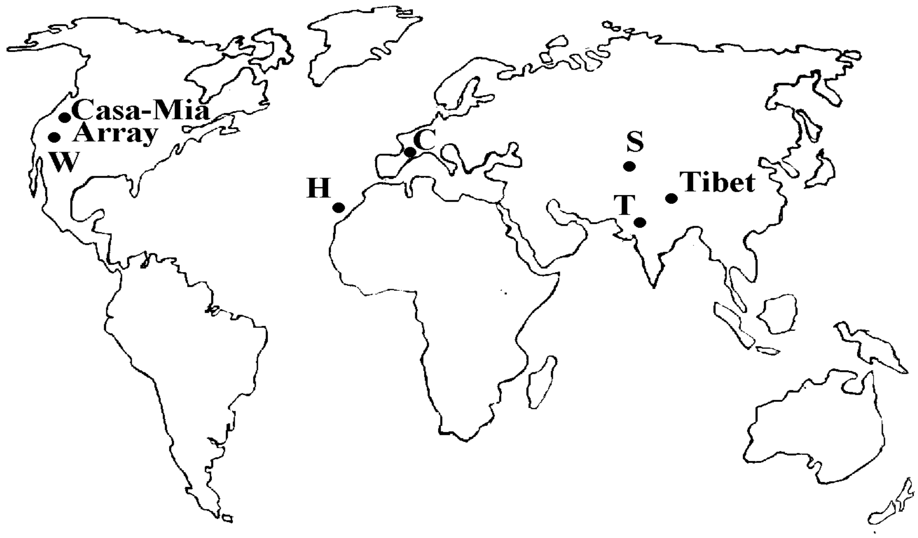


Table 1.Experimens reported to have detected Markarian 421 and Markarian 501

Experiment, altitude	Site, Country	Area	Range of measurment	Full angle image.	Pixel res.(°)•N
Whipple, 2300 m	Arisona, U.S.A., 31° 41.3’ N 110° 53.1’ W°	70 m^2	300 GeV→ 12 TeV 5σ	3°	0.25°•150
CAT, 1650 m	French Pyrennees, 42° N 2° E	17,7 m^2	220 GeV → 10 TeV	3.1°	0.12°•546
SHALON, 3338 m	ALATOO, Russia 42° N 75° E	11.2 m^2	800 GeV → 50 TeV	8°	0.6°•144
TACTIC, 1300 m	Mt.Abu, India, 24° 39’ N 72°47’ E	9.5 m^2	700 Gev →10 TeV	2.6°	0.31°•81
HEGRA, 2240 m	Canary Islands 28.75° N 17.89° W	8.5 m^2 5 m^2	700 GeV →> 10 TeV 1.5 TeV → 15 TeV	4.3° 3.25°	0.25°•271 0.25°•127
Telescope Array, 1600 m	Mt. Cedar, Utah, U.S.A., 40.33° N 113.02° W	6 m^2	600 GeV → 10 TeV 3σ	4°	0.25°•256
Tibet II EAS array, 4300 m	Yangbajing,Tibet, China, 30.1 ° N 90.53° E	3,7*10^4m^2	>3σ above 10 TeV	Angel resolution ~1° at E_γ =7 TeV	
CASA-MIA, 1450 m	Dugway, U.S.A., 40.2° N 112.8°W	23*10^4m^2	>45 TeV	Angel resolution ~0.15° at E_γ =70 TeV	

and extragalactic. The last seems very wonderful, if the significant number of galactic objects with the less flux intensity will not be found and systematic number exceeding of extragalactic sources will not become essentially less then galactic sources number with the equal gamma-quanta flux intensity, so it is necessary to find the protons and nuclei sources of the cosmic rays with energy 10^{13}-10^{14}eV not in the our galaxy, but out of its area, it is because of the equal observational gamma-quanta flux intensity from the source near the observer and far off from observer means the difference of emited flux in the square of the relation of distances to observing sources.

The estimations of diffusee gamma-quanta flux with energy >400 TeV, of the flux

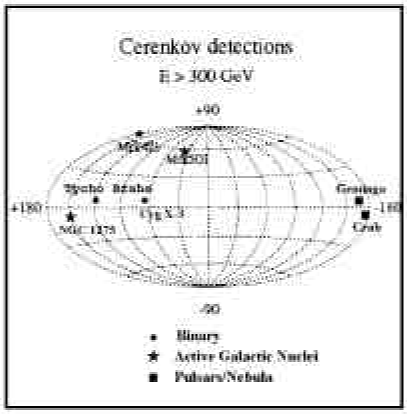
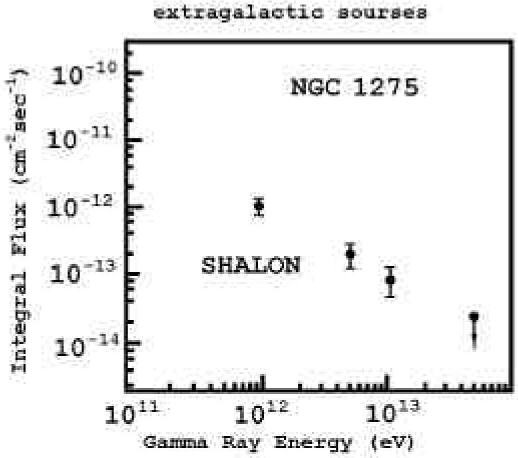
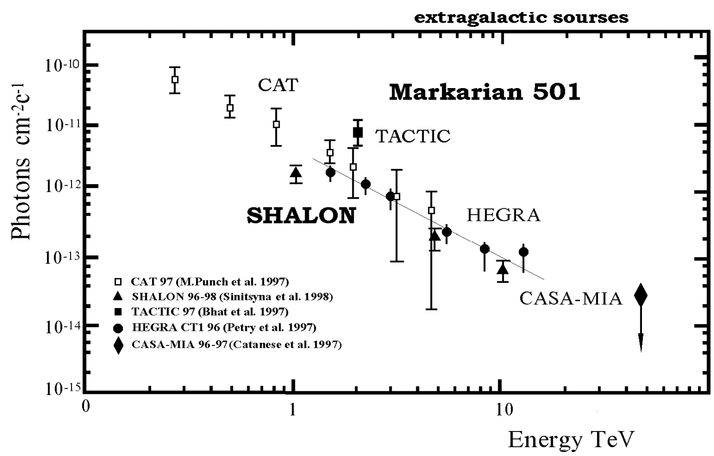


Fig. 1. *Sky map of gamma-quanta point sources in galactic coordinates that observed by gamma-telescope SHALON*





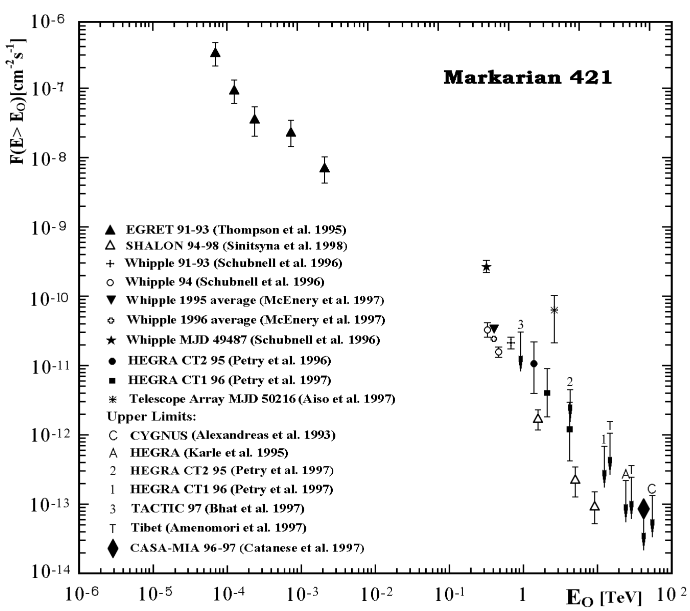


Fig. 2. ***The spectrum of the gamma- radiation of extra-high energies from active galactic nuclei NGC-1275, Markarian 421 and Markarian 501.***

Table 2. ***The catalog of observing by SHALON telescope in TeV energies since 1994.***

Source	Type	Flux sm^{-2} s^{-1} E > 0.8 TeV SHALON	Distance
Galactic			kpc
Crab Nebula	Plerion	$(1.1\pm0.30)\cdot10^{-12}$	2.0
Cygnus X-3	Binary	$(4.2\pm0.80)\cdot10^{-13}$	11.0
Tycho Brahe	Supernova	$<2\cdot10^{-13}$ upper limit	2.0-5.1
Geminga	Supernova	$(5.7\pm4.0)\cdot10^{-13}$	0.25
Extragalactic			mpc
Mkn 421	AGN	$(1.09\pm0.41)\cdot10^{-12}$	124
Mkn 501	AGN	$(1.32\pm0.30)\cdot10^{-12}$	135
NGC 1275	AGN	$(1.10\pm0.40)\cdot10^{-12}$	71

including in itself gamma-quanta from local sources, dictat to look about the intensity of gamma-quanta flux with energy ≥1 TeV of local sources $<10^{-12}cm^{-2}s^{-1}$.

Table 3. ***Upper limit for diffusion flux of ultra high energy g rays in the primary cosmic radiation***

Experiment	Level	Energy	Flux
EGRET		$>1\cdot10^{9}$ eV	$(1.45\pm0.05)\cdot10^{-5}cm^{-2}s^{-1}sr^{-1}$
Tien Shan - selection of muon and hadron - poor showers, 1984.	3338 m	$>4\cdot10^{14}$ eV	$<(3.4\pm1.2)\cdot10^{-13}cm^{-2}s^{-1}sr^{-1}$
EAS-TOP GRAD SASSA lab - selection of extensive Air Shower characterused by no muons recorder in 140 m^2 detector, 1996.	2005 m	$>8.7\cdot10^{14}$ eV	$<1.8\cdot10^{-14}cm^{-2}s^{-1}sr^{-1}$
CASA-MIA -poor in muons 1997.		$>1\cdot10^{14}$ eV	$<6\cdot10^{-13}cm^{-2}s^{-1}$

CONCLUSION.

Observed fluxes from already known sources are about equal. Distance from Earth to Galactic and Extragalactic Sources differs for about 10^4 times, that means into 10^8 times larger intensity of the observed extragalactic sources. With allowance for the limited number of sources in our Galactic in comparison with Metagalactic it is necessary to suppose Extragalactic origin of the cosmic rays with energy more then 10^{13} eV, if all this is not connected with the small sensitivity of the contemporary gamma-telescopes.

REFERENSES.

Nikolsky S.I., Sinitsyna V.G., 1987, VANT, Ser.TFE(1331), 30.

Nikolsky S.I., Sinitsyna V.G., 1989, Proc. Workshop VHE Gamma-ray Astr., 11-21.

Sinitsyna V.G., 1992, Proc. Workshop, Towards a Major Atmospheric Cherenkov Detector -I, ed. P.Fleury, (Paris), 299-304; 1993, Detector -II, ed. R.Lamb, (Calgary), 91-101; 1995, Detector-IV, ed. M.Cresti, 133-140; 1997, Detector-V, ed. O.De Jager, Kruger Park, 136-141, 190-195

Bhat, C et al. 1997, Detector-V, ed. O.De Jager, Kruger Park, p. 196-201

Djannati - Atai, A., CAT collab., the same, p. 21-25.

Petry, D., et al., 1997, Proc. 25th ICRC., 3, 241

Petry, D., et al., 1996, A&A, 311, L13

Karle, A.D., et al., 1995, Astropart. Phys., 4, 1

Aiso, S., et al., 1997, Proc. 25th ICRC., 3, 261

McEnery, J.E.,et al.,1997, Proc. 25th ICRC., 89,

Thompson, D.J., et al.1995, ApJS, 101, 259

Schubell, M.S., et al., 1996, ApJ, 460, 644

Alexandereas, D.E.,et al., 1993, ApJ, 418, 832

Amenomori, M.,et al., 1997, Proc. 25th ICRC., 3, 297