A. A. **Stepanyan.** *The Object Cygnus X-3 as a Generator of Superhigh-Energy Gamma Quanta.* The results of observations of the gamma-quantum fluxes from the x-ray source Cyg X-3 are compared with the results of similar observations of the pulsars PSR 0833-45 and NP 0532.

Spark-chamber observations of the pulsar PSR 0833-45 in the Vela Nebula on the SAS-2 satellite[1] indicated that the gamma radiation with energy >35 MeV pulsates with the period of the pulsar and has two peaks. To all appearances, the gamma spectrum matches the spectrum formed on the decay of $\pi^0$ mesons.

Registration of Čerenkov extensive air shower bursts[2] for the same object in the range of superhigh-energy $\gamma$ quanta ($>3\cdot 10^{11}$ eV) indicated that the radiation pulsates with the period of the pulsar and has one peak. The peak width is somewhat smaller in the superhigh-energy $\gamma$-quantum radiation as compared to the $10^8$-eV range.

Data have also been obtained on the emission of $\gamma$ quanta with energies $>10^9$ eV from PSR 0833.[3] Assuming that the radiation is isotropic, the integral radiated powers of the $\gamma$ quanta with energies >35 MeV, >100 MeV, >1 BeV, and $>3\cdot 10^{11}$ eV are $3.3\cdot 10^{38}$, $1.4\cdot 10^{38}$, $4.5\cdot 10^{36}$, and $3.1\cdot 10^{32}$ kV/sec, respectively.

SAS-2 also obtained data on the radiation of gamma quanta from the pulsar NP 0532 with energies $E>35$ MeV and $E>100$ MeV.[4] Values of the pulsating flux of gamma quanta with energies greater than 400 MeV have been obtained on balloons with gas-type Čerenkov detectors.[5] The flux of gamma quanta with energies $>8\cdot 10^{11}$ eV from NP 0532 was registered with ground instruments that registered Čerenkov bursts.[6] Just as in the case of PSR 0833, the width of the time peak in the radiation of the superhigh-energy gamma quanta is a small fraction of the peak width for $E>35$ MeV. On the other hand, two peaks are observed for $E>35$ MeV and only one for $E>8\cdot 10^{11}$ eV. The integral powers of the gamma radiation at >35 MeV, >100 MeV, >400 MeV, and $>8\cdot 10^{11}$ eV are $2\cdot 10^{39}$, $8\cdot 10^{38}$, $1.2\cdot 10^{38}$, and $1.6\cdot 10^{33}$ kV/sec, respectively. A Soviet group (MIFI) has observed the gamma fluxes with energies >40 MeV from the x-ray source Cyg X-3.[7] Observations of this source in the superhigh-energy range ($>2\cdot 10^{12}$ eV) were started in 1972 at the USSR Academy of Sciences Crimean Astrophysical Observatory using a Čerenkov burst detector (see, for example, [8]) (Fig. 1).

In contrast to the pulsars in Vela and in the Crab Nebula, the nature of the object Cyg X-3 is not quite clear. We know that the x-ray emission of Cyg X-3 is modulated with a period of 4.8 hr. Analysis of the observational data[8] indicated that the gamma radiation pulsates with the same 0.199682-day period.

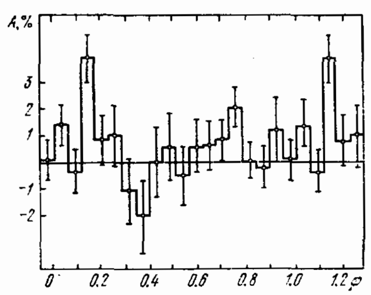


FIG. 1

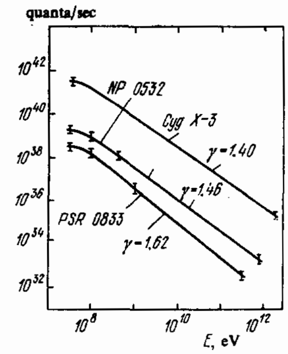


FIG. 2

Intensity variations with a period of 4.8 hr are also clearly seen in the measurements of $\gamma$ quanta with energies >40 MeV.[9] As in the case of the pulsars PSR 0833 and NP 0532, the width of the time peak in the gamma radiation with energies $>4\cdot 10^7$ eV is several times wider than that for $E>2\cdot 10^{12}$ eV. The integral radiated powers for these energies are $3\cdot 10^{41}$ and $1.8\cdot 10^{35}$ kV/sec. Here, as everywhere above, we refer to the period-averaged number of radiated quanta. The distance to the object Cyg X-3 is approximately 11 kiloparsecs. Figure 2 shows the gamma spectra of the pulsars PSR 0833 and NP 0532 and the object Cyg X-3. Energy in electron volts is plotted as the abscissa, and the radiated power in quanta per second as the ordinate.

The similarity of the spectra suggests that the $\gamma$ quanta are formed by the same mechanism, namely by the interaction of the nuclear cosmic-ray component with matter via the formation of $\pi^0$ mesons. The only differences between the objects are in the power of their $\gamma$ radiation.

Since only part of the energy goes into the $\gamma$ quanta in the interaction with matter, this implies that the total power going into the formation of the cosmic rays is greater than the power released by the other forms of radiation.

It is difficult at this time to draw any definite conclusions as to the nature of Cyg X-3. To all appearances, however, the principal processes in this object involve high-energy particles. They are presumably important both in the Crab Nebula and in the nebula in Vela. It seems to us, therefore, that research in the area of superhigh-energy $\gamma$ quanta may play an important role in study of the cosmic-ray generating mechanisms and the processes that take place in these objects.


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