Scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR (24–25 December 1986)

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A joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held on December 24 and 25, 1986 at the S. I. Vavilov Institute of Physical Problems of the USSR Academy of Sciences. The following reports were presented at the session:

December 24

1. *I. A. Fomin*. Spin currents in superfluid ^{3}He-B.
2. *Yu. M. Bun'kov*. Direct observation of the spatial transport of magnetization.
3. *V. V. Dmitriev*. Observation of phase slipping accompanying superfluid spin current flow in ^{3}He-B.

December 25

4. *I. S. Shapiro*. Structure of cold nuclei.
5. *É. A. Mamidzhanyan and S. I. Nikol'skiĭ*. Possibilities of experimental ultrahigh-energy gamma-ray astronomy.

A summary of one of the reports is presented below.

É. A. Mamidzhanyan and S. I. Nikol'skiĭ. *Possibility of experimental ultrahigh-energy gamma-ray astronomy.* Ultrahigh-energy gamma-ray astronomy differs from high-energy gamma-ray astronomy in two respects. It is impossible to perform exoatmospheric experiments in ultrahigh-energy gamma-ray astronomy under "pure" conditions, first, because of the weak flux of gamma rays with energy $\gtrsim 10^{12}$ eV ($\sim 3\ m^{-2}\cdot yr^{-1}$) and, second, searches for local sources of gamma rays with such energies are in many ways identical to searches for the location of acceleration and high density of protons and nuclei in cosmic rays. This, however, does not exhaust the information yield of the experimental study of sources of ultrahigh energy gamma rays. It is sufficient to note that known sources of gamma rays with energy $\sim 10^{12}$ eV include pulsars and quasars, binary stars, and remnants of supernovae to see the value of additional information in the gamma range for constructing and checking astrophysical models of these objects. To this we should add that gamma rays with energies near $\sim 10^{15}$ eV are additionally absorbed in the galaxy owing to interactions with the relic radiation. Correspondingly the features in the energy spectrum of gamma rays in this energy range can be employed to determine distances up to the emitting objects at distances exceeding 10 kpc. The study of the correlation of the phases of luminosity changes in substantially different ranges of the electromagnetic radiation of variable sources lies in the future.

Experimental studies of ultrahigh-energy ($\geqslant 10^{12}$ eV) gamma-ray astronomy were begun in the Soviet Union by A. E. Chudakov's group.[1] The method of observation was based on the narrowly directed Cherenkov radiation from the electrons in an extensive atmospheric shower, formed in the earth's atmosphere by protons and nuclei in cosmic rays and by primary gamma quanta. Since the cosmic rays scattered by the galactic magnetic fields arrive virtually isotropically, while the gamma quanta indicate the direction to the location at which they were generated, an excess of avalanches in some narrowly defined direction indicates a local gamma-ray source.

The observation of gamma-ray sources under conditions for which the intensity of the cosmic-ray background predominates is a strongly complicating feature of ultrahigh-energy gamma-ray astronomy. Since a hadron cascade forms the basis for the extensive atmospheric showers formed by protons and nuclei, while showers from primary gamma quanta are basically electron-photon cascades, the cosmic-ray background can be suppressed by requiring a much smaller number of muons (hadrons) in the recorded showers.[2] Experiments,[3] in which the upper limit of the diffusion flux of gamma rays in the energy range 10^{14}–10^{15} eV is determined, have shown that the computed number of muons in an electron-photon cascade is consistent with experimental observations.

Experimental installations corresponding to the modern problems of ultrahigh-energy gamma-ray astronomy are in the stage of design and development in the energy range $\sim 10^{12}$ eV and in the design for energies $> 10^{13}$ eV. At lower energies the optimal solution is detection of the Cherenkov radiation from a shower in the atmosphere by a high-altitude mirror system with an area exceeding 10 m^2 and angular resolution $\sim 0.5°$.[4,5] The proton and nuclear cosmic-ray background can be reduced by studying with the help of a multichannel mosaic of photomultipliers the angular distribution of the Cherenkov radiation from a shower in the range of 2–3° around the direction of the shower axis.

At energies $\gtrsim 10^{14}$ eV the method of detection of Cherenkov radiation from the atmosphere is ineffective because of the limited observation time (clear nights with no moon). Installations for studying extensive atmospheric showers based on particle fluxes at the level of observation, aimed at gamma-ray astronomy, should have quite a large area in which the shower can be detected reliably ($\gtrsim 10^5\ m^2$), high angular resolution of directions toward the source ($\lesssim 1°$), and a relatively large muon detector area compared with the

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total area of the detectors for electrons and photons in the shower.

[1]A. E. Chudakov, V. L. Dadykin, V. I. Zatsepin, and N. M. Nesterova, Tr. FIAN SSSR (in Russian) **26**, 118 (1964).
[2]R. Maze and A. Zawadzki, Nuovo Cimento **17**, 625 (1960).
[3]S. I. Nikol'skiĭ, I. N. Stamenov, and S. Z. Ushev, Zh. Eksp. Teor. Fiz. **87**, 18 (1984) [Sov. Phys. JETP **60**, 10 (1984)].
[4]T. C. Weekes, R. C. Lamb, and A. M. Hillas, Preprint No. 2393, Center for Astrophysics, Massachusetts (1986).
[5]R. U. Beĭsembaev, S. I. Nikol'skiĭ, and V. G. Sinitsyna, Preprint No. 175, (in Russian), Physics Institute of the USSR Academy of Sciences, M., 1985.

Translated by M. E. Alferieff