Scientific Session of The Division of General Physics and Astronomy, USSR Academy of Sciences (23-24 January, 1974)

Usp. Fiz. Nauk 113, 718-728 (August 1974)

A scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences was held on January 23 and 24, 1974, at the conference hall of the P. N. Lebedev Physics Institute. The following papers were delivered:

1. O. F. Prilutskiĭ, I. L. Rozenthal', and V. V. Usov, On the Nature of Bursts of Cosmic γ Radiation.

2. V. S. Troitskiĭ, L. N. Bondar', and A. M. Starodubtsev, The Search for Sporadic Radio Emission from Space.

3. F. Yu. Aliev and É. G. Kasumova, Thermal Expansion and Electric Conductivity Anomalies in Cooled $CuFeS_2$ Films.

4. I. M. Dmitrenko, I. S. Shchetkin, T. V. Sil'vestrova, and E. A. Osika, The Anomalous Electric Conductivity of Metal-ammonia Solutions.

5. N. E. Alekseevskiĭ and A. A. Slutskin, Magnetic Breakdown in Metals.

We publish below brief contents of four of the papers.

O. F. Prilutskiĭ, I. L. Rozenthal', and V. V. Usov. On the Nature of Bursts of Cosmic γ Radiation. About six months ago, powerful bursts of γ radiation in the energy range 0.2–1.5 MeV were detected during processing of observations from Vela satellites. The bursts ranged from 0.1 to 30 sec in duration, the radiation flux densities reached $4 \cdot 10^{-4}$ erg/cm^2 · sec, and the total energy flux per pulse ranged from 10^{-5} to 2×10^{-4} erg/cm^2 (the lower limit of this range was determined by the sensitivity of the detector). As a rule, the time profile of a γ burst took the form of a sharp increase in radiation flux density followed by a slower decrease. In some cases, the decrease in the radiation flux density was nonmonotonic, and intensity maxima and minima lasting up to 0.1 sec were observed within a pulse. Detectors on the OSO-7 and IMP-6 satellites measured the spectra of the γ bursts. The observed spectra indicate both an exponential cutoff at an energy $\epsilon_\gamma \sim 150$ keV and a power-law decrease in the 11–100 keV range, with the hardness of the spectrum increasing with flux density.

Measurement of the difference between the times at which the γ-burst front was registered on several satellites made it possible to estimate the directions to their sources. It was found that objects within the solar system could not have generated the observed γ bursts. However, the presently available information is inadequate to decide whether the γ bursts are of galactic or metagalactic nature.

Several hypotheses have been advanced to account for the nature of the observed γ bursts. Thus, the original observers note the possibility that the γ bursts may be related to supernova flareups. But the original hypothesis of Colgate, who considered the generation of γ radiation in supernova outbursts, results in different characteristic times ($\tau \sim 10^{-5}$ sec) and energies ($\epsilon_\gamma \sim 1$ GeV) for the γ bursts. The increase of the presupernova's radius to $\sim 10^{12}$ cm that was proposed in Colgate's recent paper could bring the times and energies of the γ bursts close to the observed values, but then we have the problem of supporting the energy output. Namely, as was pointed out by D. K. Nadezhin and D. A. Frank-Kamenetskiĭ, a relativistic shock wave is weak in stars with small parabolic velocities (large radii) and, consequently, the energy that can be radiated in the γ band is small.

Stecker and Frost recently proposed that the sources of the γ bursts are flare stars, with the flare mechanism similar to that of solar flares. An argument in favor of this hypothesis is the similarity between the durations and spectra of the γ radiation in the bursts and the hard x-ray emission of solar flares. But in this model a γ burst should be accompanied by exceptionally powerful soft x-ray emission (with a flux $\gtrsim 1$ erg/cm^2 · sec). There is no doubt that this emission would be detected in the form of ionospheric disturbances.

Another possible mechanism for the formation of the γ bursts is nonstationary accretion on compact objects—white dwarfs, neutron stars, and "black holes." Two concrete models have been proposed in the paper by M. Harwit et al. for the generation of γ bursts during accretion.

In the first model, the γ bursts are related to accretion of comets on single neutron stars, and in the second to accretion of gas ejected from the normal component of a close binary system onto its compact companion. These models explain the energy and time characteristics of the γ bursts. The most complex question in these models is that concerning the possibility of explaining the observed frequency of the bursts. Thus, for example, the preservation of a dense cometary cloud in a supernova outburst is improbable.

It is also possible that the γ bursts are generated in the collapse of rotating magnetic stars with masses $10^5 M_\odot$ at cosmological distances. The activity of galactic nuclei is now being linked more and more frequently to the presence of precisely such supermassive stars. The energy fluxes, duration, spectra, and expected numbers of bursts calculated in the framework of this hypothesis are in agreement with the observed values.

The decisive test of the various hypotheses as to the nature of the γ bursts is a statistical test—determination of the number of bursts N(S) with flux larger than S. Correlated observations of this phenomenon in various ranges—radio, optical, x-ray, and gamma—must also play an important role in investigation of the γ bursts.

S. A. Colgate, Canad. J. Phys. **46**, S476 (1968); R. W. Klebesadel, J. B. Strong, and R. A. Olsen, Astrophys. J. **182**, L85 (1973); T. L. Cline, U. D. Desai, R. W. Klebesadel, and J. B. Strong, ibid. **185**, L1 (1973); F. W. Stecker and K. J. Frost, Nature (Phys. Sci.) **245**, 71 (1973).

V. S. Troitskiĭ, L. N. Bondar', and A. M. Starodubtsev. The Search for Sporadic Radio Emission from Space. The search for irregular pulsed radio emission from space that might be associated with various explosive processes in the cosmos, or accompany the gravity waves emanating from the center of the Galaxy that were observed by Weber or, finally, that might be due to activity of an extraterrestrial civilization possibly present in the neighborhood of the solar system has recently been intensified. Weber's waves have high energy at the earth, and their explanation requires a source at the Galactic center with a power output on the order of 10^{51} erg/sec · Hz. In the powerful processes associated with the collapse of massive objects, it seems inevitable that at least a minute part of the energy should exist in the form of electromagnetic waves.

Several groups of investigators have recently been formed to engage in the search for irregular pulsed radio emission from space: in England (the Cambridge group), in the USA (Princeton and Bell Telephone groups), in Canada, and in the USSR (Scientific Research Radiophysics Institute, Academy of Sciences Institute of Cosmic Radiation). The Table gives a brief sketch of their observing conditions. The purpose of the study [1] was to look for pulsed irregular radio emission from the region of the Galactic center that might perhaps accompany Weber gravity waves. Local noise was excluded by conducting observations simultaneously at five stations: Cambridge, Dublin, Harwell, Glasgow, and Malta. Provision was also made for elimination of local interference by measuring the velocity dispersion of the wave as the difference between the arrival times of pulses at a slightly different frequency. The group reported 242 double coincidences in 1114 hours of observations made at night from May through August of 1970 at a frequency of 151 MHz. Six triple coincidences were observed in 586 hours. No cases of coincidence at four