48. HIGH ENERGY ASTROPHYSICS
(ASTROPHYSIQUE DE GRANDE ENERGIE)

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1. INTRODUCTION
(F. Pacini)

In view of the broad range of topics covered by Commission 48 and the consequent inevitable overlap with other commissions, it is not feasible to produce a comprehensive self-contained report. The commission therefore restricts its report to a selected list of accessible recent review articles and conference reports, wherein up-todate summaries of various topics can be found. Such a list is given below. A special report by I. S. Shklovsky on work done in the Soviet Union follows.

A. Review articles

Bahcall, J. N., 1978 Masses of Neutron Stars and Black Holes in X-ray Binaries Ann. Rev. Astron. Astrophys. 16.

De Young, D. S., 1976 Extended Extragalactic Radio Sources Ann. Rev. Astron. Astrophys. 14.

Culhane, J. L., 1978 Extragalactic X-ray Astronomy Quarterly Journ. R.A.S. 19, 1.

Ginzburg, V. L. and Ptuskin, V. S., 1976 On the Origin of Cosmic Rays: Some Problems in High Energy Astrophysics Rev. Mod. Phys. 48, 2.

Gursky, H., Schwartz, D. A., 1977 Extragalactic X-ray Sources Ann. Rev. Astron. Astrophys. 15.

Lewin, W. H. G., Joss, P. C., 1977 X-ray Burst Sources Nature 270, 211.

Pinkau, K., 1979 Present Status of Gamma-Ray Astronomy Nature 277, 17.

Taylor, J. H. and Manchester R. N., 1977, Recent Observations of Pulsars Ann. Rev. Astron. Astrophys. 15, 19.

Tyson, J. A., Giffard, R. P., 1978, Gravitational Wave Astronomy Ann. Rev. Astron. Astrophys. 16.

B. Conference, Proceedings, etc.

Physics and Astrophysics of Neutron Stars and Black Holes: Proc. E. Fermi Summer School, Ed. R. Giacconi and R. Ruffini (Academic Press, N.Y. 1978)

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Physics of Non-Thermal Radio Sources: Proc. NATO Advanced Study Institute, Urbino, July 1975, Ed. G. Setti.

Proceedings 8th Texas Conference on Relativistic Astrophysics, Ann. N.Y. Acad. Sci. (1977).

Quasars and Active Nuclei of Galaxies, Proc. Copenhagen Symposium 1977, Physica Scripta 17, 3, Ed. O. Ulfback.

Recent Advances in Gamma-ray Astronomy: Proc. 12th ESLAB Symposium, May 1977, Ed. R. D. Wills and B. Battrick (ESA publication).

Structure and Contents of the Galaxy and Galactic Gamma-Rays: Proc. NASA Symposium, June 1976.

Supernovae and Supernova Remnants, Proc. Erice Workshop 1978, Memorie S. A. It. 49, 2-3, Ed. J. Danziger, A. Renzini.

X-Ray and Gamma Ray Astronomy in the 1980's. Proc. ESF-NSF Workshop, Ed. B. Aschenbach, K. Pinkau.

2. SPECIAL REPORT ON WORK IN THE SOVIET UNION
(I. S. Shklovsky)

A. Galactic X-Ray Sources

The Salyut-4 station, with an X-ray mirror telescope which recorded 0.14 to 0.25 KeV quanta with a high-time resolution, observed Her X-1 in the initial phase of its 35-day cycle (Beigman, et al., 1976). Its emission was strikingly low. Upper limits for X-ray fluxes from a number of stars were also measured (Beigman et al., 1978).

The Cosmos-856 and Cosmos-914 satellites investigated hard X-ray radiation from some sources (20 to 300 kev). The existence of bright variable sources (up to 0.2 times the intensity of the flux from the Crab Nebula) similar to those detected earlier from Cosmos-428 (Melioransky et al., 1978) was confirmed.

Observations by Bruevich et al. (1978) showed that the normal star in the Cyg X-1 system is eclipsed by the accretion disk.

A great deal of theoretical studies have been carried out.

In X-ray spectroscopy Pozdnyakov, Sobol', and Syunyaev (1977) used the Monte Carlo method to calculate how comptonization affects the spectrum of radiation from a cloud of a weakly relativistic and relativistic plasma. Multiple scattering causes the formation of a power-law radiation spectrum.

Krasnobaev and Syunyaev (1977) studied the effect of the X-ray-emission from the source on the stellar wind flowing around it. Heating of the wind gives rise to a bow shock ahead an intense source. Bisnovatyi-Kogan et al. (1978a) developed a self-similar solution for gas accretion onto a fast-moving black hole. There is only a cone shock and no bow shock. In many cases a hollow cone may exist behind the body. Syunyaev (1978) developed a model of a non-stationary accretion onto relativistic objects, the model can explain such phenomena as bursters and transient sources. Some papers were devoted to the more detailed study of a disk-accretion process. Syunyaev and Shakura (1977) pointed to a possibility that matter-accumulating disks may exist. In their paper Bisnovatyi-Kogan et al.(1978) analyzed the data provided by the HZ -Her optical observations during the periods when no reflection effect was present; they made a conclusion that an accretion disk

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becoming laminar can possibly be a cause of a temporary turn of mechanism of an X-ray source. Lyuti and Syunyaev (1976) have calculated the luminosity of accretion disks in the Cyg X-2 Sco X-1 and Her X-1 systems; Bisnovatyi-Kogan et al. (1977) have used the data of optical observations carried out by P. Boyhton (USA) (more than 1000 individual points) to study properties of the HZ Her- Her X-1 accretion disk. It was obtained that the luminosity of the disk has two maxima during a 35-day cycle which agrees with X-ray observations. Bisnovatyi-Kogan and Blinnikov (1976, 1977) showed the convective instability of an accretion disk around a black hole in the region where radiation pressure dominates. Convective heating and light pressure bring about the formation of a hot corona with $T \gtrsim 10^9$K whose properties explain the presence of hard radiation in Cyg X-1 and its variability. Shakura, Syunyaev and Zilitinkevich (1977) studied the role of convective heat transfer in accretion disks. Bisnovatyi-Kogan and Blinnikov (1978a, b) investigated the heating of accretion disk and superstar coronae by waves arriving in the optically thin region from those parts of disk convective regions where radiation pressure dominates. Fluctuations in the corona and photosphere heating, associated with the convection may explain chaotic light variations in the Cyg X-1 source.

Bisnovatyi-Kogan, Syunyaev, Cherepaschuk and Shakura (1978) analyse V861 Sco = OAO 1653-40 model systems. They consider either the model of collision between two stellar winds from normal stars or that of a black hole. It is mentioned that in the first model X-ray eclipse must be much smoother and there might be observed the secondary eclipse in the X-ray light curve. In the paper by Bisnovatyi-Kogan, Kulikov and Chechetkin (1976) the evolution of a non-equilibrium layer in the envelope of a neutron star was studied. Diffusion of neutrons into the star will sustain X-ray luminosity during about 10^5 years and lead to starquakes. Ardelyan et al. (1978) calculated the model of a magnetic-rotation explosion of a Supernova with a weak initial field. It is shown that with the field decreasing the duration of the process becomes longer, but the energy released is almost the same. Basko (1977a) calculated basic parameters of a gaseous layer over the Alfvèn surface, which forms when an accreting plasma flow collides with the magnetic field of a magnetic star. Both cases of radial fall and disk accretion have been considered. Basko and Syunyaev together with Hatchett and McGrey (1977) published a theory of X-ray-radiation-induced evaporation of the matter from the surface of a star. It is shown that the induced stellar wind in some X-ray binary objects may be the source of the matter the accretion of which onto a neutron star is responsible for the luminosity of the X-ray source. Basko in his paper (1978a) calculated in detail the fluorescence of heavy elements for the case when the surface of a normal star is irradiated by the external flux of X-ray radiation. Similar calculations for solar flares were made by Basko (1977b). In the latter paper a model is suggested which explains an emission feature $h\nu \approx 7$ keV with an equivalent width of several hundreds of eV, observed in the spectra of binary X-ray pulsars. Polnarev and Turchaninov (1978) discussed the propagation of electromagnetic radiation of an accretion disk in the gravitational field of a rotating black hole. The problem is applied to the theory of X-ray sources and to the theory of black holes.

In the paper by Shklovsky (1978) arguments are given that 'bursters' must be objects of Sco X-1-type.

Kompaneetz (1978) calculated a probability of positron annihilation processes in the strong magnetic fields near pulsars and pointed out a possibility of a one-photon process which results in a line in the X-ray spectrum of pulsars at about 1 GeV.

B. Gamma-astronomy

The Meteor satellite, launched on June 29, 1977, had on its board a scintillation γ - detector. The detector was developed in the Ioffe Physics and Engineering Institute, Academy of Sciences, USSR, for γ - bursts recording in the range 22 to 650 keV. The data obtained make it possible to determine a new upper limit of low-intensity γ - burst occurence rate, $S = 5 \cdot 10^{-7} erg \cdot cm^{-2}$, $N (>S) \leqslant 8.5$ events per year which is much lower than extrapolations $N (>S) \sim S^{-\alpha}$ for $\alpha = 1.5$ and 1 according to the Vela data is the evidence to the most probable galactic nature of γ - bursts (Mazetz et al., 1978). Fully confirmed is the conclusion about the high isotropic of the diffuse background, made previously in the Cosmos-461 experiments (Mazetz et al., 1976). The weak anisotropy component observed is due to the net radiation of the sources in the central part of the galactic disk, it is about 5% in the ranges 22 to 50 keV and 50 to 150 keV.

In the period from October 1977 to February 1978 the Prognoz-6 satellite had been surveying the sky and recorded 3 γ - bursts with $E_\gamma > 0.1$ MeV also detected by other satellites. Characteristics of the events: the release of energy near the Earth is above 10^{-5} $erg \cdot cm^{-2}$, duration is 3 to 30 s, occurrence rate is 0.5 events per month. Precise time and position reference allows localization of the sources of 20.10.77 and 10.11.77 γ - bursts in the sky with an accuracy of 1 to 01 sq. degrees. Within the range of the release of energy $10^{-6} < W < 10^{-5} erg \cdot cm^{-2}$, $E_x > 30$ keV, spikes in the detector count during 10 second intervals were observed at a rate of 1 event per day (Estulin et al., 1978). The Sneg-3 and Prognoz-6 satellites observed the transient source A0535÷26 which has appeared on December 3, 1977 (Rakhamimov, Estulin, 1978).

C. Studies of the Sun in the X-Ray and γ -regions

On November 22, 1977, the Prognoz-6 satellite observed a flare in the range $E > 0.1$ MeV. During the flare the flux in 2.2 MeV γ - line was 0.15 quanta $cm^{-2}s^{-1}$ (Gro, Kuznetzov et al., 1978).

The special-purpose satellite Interkosmos-16 had been studying short-wave 0.3 to 60 kev solar radiation during 3 months. Much information was obtained about the fluxes, spectral composition polarization of the hard radiation from the Sun during its minimum activity. Detailed consideration was given to the spectra in the Mg XII, Fe XXV, and Fe XXVI- resonance line regions (Aglizsky et al., 1978, Kononov et al., 1978, Yakimetz et al., 1977). The analysis of the data of measurements of X-ray radiation polarization during solar flares, carried out on-board the Interkosmos-1, -4, -7, -11 satellites has been completed (Somov and Tindo 1978, Tindo and Somov, 1977). The results obtained agree with the existing theories of outbursts. The data from the Prognoz-2 satellite were used to continue searching for periodic ($T > 1^h$) fluctuations of the level of X-ray radiation in the active regions of the Sun. Correlation has been detected between the fluctuation period and the area of a group of spots (Illario-nova et al., 1976).

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