B. JOINT DISCUSSION OF COMMISSIONS 28, 33, 34, AND 44
X-RAY ASTRONOMY

(Monday, August 28, 1967)

Organizing Committee: S. B. Pikelner (Chairman), B. J. Bok, H. Friedman, L. Gratton, H. M. Johnson

Contents:

https://doi.org/10.1017/S153929960000109X Published online by Cambridge University Press

INTRODUCTION

S. B. PIKELNER
(Sternberg Astronomical Observatory, Moscow, U.S.S.R.)

Observations in the invisible regions of the spectrum have become more common in astronomy during the last 20 years. After radio-astronomy, astronomy of ultraviolet, X- and γ-rays appeared. X- and γ-astronomy are still only beginning to develop, even now they give important information which cannot be obtained with former methods. High-energy quanta are produced with high-energy electrons. Therefore X-rays are the emission of high-speed particles which reveal themselves weakly in the other part of the spectrum.

Our programme is heavy today, and I will only remind you of the list of objects which are or may be X-ray sources. Black-body thermal emission is expected from neutron stars, which having a temperature higher than 10000000 °K and radius about 10 km can be observed only in X-region. Besides the emission from the stars themselves we can expect the emission from their transparent high-temperature envelopes formed, as was suggested by Zel'dovič, in the process of accretion of the gas. The temperature of a stationary shock wave in falling gas can be very high. Similar waves of lower temperatures may be found around the white dwarfs. The possibility of formation of shock waves in close binary systems was discussed, in application to the Sco XR-1. Thermal emission of transparent high-temperature envelopes may be expected in supernovae, especially of type II. Here the peak temperature behind the shock is higher than 10^8 °K, the radius R is about 1 ps, the spectrum of free-free emission in the transparent envelope should be flat. Besides, the linear emission of hydrogenlike ions N, O, Mg and others, excited with electron impacts and recombination emission of the same ions are expected. Observations of X-rays from the envelopes allow us to improve knowledge of physical conditions and particularly the kinetics of cooling. Similar phenomena of larger scale may be expected after explosions of more massive bodies as in galaxy M 82 and also in quasars, radiogalaxies, and galactic centers.

The exploration of thermal X-ray emission of intergalactic gas would be of high importance. Even now its upper limit shows that the temperature is no more than a few million degrees if the density of the gas is close to the critical one. But the absence of absorption Lyman-α line in spectra of very distant quasars, is an argument in favor of very high temperature and apparently of low density of the gas.

Non-thermal emission of high-energy electrons-bremsstrahlung and synchrotron one is connected with cosmic rays and their sources. In sources with flat spectra as

Perek (ed.), Highlights of Astronomy, 178–179. © *I.A.U.*

in the Crab nebula there are high-energy electrons and the spectrum of synchrotron emission is continued up to the X-ray region. In other sources and radiogalaxies usually there are no even optical spectra, therefore electrons producing X-rays are not the tail of general energy spectrum but appear due to some secondary processes, for instance due to nuclear collisions which give chains $\pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm} \rightarrow X$ or $\pi^{0} \rightarrow \gamma$. These processes are taking place in interstellar gas of the Galaxy too, but the intensity of producing X-ray background is much lower than the observed one.

There are low-energy cosmic rays (10–100 MeV) in the interstellar gas, with the number density about 10^{-7} cm^{-3}. They can strip inner electrons of C, N, O and others and produce characteristic X-ray linear emission. The direct collisions of such cosmic rays with electrons and bremsstrahlung of the faster stripped electrons may give the continuum background. Its intensity may be comparable with the observed background but special investigations are necessary here. The similar process in the metagalactic plasma may give us an upper limit of number density of low-energy cosmic rays in intergalactic medium. The last process of formation of X-rays is an inverse Compton effect for optical and relict radio quanta. It needs rather high-energy electrons about 10^7 and 10^9 eV correspondingly. This process may be effective in a powerful radiative field near quasars. Besides the uniformity of black-body radio-emission at the enormous distances allows us to evaluate an upper limit of density of relativistic electrons in metagalactic space. Even now it is shown that the density of such electrons is several orders of magnitude lower than that in the Galaxy. It is an argument against the metagalactic theory of the origin of cosmic rays. Similar evaluation was inferred by Ginzburg and Syrovatskii from the upper limit of γ-rays as the electrons which transform radioquanta into X-rays, transform optical quanta into γ-rays. The accuracy of such evaluations is dependent also on the accepted model of the Universe. The improvement of experimental data on X-rays which we shall hear today and in the future, allows us to obtain a number of interesting results.