NEWS AND VIEWS

High Energy Gamma Rays from the Galactic Centre

AMONG the new astronomies which rely principally, though not entirely, on the use of space vehicles for detecting quanta that would otherwise be absorbed in the Earth's atmosphere, X-ray astronomy in particular shows promise of rivalling radio astronomy in its capacity to clarify a wide range of astrophysical problems. The importance of both the radio and X-ray spectral ranges to astronomy was established by accident during unrelated investigations. These disciplines have provided significant surprises both in the number of sources detected and in the intensity of fluxes observed. By contrast, gamma ray astronomy—say the study of quanta at energies greater than 30 MeV—began with detailed calculations of the fluxes to be expected and the first such estimates were contained in a review by P. Morrison in 1958. Observations have since shown that the fluxes are less than was predicted in some of the more optimistic calculations. Furthermore, the field has developed slowly because gamma ray sources are very faint relative to the background counting rates in the detectors that are useful at high photon energies.

Although a considerable effort has been made during the past ten years to detect high energy photons of celestial origin, there are very few positive results to hand. The first good evidence for the detection of a celestial gamma ray flux has come from the counter telescope flown on the OSO-3 satellite by Clark, Garmire and Kraushaar (*Astrophys. J.*, **150**, L203 ; 1968). This instrument detected photons at energies above 100 MeV from the neighbourhood of the galactic centre. After a recalibration of the instrument, the latest flux value of $1.2 \pm 0.3 \times 10^{-4}$ photons $\text{cm}^{-2} \text{s}^{-1} \text{rad}^{-1}$ is in acceptable agreement with the results obtained by balloon borne spark chamber experiments. One observation of the galactic centre (Frye *et al.*, *Nature*, **223**, 1320 ; 1969), however, failed to detect any excess flux over background at energies above 50 MeV. Because the width of the region emitting the gamma rays may be smaller than the detector resolution, the intensities are usually quoted in terms of a line intensity. Uncertainty about the source size coupled with the fact that the net flux value is obtained from the difference between two large numbers leads to difficulty in both the detection of fluxes and the determination of their values. Three different groups of workers have nevertheless presented evidence for high energy photon emission from the centre of our Galaxy.

There are several possible mechanisms for producing high energy photons in the galactic centre region ; cosmic ray electrons could either collide with interstellar matter to produce photons by the bremsstrahlung process or spiral in magnetic fields to radiate photons by the synchrotron process. High energy electrons could also lead to high energy photon production by interacting with the 3°K black body radiation through the inverse Compton process. Cosmic ray protons can produce neutral π mesons by collision with the interstellar gas. The π^0 mesons decay to produce pairs of gamma ray photons with a characteristic energy spectrum that permits this process to be distinguished from the other mechanisms. Fichtel *et al.*, in

addition to detecting radiation above 100 MeV from the galactic centre, established an upper limit for the radiation in the 50–100 MeV range (*Astrophys. J.*, **171**, 31 ; 1972). According to these workers, a comparison of the flux above 100 MeV with this upper limit suggests that π^0 meson decay is the source of the radiation.

One model of the galactic centre region would then be based on the suggestion that there is a source of perhaps ten degrees extent surrounding the centre in which π^0 mesons are produced by fluxes of cosmic ray protons that are large compared with the particle fluxes in other parts of the galaxy. There is, however, another possible explanation, namely that the emission arises from a number of discrete sources, of strength around 10^{-5} photons $\text{cm}^{-2} \text{s}^{-1}$ above 100 MeV that are not resolved by the OSO-3 detector or by the balloon borne spark chambers flown by Fichtel and his colleagues. The University of Southampton group—Browning, Ramsden and Wright—in their article on page 138 of this issue of *Nature* provide experimental evidence in support of this suggestion. The data were obtained with a spark chamber system that was flown from Palestine in Texas on September 21, 1971, carried on a balloon.

Three regions of anomalously high gamma ray intensity were observed near the centre of the galaxy. These sources have fluxes of around 2×10^{-5} photons $\text{cm}^{-2} \text{s}^{-1}$ and produce an excess over the background that is more than 3σ in each case. Although Clark *et al.* and Fichtel *et al.* identify only a line source of gamma rays in this region of the galactic plane, the Southampton workers point out that if the three sources which they observe were unresolved, they would give rise to a line source identical to that observed by the other two groups. After subtracting source contributions they are able to set an upper limit of 8×10^{-5} photons $\text{cm}^{-2} \text{s}^{-1} \text{rad}^{-1}$ on the line source strength along the galactic equator.

The Southampton group have recently (Browning *et al.*, *Nature Physical Science*, **235**, 129 ; 1972) detected several sources in the Cygnus region of the galactic plane, so that it may no longer be necessary to argue that the only site of observable gamma ray production is an extended region in the galactic centre. On the other hand, their possible identifications of soft X-ray counterparts for these Cygnus region gamma ray sources include the supernova remnants SN1572 and Cas A, both recent non-thermal X-ray emitting objects, and the Cygnus Loop which is a much older remnant ($\sim 5 \times 10^4$ years) emitting its X-rays thermally from the shock heated interstellar plasma. The three galactic centre gamma ray source positions include three soft X-ray sources. One of these (2U1813–14) coincides with a weak variable radio source and is therefore likely to be a binary system with a degenerate member. It is difficult to see the emission of high energy gamma rays as a common feature of all these objects. As the angular resolution and sensitivity of gamma ray telescopes improve, however, more information will be obtained which should strengthen and clarify the relationships between the new astronomies.—From a Correspondent.