same issue of *The Astrophysical Journal* as a companion letter to that of Gursky and his associates.

The new size determination for Sco X-1 represents a significant advance in the resolution and discrimination of celestial x-ray sources. "X ray" in this context signifies primarily electromagnetic radiation in the wavelength range 0.1 to 1 nanometer (1 to 10 keV energy). Since the earth's atmosphere is opaque to radiation in in this range, observations have customarily been made from rockets with accompanying difficulties of stabilization, orientation and duration. Nevertheless in one case lunar occultation has been used for a determination of the size of the x-ray source in the Crab Nebula, an operation that requires extremely precise timing of rocket flights not to mention other experimental parameters.

Radiation in the range considered can be measured by counting equipment as in the Gursky experiment where wire-grid collimators were used to pass 1–20-keV x rays (with an angular resolution of 40 sec of arc) or by reflecting equipment such as Giacconi and Bruno Rossi have proposed (*J. Geophys. Research*, **66**, 173, 1960). Such reflectors differ from radio and optical reflectors by employing grazing incidence instead of the near-normal incidence employed in the optical and radio cases. Grazing reflection is the only way to collect radiation of this range since at these wavelengths the natural vibration frequencies of electrons in the reflecting solid are smaller than the radiation frequency, and x rays entering a solid from air speed up in phase rather than slowing down (as visible light does). In general, for most materials, reflection takes place at angles less than a degree.

As a result x-ray telescopes need extremely long focal lengths. A simple paraboloid similar to a truncated cone of narrow vertex angle will serve, but it suffers from severe astigmatism unless corrected by subsequent reflection from a hyperboloid. A telescope of this configuration (9-cm diameter, 64-cm focal length) has been built by a group at American Science and Engineering Corp. and the NASA Goddard Space Flight Center and successfully flown on an aerobee rocket to photograph the sun. Giacconi has high hopes for the future of x-ray reflectors. According to him a telescope of about 30 meters focal length could observe sources a million times weaker than the one in the Crab Nebula. (The Crab yields 3 counts/cm^2/sec between 0.1 and 1.5 nanometers.) The telescopes, however, are a very new thing; earlier observations were done with counters.

Earlier observations are themselves very recent. Although x-ray emission from the sun has been known since 1949, discrete sources elsewhere were not seen until 1962. Since then about a dozen have been seen, most of them standing quite apart from known optical or radio objects. These discoveries were something of a surprise since known objects radiating x rays by the solar mechanism would have produced a flux too weak to be recorded at the earth. Various new mechanisms were suggested, including synchrotron radiation from nebulae and neutron stars.

Now Manley suggests that Sco X-1 (which he also calls an "extar" to distinguish it from other classes of objects) is a protostar engaged in shedding its magnetic field. To reach this conclusion he first calculates the distance of Sco X-1 from its apparent size and energy loss (assuming synchrotron radiation); then he calculates an actual size and an energy density that comes out considerably greater than that for a supernova remnant.

According to Manley, his suggestion would solve a difficulty of current theories of stellar evolution, namely the lack of a rapid mechanism for dissipating the primordial magnetic field trapped in a mass of protostellar material. The magnetic energy would transform to x rays by synchrotron processes, and in astronomical terms it would go very fast ("more than 30 years" is Manley's figure for the lifetime).

If one assumes that the stellar population of our galaxy is in an approximately steady state, new stars must appear to offset the formation of white dwarfs. The rate at which stars turn into white dwarfs is estimated at about 10^{-12} per cubic parsec per year. If the rate of extar appearance balances this, then at any given time there are about 20 extars in our galaxy. (There are at present about a dozen known x-ray sources not identified with supernovae.)

The observable consequences of this model are that new extars radiating x rays will appear from time to time as new stars begin to form and that older extars, as they evolve, will cease to radiate x rays and eventually appear in the visible as young stars.

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NRAO equipment available

The radio telescopes and other equipment of the National Radio Astronomy Observatory are available for use by qualified scientists and graduate students from any institution. Observing time is allocated solely on the basis of the scientific merit of the proposed program and the suitability of the program for the telescope requested. More than 60% of the telescope time on major instruments is allocated to non-staff observers from all over the country. There is no charge for telescope time or for the supplies and services ordinarily required for a program.

The major instruments of the NRAO, located at Green Bank, West Virginia, include a 300-foot diameter transit telescope, a 140-foot diameter fully steerable telescope, and a variable baseline interferometer consisting of two fully steerable 85-foot diameter telescopes. Radiometers, feeds, and associated equipment, for frequencies ranging from 200 MHz to 30 000 MHz, are available, or an observer may provide all or part of his own equipment. A 36-foot diameter telescope, for observations at millimeter wavelengths, is under construction in Arizona. Library, laboratory, shop and computer facilities, and technical assistance are provided at Green Bank and at the NRAO office in Charlottesville, Virginia.

Further information and technical data on telescopes and equipment can be obtained from the Director, National Radio Astronomy Observatory, Edgemont Dairy Road, Charlottesville, Virginia 22901. NRAO is operated by Associated Universities, Inc., under contract with the National Science Foundation. □