often produced in the high density, high temperature, accreting plasma close to a compact star while the radio emission is formed further out by the interaction of the relativistic plasma and the magnetic fields that are generally present. The well known X-ray binaries, Cyg X-1, Cyg X-3, Cir X-1 and Sco X-1 as well as GX17+2, the Galactic Centre and various RSCVn stars have been detected at radio frequencies.

The optical characteristics of high mass binary systems were discussed by J. B. Hutching of the Dominion Astrophysics Observatory (DAO). Detailed spectroscopic studies of eight of the hot supergiant components indicate that although these primary stars are undermassive (compared with normal stars of the same spectral type) their elemental constituents are apparently normal. The transfer of mass is made evident by the emission lines at λ4684 (He II) and the λλ4640 — 4650 (C III — N III) blend. Both emissions almost certainly occur in the accreting matter.

Analysis of optical light curves for these systems is complicated by the need to correct for non-circular orbits, tidal deformation, X-ray heating, non-synchronous rotation of the primary and the presence of an accretion disk.

A. Cowley (University of Michigan) presented a review of optical investigation of low mass binary X-ray systems. These fall broadly into three groups: first, those in which the optical output from the disk dominates that from the 'normal' star. The optical spectrum then consists of a hot, blue, relatively featureless continum with λ4686 He II emission. An example of such a system is Sco X-1 for which spectroscopic radial velocity measurements imply an orbital period of 0.782 days. However, no eclipse (or pulse) periodicity has been detected in the X-ray data. The second type of system is where the optical emission is dominated by the 'normal' star, for example Her X-1 and Cyg X-2. The latter system contains a low mass population II F star which fills its Roche lobe. A 9.8 day orbital period has been determined for this system by radial velocity measurements. The third type of low mass systems are the cataclysmic variables. These consist of the AM Her types (with strong emission lines and magnetic fields), SS Cyg type systems (common dwarf novae) and some of the X-ray transients (for example AO620-00).

A. K. Dupree of the Smithsonian Astrophysical Observatory (SAO) reviewed recent IUE and Copernicus observations of X-ray binaries. Such observations can lead to a better understanding of many problems such as the interaction between X rays and a radiatively driven stellar wind. High temperature material in an accretion disk or X-ray heated photosphere can also be observed in the ultraviolet. Changes in the ultraviolet spectrum of Vela X-1 may be caused by X-ray photoionisation and heating of the stellar wind. The effect of X rays on the interstellar medium has been detected in observations of both this source and 4U1700-37. Two narrow, highly excited, C IV and Si IV interstellar lines have been detected with absorption features separated by 50 km s^{-1}. These may be produced by the expansion of a 'bubble' of ionisation which expands as the X-ray source photoionises the interstellar medium. Ultraviolet analysis of the chromospheric emission from many of the hot single stars, which are now being found to be X-ray emitters, is an important new means for investigating the intriguing problem of the formation of the coronae.

Observations using the HEAO-1 and Einstein satellites have identified new classes of X-ray emitting objects and made possible a more comprehensive survey of known types of source. The emission of X rays from RSCVn, flare and main sequence stars has now been verified. About 80 discrete sources can be seen in the nearby galaxy M31, whereas the last generation of X-ray instruments are only able to detect the whole galaxy as a single source.

J. Grindlay (SAO) reported recent results on the enigmatic X-ray sources seen in some globular clusters. With the increased positional resolution of the Einstein Observatory it has been possible to measure the offset of the X-ray source from the centre of the optical cluster with precision. From an assumption that the stars in the core have an isothermal velocity dispersion, he has calculated the mean mass of this class of X-ray source. This turns out to be of order 20 $M_\odot$. There is, however, a large error associated with this value (2 $M_\odot$ is allowed for with a confidence of 10%) owing to the uncertainty in position of the optical centre of each cluster.

Previous Copernicus results which have tenatively identified OAO1653-40 with the massive binary V861 Sco were supported by more recent data from the same satellite which was presented by A. Parmar (MSSL). This showed an ultraviolet burst, which in one C III line alone had a luminosity of 2×10^{37} ergs s^{-1}, occurring simultaneously with an X-ray turn on. If it can be shown that V861 Sco is indeed associated with the X-ray source then it becomes a firm candidate for a black hole of mass between 7 and 13 $M_\odot$.

H. Bradt (MIT) described the detection of rapid aperiodic variability in Galactic X-ray sources. This has long been known to characterise Cyg X-1 and Cir X-1 although, with the recent detection of pronounced flaring and millisecond bursts, it also seems that the time variability of these sources is significantly more complicated than was once realised. In the past year, rapid aperiodic variability has been observed from GX301-2 and GX339-4. A 7 to 8 second delay between the arrival times of the optical and X-ray signals from Sco X-1 has been interpreted as the light travel time from the compact body to the primary. Correlated optical and X-ray activity has been found by S. Ilovaisky (Observatoire de Paris, Meudon), when the source flares.

Seven of the 16 known X-ray pulsars have had their orbits accurately measured by Doppler analysis of their varying pulse periods. One source, which may be a system containing a neutron star and a low mass white dwarf is 4U1626-67. S. Rappaport (MIT) reported on the search for orbital motion and the detection of as yet unexplained quasi-periodic bursts with a 1000 s characteristic timescale, which could be caused by material in unstable orbits which decay onto the neutron star.

Rappaport has combined data from the Ariel 5 and SAS-C satellites, and obtained a revised orbit for GX301-2 (4U1223-62) which has been determined with a most probable period of 40.8 days and a non-zero eccentricity. Optical photometry on the other hand suggests a period of about 20 days. Vela X-1 has been shown to have an eccentric orbit. Future observations of the change in the longitude of periastron will enable the amount of central condensation of the primary star to be calculated.

Detailed analysis of the X rays detected during an optical flare from the dwarf nova SS Cyg undertaken by F. Cordova (Caltech) shows the 9 s pulses to have a very sinusoidal shape. However, the pulse phase is unstable which makes a determination of the orbit very difficult. Similar

A. N. Parmar and P. A. Lamb are at the Mullard Space Science Laboratory, University College London.

A hundred years ago

ONE feature of the last eruption of the remarkable volcano of Kilauea, in the Sandwich Islands, is the fact that the great molten lake of lava, occupying a hugh caldron nearly a mile in width, and known as the "South Lake," was drawn off subterraneously, giving no warning of its movements and leaving no visible indication of its pathway or the place of its final deposit. "Other eruptions," writes Dr. Coan to Prof. Dana, in a letter dated June 20, "have blazed their way on the surface to the sea, or while on their subterranean way have rent the superincumbent beds, throwing out jets of steam or of sulphurous gases, with here and there small patches or broad areas of lava. But as yet no surface-marks of this kind reveal the silent, solemn course of this burning river. One theory is that it flowed deep in subterranean fissures, and finally disembogued far out at sea.

From *Nature* **20**, 25 September, 513; 1879.