An X-ray outburst from the RS CVn binary HR1099

RS CANUM VENATICORUM systems are the most plentiful binary stars known, having a space density of at least 10^{-6} systems pc^{-3} (ref. 1). They are detached subgiants of class KO+F to G with orbital periods between 1 day and 2 weeks (ref. 1). Many exhibit wave-like distortions in V which sometimes migrate to earlier binary phase with periods of 10–20 yr. This phenomenon has been interpreted by Hall[2] as resulting from extensive star spot activity on the surface of the cooler companion. Steady radio emission has been detected from several RS CVn systems with occasional flares involving an order of magnitude change in flux[3–5]. More recently, HEAO-A has detected soft X-ray emission (0.2–2.8 keV) from three of these systems HR1099, UX Ari and RS CVn itself[6,7], with source luminosities of $\sim 10^{30}$ erg s^{-1}. We report here the detection by the Copernicus 2.5–7.5 keV detector of a 3-h outburst from HR1099, coincident with a radio flare.

In September 1976, the Princeton University ultraviolet spectrometer on board Copernicus was used in a coordinated UV, radio and visual study of HR1099 (ref. 5). This instrument is coaligned with the UCL/MSSL X-ray detector[8] and during the vast majority of the UV observations this instrument collects background data[9]. Figure 1 shows the background subtracted flux recorded in 30-min time intervals during the first two days of the HR1099 observations and the two preceding observations of UX Ari and the X-ray target X Per (3U0352+30) (ref. 10). When Copernicus was pointed at X Per, a clear excess of counts above the background recorded during the UX Ari observation can be seen. The subsequent pointing at HR1099 revealed a 5σ signal, similar in strength to that recorded from X Per, for about 3 h centred on 0600 h on 24 September 1976.

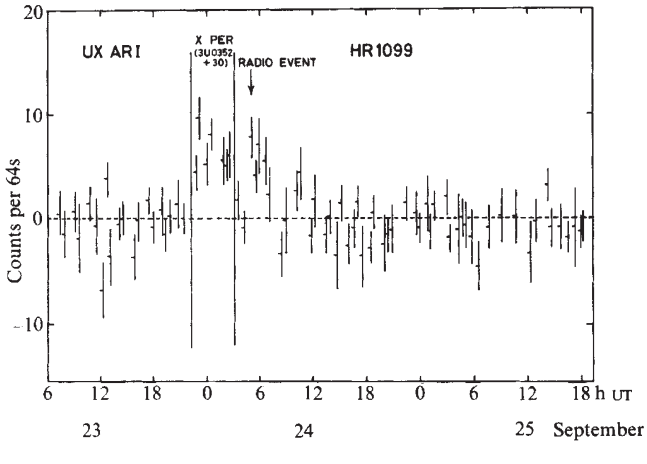

Fig. 1 The flux seen in the 2.5–7.5 keV band integrated in 30-min time bins. One count $\sim 4\times10^{-11}$ erg cm^{-2} s^{-1}.

This coincides with a radio outburst and enhanced Hα and Lyα emission from HR 1099 (ref. 5), that lasted for less than a day. Only one radio measurement was made at 0500 h UT and hence no information is available about the hour by hour evolution of the radio event. The precise end of the X-ray event is unclear as there is some evidence at the 2σ confidence level for a second outburst 2–3 h after the principle flare-up. The flux is too low to obtain a spectrum; however, the total flux is very insensitive to the assumed spectral model. A power law photon index of −2.0 yields a source luminosity of $(2.2\pm0.4)\times 10^{31}$ erg s^{-1} in the 2.5–7.5 keV band, assuming a source distance of 33 pc (ref. 11). Observations of other background targets revealed no evidence for a quiescent flux from either HR1099 or UX Ari at a level of 6×10^{-11} erg cm^{-2} s^{-1} (7×10^{30} erg s^{-1} for HR1099). There was a total of three weeks of Copernicus observations of HR1099 in the autumns of 1976 and 1977 and no other flares of a similar or greater magnitude were seen.

The spectra of the radio outbursts along with the proposed star-spot activity on the cooler star indicates that the radio events may result from solar flare-like activity[1,2,12]. The properties of the 24 September outburst from HR1099 qualitatively resemble that of a large solar outburst scaled up by 2 or 3 orders of magnitude[5] and this detection of a 2.5–7.5 keV X-ray flare supports this view.

Two other 2–10 keV outbursts have been reported from systems that do not contain a degenerate object (Algol[13] and the flare star YZ Cmi (ref. 14)); however, this is the first instance of a simultaneous measurement of an X-ray outburst coincident with a radio event. The fact that all these systems are so common indicates that each must represent an important class of X-ray source. Indeed, they may be responsible for some of the short-lived X-ray transient events that are currently being reported (see refs. 15, 16) and refs therein), especially with the possible associations of HR1099 with the transient 4U0336+01 (ref. 17), which was 10 times brighter than the event reported here.

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Discovery of quiescent X-ray emission from HR1099 and RS CVn

OBSERVATIONS with the HEAO 1 satellite have shown that RS CVn binary systems represent a new class of soft X-ray sources[1]. While the space density of the normal period RS CVn systems is large[9], only 26 are known optically[10] and, because of their low X-ray luminosity, only about nine of these should be observable from HEAO 1. We present here our discovery of X-ray emission from HR1099 (ref. 2) and the prototype member of this class, RS CVn itself. We also comment on the

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