EVN Observations of the Quiescent Radio Emission of HR 1099

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1. Introduction

HR 1099 is an RS CVn type close binary system, and, as usual for the binaries of this type, displays phenomena of intense magnetic activity at various atmospheric levels, similar to those observed on the Sun, but considerably more energetic. After its discovery as a radio source in 1976 (Owen et al., 1978), HR 1099 was the target of extensive observational campaigns at radio wavelengths. The non-thermal nature of its emission, related to and consistent with the magnetic activity scenario emerging from observations in other spectral regions (Rodonò et al 1987), was immediately evident. In this scenario the radio emission is due to gyrosynchrotron from one or both components. The radio behaviour of HR 1099 is characterized by two irregularly alternating phases, quiescent (10-15 mJy) and active (up to 1 Jy) periods (Umana et al., 1995).

2. Observations and Results

HR1099 was observed on 9 and 10 September 1998 at 6 cm with the European VLBI Network (EVN), during a multiwavelength campain involving also X-ray observations with Beppo SAX. The observations lasted 8 hour per day. Since HR1099 shows highly

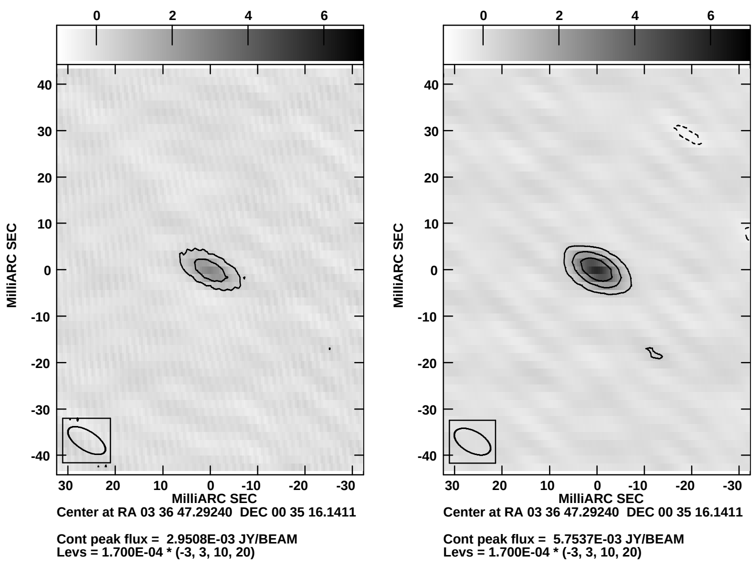

FIGURE 1. Images of HR1099 during the two runs of 1998 Sep. 9 and Sep. 10. The peak flux densities are 3 and 6 mJy and the source is unresolved.

variable flux density, the source was observed in phase referencing mode, to allow detection whether in quiescence or in the active period. The telescopes involved were Noto, Medicina, Shangai, Jodrell Bank, Onsala, Effelsberg, Westerbork and Urumqi. The phase calibrator was CTA26 ($S_{5GHz} = 2$Jy).

During the EVN observations, HR1099 was in a period of low activity, with a flux density of 3 mJy on the first day and 6 mJy on the following day. In both runs the source was not resolved and a size upper limit of 1.7×0.4 mas was estimated, i.e. 1/3 of the synthetized beam size. This would imply an overall size of the radio source, during quiescence, comparable to the angular diameter of the active K star and thus much smaller than the radio source when it is active (Trigilio, Umana & Migenes, 1993). This is in contrast with what is seen in the other RS CVn UX Ari, where extended structures have been observed in both quiescent (Beasley & Gudel, 2000) and active (Franciosini et al., 1999) periods.

A lower limit of the brightness temperature was estimated, obtaining $T_{\rm B} > 3 \times 10^8$K and $T_{\rm B} > 6 \times 10^8$K for the two days respectively.

3. X-rays versus Radio wavelengths

HR1099 was observed with Beppo SAX between 1998 Sep. 6 and Sep. 10 overlapping with the EVN observations at the end. The X-ray light curve from MECS measurements indicate a very weak flare at the beginning, a possible weak flare at the end and quiescent emission in between.

From the spectral analysis, a quiescent X-ray luminosity of $L_{\rm X} = 6.3 \times 10^{30}{\rm erg\,s^{-1}}$ was derived. As usual for RS CVns, the thermal spectrum of HR 1099 is consistent with two components at two different temperatures. During the overlap with EVN observations we obtain a $T_1 = 9.4 \times 10^6$K and $T_2 = 24 \times 10^6$K and these values did not change much during the entire SAX observations. Note that the very weak X-ray flare corresponds to the increase of the observed 6 cm flux densities.

The origin of the quiescent radio emission from active binaries and its relation to the X-ray emission is still not clear. A common origin is supported by the existence of a correlation between the quiescent X-ray and radio luminosities and quiescent radio emission due to thermal gyrosynchrotron radiation has been proposed by some authors (Drake et al., 1992).

Our main results ($T_{\rm B} >> T_{\rm X}$) enforces the hypothesis that also the quiescent radio emission is due to a non-thermal emission. Such quiet radio corona is probably sustained by a continuous series of small flares, as it has been suggested for similar objects such as UX Ari (Beasley & Gudel, 2000) and AR Lac (Trigilio et al., 2000).

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