RADIO LIGHT-CURVES AND CIRCUMSTELLAR MAPPING OF THE COLLIDING WIND BINARY WR140

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Abstract. New observations of the colliding wind Wolf-Rayet WC7+O4-5 binary WR140 (HD 193793) at 6 cm and 21 cm with the *Westerbork Synthesis Radio Telescope* are presented. They show that the 21 cm flux, in particular, rose to a sharp maximum in 1992, lagging about a year behind the 6 cm flux. After maximum, both fell simultaneously. The data are interpreted in terms of the varying circumstellar extinction to a non-thermal source in the wind interaction region due to the winds of both WC and O stars.

Key words: stars: Wolf-Rayet – binaries – radio emission – individual: WR140

Since 1986, we have been using the *Westerbork Synthesis Radio Telescope* (*WSRT*), mostly in "filler" time, to observe WR140 (WC7+O4-5, P =7.94 yr, e = 0.84) to develop our model for its radio variations in terms of an embedded synchrotron source suffering variable circumstellar extinction (Williams *et al.* 1990 = W90). Our observations, together with previously published observations, are plotted against phase in Fig. 1. The fluxes at both wavelengths rose as the system moved though apastron, that at 21 cm lagging 0.1–0.2 P behind the 6 cm flux. After rising steeply around $\phi \approx 0.8$, the 21 cm flux then ($\phi \approx 0.9$) fell sharply, together with the 6 cm flux. The relative narrowness of the 21 cm maximum is a consequence of the $\lambda^{2.1}$ dependency of free-free extinction.

The phase of the 21 cm flux maximum, $\phi \approx 0.85$, is significantly earlier than that ($\phi \approx 0.955$) of conjunction, when the O component is directly in front of the WC component and the circumstellar extinction due to the WC stellar wind is expected to be at a minimum owing to its "shadowing" by the O star wind. Accordingly, we conclude that the decline of the flux after $\phi \approx 0.85$ is not caused by extinction in the WC wind, which remains low until well after conjunction, but in that of the O star.

The extinction through the pre-shock O star wind along a sightline having impact parameter q and extending from the observer to a point in the wind at the same distance as the star can be shown to be $\propto q^{-3}$. The size of the wind interaction region where the synchrotron emission is believed to arise is proportional to the separation, D, of the WC and O stars. Consequently, q is approximately proportional to D and the extinction to D^{-3}. Between phases 0.85 and 0.95 the separation falls by a factor of 2.1 so the O star

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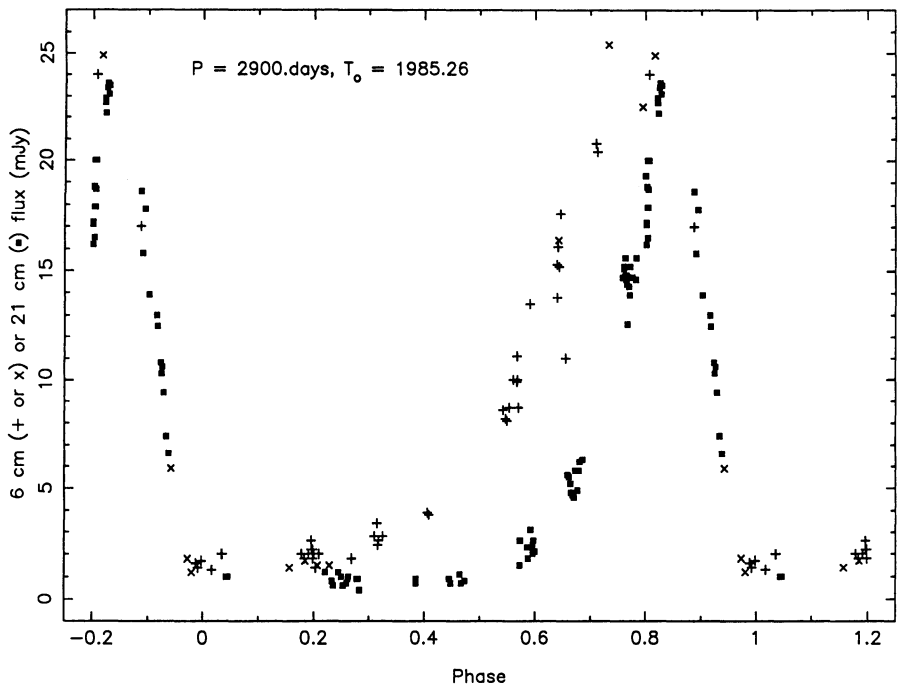

Fig. 1. Flux densities from WR140 phased against elements from W90. The *WSRT* 6 cm observations are marked '+' while the observations made prior to the 1985.3 periastron passage and quoted in W90 are marked '×'

wind extinction to a given part of the interaction region rises by a factor of $\sim$ 8. Secondly, unless the intensity profile of the intrinsic source is steeper than r^{-3}, the flux from the centre of the interaction region will suffer the most extinction and the appearance of the source will be annular.

A fuller account of this work is given by Williams *et al.* (1994).

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