EPISODIC DUST FORMATION IN THE WIND OF HD 193793

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ABSTRACT. In 1985 April, the WC7+abs star HD 193793 was observed, using UKIRT, to have brightened significantly in the infrared owing to the formation of a new dust shell. Examination of infrared photometry of this star since 1979 and previously published data indicates that the dust formation occurs at intervals of 7.9 years. Phasing the published radial velocities of the absorption line component with this period confirms that it is a member of an eccentric (e = 0.7-0.8) binary system having periastron passage shortly before dust formation. The X-ray spectrum also changed between 1984 and 1985 in becoming significantly "harder" while the non-thermal radio source disappeared, both changes indicating greater extinction. This suggests a model wherein the source of the non-thermal radio and X-ray emission moves deep into the Wolf-Rayet wind.

1. INFRARED, RADIO AND X-RAY VARIATIONS

During 1985, the infrared emission from HD 193793 (= WR 140) was observed to rise by over 2.5 mag. at 3.8 μm over an interval of about ten weeks, reaching a maximum in 1985.4. This is attributed to the formation of 5 x 10^{-9} $M_{\odot}$ of amorphous carbon grains. Comparison with the 1977 dust formation event studied by Williams *et al.* (1978) and Hackwell, Gehrz & Grasdalen (1979) confirmed that grain formation is a recurrent phenomenon and indicates a "period" of 7.9±0.1 years. In 1975.8, Florkowski & Gottesman (1977) observed HD 193793 to be a strong radio source having a spectrum quite different from that observed from γ Vel or expected from free-free radiation by a steady stellar wind. During and after the 1977 dust event, the radio souce had faded significantly (Florkowski 1982). In 1984.4, Pollock (1985) observed a strong X-ray source associated with HD 193793, confirming the presence of relativistic electrons in its wind. We re-observed HD 193793 with EXOSAT in 1985.5 and 1985.8 and found that the X-ray source was significantly "harder" than in 1984.4 (Williams *et al.* 1987).

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2. A COLLIDING WIND MODEL

Although HD 193793 has a composite spectrum, WC7+O5, its status as a physical binary has been controversial (Lamontagne, Moffat & Seggewiss 1984 and Conti *et al.* 1984). Re-examination of the 60 years of radial velocities presented by these authors using the 7.9 year period determined from the infrared maxima indicated that the system *is* a binary of high eccentricity having periastron passage shortly before infrared maximum (Williams *et al.* 1987). Other WC+O binaries, including γVel, show X-ray emission probably originating in standing shocks where the WC and O star winds collide. Because the mass-loss rate of the WC stars are 1-2 orders of magnitude greater than those of the O stars, the standing shocks are much closer to the latter than to the WC components. In a system with a highly eccentric orbit, like HD 193793, the shocked region will move in and out of the dense Wolf-Rayet wind along with the O star. Near periastron, the intrinsic X-ray emission will be greatest; but the low energy flux will suffer more absorption in the wind, resulting in the "harder" spectrum we observed with EXOSAT. The same region must be responsible for the non-thermal radio emission. The extinction of this from HD 193793 near infrared maximum (and periastron passage) and the fact that non-thermal radio emission is not observed from systems like γ Vel are a consequence of free-free absorption in the dense Wolf-Rayet winds. The radius of the 5GHz radio "photosphere" (Wright & Barlow 1975) around HD 193793 or γ Vel is about 5 x 10^{14} cm. This is 30 times the semi-major axis of γ Vel's orbit so we would never expect to see non-thermal emission from this system at 5 GHz. For reasonable masses, the semi major axis of WR 140's orbit is 2.6 x 10^{14} cm so that the separation of the WC and O components varies between 4.6 x 10^{14} cm and one-seventh this value. Apart from times around periastron, non-thermal radio emission will escape from the wind. The phases at which we can observe it depend on the orientation of the orbit. The dust formation itself must the consequence of the compression of part of the stellar wind by the standing shock, greatest at periastron, and the advection of this material by the stellar wind to a region sufficiently far from the star that it can make dust. The infrared data indicate that dust formation first occurred at a radius of 2.5 x 10^{15} cm. Given a wind velocity of 3000 km/s, this implies that the critical compression occurred ≈3 months before dust formation began.

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