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The Symbiotic-Like/Cataclysmic Triple System 4 Dra (=CQ Dra): Detection of a Post-Periastron Passage Brightening

The unique triple stellar system 4 Dra A + BC = CQ Dra (Reimers, 1985; Reimers et al., 1988) combines in itself the basic structural properties of a symbiotic-like binary (M3 III giant 4 Dra A + hot companion 4 Dra BC) and a cataclysmic one (presumable red dwarf-white dwarf configuration of 4 Dra BC). Such a unique combination makes 4 Dra to be an extraordinarily astrophysically attractive environment of high interest for the study of both above classes of interacting binaries. Although it has been possible to provide a spectroscopic orbital solution for the wide system (4 Dra A + BC; Reimers et al., 1988), the detailed system's setting is far from be known. Earlier observers of 4 Dra have found an irregular optical variability with the amplitude of about 0.1 mag in V (Eggen, 1967) and radio-flux fluctuations on time scales of weeks to months and maybe also on shorter ones of hours to days (Brown, 1987). The data from the UV suggest the presence of significant variations on the scale of days to weeks, too (Reimers et al., 1988; Reimers, 1990, 1991). We have performed long-term UBV monitoring of the system from early 1989 until the end of 1991 October and our interest in the system continues (Skopal et al., 1990; Hric et al., 1991). Our data suggest we have accomplished the first optical photometric detection of the orbital motion within the wide 4 Dra A + BC system (Urban and Hric, 1990). In this contribution we present short description and preliminary discussion of an unexpected feature we have discovered in our UBV light curves - a sudden post-periastron passage brightening of the system in the U colour which is only weakly manifested in the B and V.

All our observations were performed using 60-cm Cassegrain reflectors of the Skalnaté Pleso and Stará Lesná observatories of the Astronomical Institute of the Slovak Academy of Sciences located in the High Tatras Mountains region of northern Slovakia. Both telescopes are equipped with a single-channel pulse-counting photometers. Our data consists of 97 observational runs obtained in 95 nights between 1989 March 12 and 1991 October 29. This data base forms our long-term UBV coverage of the 4 Dra system.

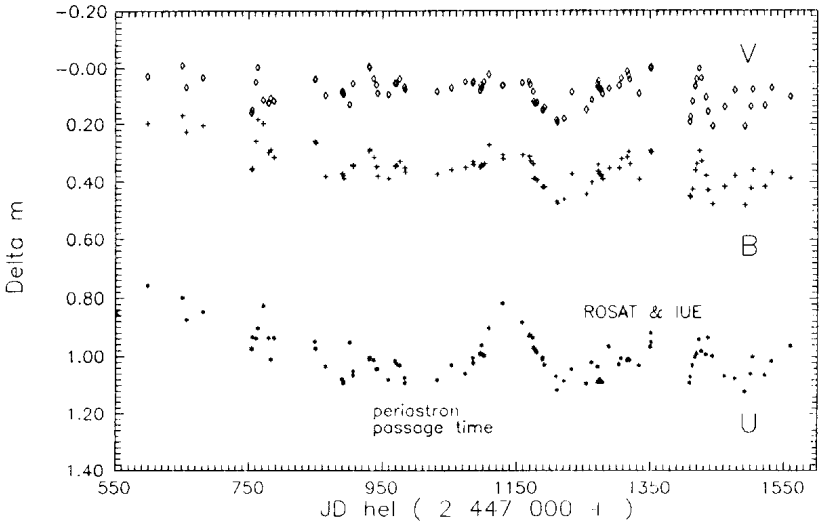

Figure 1: The long-term UBV light curves of the 4 Dra system obtained between 1989 March 12 and 1991 October 29. The data point just below the "and" in the "ROSAT and IUE" inscript corresponds to the night of April 4/5, 1991, when the simultaneous ROSAT and IUE (D. Reimers) and UBV observations (L.H. and Z.U.) were obtained.

As can be easily discerned from Fig. 1, our light curves of the 4 Dra system reflect some long-term modulation with varying degree in the individual colours. The modulation, which we have identified with the 1703-day orbital motion within the 4 Dra A + BC system (Urban and Hric, 1990), is most apparent in the U colour, less prominent in the B and only weakly visible in the V. As the immediate cause of this modulation we have suggested some combination of the reflection effect with a kind of partial eclipse. The unexpected brightening, which maintains almost identical hierarchy of conspicuency in the individual filters, starts shortly after the time of the periastron passage within the 4 Dra A + BC system (according to an ephemeris derived by Reimers et al., 1988). It is hard to specify the exact time of the beginning of the brightness rise, all we can say on the basis of our data is that it has happened some time between 1990 April and early June. The maximum occurred in 1990 August with the overall brightening amplitude of about 0.3 mag in U and about 0.05 mag or less in B and V. By the end of the 1990 October the system has returned to its pre-brightening level. The exact shape of the brightening is, unfortunately, unclear for soon after its maximum the light curves in all three colours exhibit an eclipse-like feature arising most probably due to the approximate alignment of 4 Dra A and 4 Dra BC with the line of sight during that time. The inclination of less than 50 degrees given for the wide system by Reimers et al. (1988) does not favour the classical eclipse interpretation, nevertheless, it is still possible that partial eclipse of some radiating areas within the system has been taking place. A rapid glimpse at the post-brightening part of our light curves shows apparent increase in the general level of photometric activity in the system as compared with the pre-brightening one.

As far as the nature of the brightening itself is concerned, it is possible to consider two basic alternatives: 1. Rayleigh scattering of photons coming from within the environment of 4 Dra BC in the extended atmosphere of 4 Dra A, in an analogy with the mid-eclipse brightening phenomena observed in some eclipsing binaries (cf. Kudzej, 1985, 1986); 2. activity in the close 4 Dra BC pair with the following subalternatives - a/. response to a symbiotic-like sudden accretion following the periastron passage in an eccentric orbit system (Reimers et al., 1988, give e=0.3 for the 4 Dra A + BC wide system), b/. totally or partially stimulated intrinsic cataclysmic activity in 4 Dra BC, c/. some combination of a/. and b/. Given the as yet unique character of the observed brightening and the very fact that we have covered to date only about 0.6 of the 1703-day orbital cycle of the wide 4 Dra A + BC system, it is hard to decide now which of the above alternatives seems to be mostly favoured by the still limited data coverage of the system. The environment consisting of a mass-transferring and mass-accreting close pair with a compact component in the neighbourhood of mass-outflowing red giant star (via stellar wind and, presumably, also via mass transfer events due to orbital eccentricity or, perhaps, pulsations) offers a rich variety of scenarios more or less sufficiently explaining the observed phenomena. Nevertheless, we are now making quantitative evaluation of the above and some other more specific, but also more elusive, alternatives and the results will appear elsewhere as a part of our full-scale analysis of all the observations of 4 Dra we have obtained thus far (Urban and Hric, 1991, in preparation).

We are indebted to Professor D. Reimers (Hamburg University Observatory, F.R.G.) for providing us with a preliminary information about the results of his as yet unpublished observations of 4 Dra as well as for the information about the exact time of his recent ROSAT and IUE campaign for this star which has enabled us to obtain simultaneous optical UBV photometry.

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