70 YEARS OF OBSERVATIONS OF 4 HER: CHANGES THROUGH THREE SHELL EPISODES

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1. History

4 Her (HD 142926, HR 5938; V=$5^m.75$, v.sini=300 km s^{-1}) is a well known and rather frequently observed Be and shell star. It was recognized as a Be star by Heard (1939) and Mohler (1940). The estimates of its spectral type by different authors vary between B7 IV-V and B9e. Hubert(1971) reported remarkable spectral changes of 4 Her which occurred between 1953 and 1970. Harmanec et al.(1973) discovered periodic radial-velocity variations of the hydrogen shell lines with a period 46.023 days and suggested the object is a single-line spectroscopic binary. The system elements were later refined by Heard et al.(1975) to P=46.194 days, K=12 km s^{-1} and e=0.3. In a subsequent paper, Harmanec et al.(1976) studied the variations of emission and absorption components of the hydrogen lines and concluded that 4 Her is an interacting binary and that the observed eccentricity of the orbit is spurious, caused by the effects of circumstellar matter.

The long-term spectral variations have been monitored at Ondřejov since 1969 and at Haute Provence since 1953 at low, and since 1960 at high dispersion. The history of the recurrent shell changes of 4 Her can be reconstructed from data published by Hubert (1971) and Harmanec et al. (1976), and on new data from Ondřejov and Haute Provence Observatories. We have been able to identify two periods of different lengths when the Hα emission was absent (1948–1963, 1987–1991). We thus cannot estimate the lengths of the emission period which started after 1920 and was on in late 1930's. The present emission period re-appeared 28 years after the onset of a episode in 1960's which lasted about 18 years. The IUE spectra of 4 Her were taken in 1979 (i.e. at the end of the previous emission episode), in 1983 (normal B type spectrum) and in 1992 (the present shell phase). Most of the UV lines of 4 Her appear unchanged on all three spectra, i.e. not influenced by the presence of the shell. The important exception are the C IV lines 1548 and

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1551 Å which closely correlate with the changes of the envelope signalled by Hα.

2. Binary nature

All so far published orbital elements of 4 Her were based exclusively on the radial velocities from shell lines. A few attempts to measure the velocities of photospheric helium lines failed (c.f., e.g., Heard et al.1975). We measured RVs on the wings of the stellar hydrogen lines from the photographic spectra digitized with a microdensitometer. We also took the advantage to measure the stellar profiles from the two epochs without shell. First, we derived the new value of the period using all available H shell RVs. Then, we calculated another orbital solution based solely on the new H-wing RVs and keeping the period fixed from the previous solution for all shell RVs (P=46.192 days). The solution based on stellar lines leads to a circular orbit (e=0, K=7.5 km s^{-1}) while an eccentric orbit has resulted from RVs of the shell lines (e=0.330, K=11.3 km s^{-1}). We thus reinforce the conclusion by Harmanec et al.(1976) that the orbital eccentricity indicated by the shell lines is spurious, caused by velocity distortions due to circumstellar matter. We also tried to verify the model of 4 Her as an interacting binary advocated in the latter study. Regrettably, we have started the spectroscopic search for the lines of the secondary only after the onset of the new shell. It is therefore very difficult to distinguish faint and sharp shell lines from the lines of the secondary – unless a reasonable phase coverage by spectra can be achieved.

The phase distribution of available high-quality data from the Aurélie spectrograph at OHP and Ondřejov Reticon does not allow to check on the conclusion by Harmanec et al. (1976) that the V/R ratio of Balmer lines varies in phase with the RV curve of 4 Her.

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