

How Frequent is Evolutionary Spin-Up in Binary Be Stars?

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Abstract. Satellite absorptions are identified as a general feature of Be binaries. In addition, Be + sdO binaries seem to show a characteristic short-term emission variability and short-lived shell events. The identification of such features can ease the search for further Be binaries with hot companions to allow an estimate of the fraction of Be stars, possibly spun-up through binary evolution.

1. Introduction

Be stars are among the most rapid rotators, with about 70 % of the critical rate. Assuming standard binary evolution scenarios, a non-negligible fraction of Be stars might have undergone spin-up through mass transfer, leading either to Be + WD or Be + sdO systems. Yet, only a single confirmed Be + sdO pair, ϕ Per, is known, although Be stars belong to the most intensively studied objects.

2. Features Indicating Be + sdO Binaries

Many Be stars, archived in our data base, show specific features occurring as small absorption cores in the peaks of emission components of e.g. Balmer lines at special orbital phases (Fig. 1, left). Almost all (except one) of these stars, like ϕ Per, HR 2142, and κ Dra, are confirmed Be binaries. Therefore these features are taken as indicators for binarity.

ϕ Per, 59 Cyg, and HR 2142 in addition show a specific short-term variability of emission lines, varying periodically in anti-phase to the photospheric absorption (Fig. 1, mid). It was first observed in ϕ Per (Poeckert 1981) and successfully modeled for He I 5876 and He I 6678 by Hummel & Štefl (2001), assuming a hot companion, heating and ionizing a sector of the Be disk. It is therefore attributed to a Be + sdO nature. The heated area causes extra emission, appearing as a blue- or red shifted emission peak. Its velocity variation represents the orbital velocity of the outer limb of the disk, excited at different phase angles. Gies et al. (1998) found good indications for a sdO companion in the UV spectrum of ϕ Per.

A binary nature is also confirmed for 59 Cyg. The variation of its He I 6678 emission was successfully reproduced by the hot companion model of Hummel, too, being a strong hint to a further Be + sdO binary.

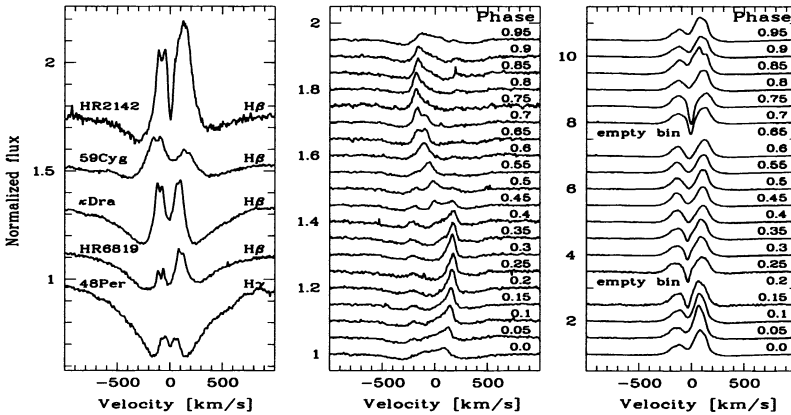


Figure 1. Satellite absorptions found in the spectra of confirmed and supposed Be binaries (left). Characteristic features of Be + sdO binaries: emission variability of He I 6678 in 59 Cyg (mid), shell event in H β in ϕ Per (right). Phase 0.0 refers to superior conjunction of the primary.

ϕ Per and HR 2142, supposed to be seen nearly edge-on, exhibit short-lived shell events occurring periodically around superior conjunction of the primary (Fig. 1, right). They are explicable by the heated sector seen in front of the primary. The companion of the well studied binary HR 2142 (Peters 1983) could not be identified yet. Since it shows the same characteristic features like ϕ Per and 59 Cyg, it is a good candidate for a third Be + sdO binary.

3. Conclusion

Satellite absorptions occur in the spectra of many Be stars archived in our data base. Since almost all of them are confirmed binaries, these features are taken as indicators for binarity. Short-term emission variability and short-lived shell events seem to be characteristic for Be + sdO binaries. They occur in the spectra of the confirmed Be + sdO binary ϕ Per and HR 2142, for which such a nature is not verified yet. Since 59 Cyg has a lower inclination, only short-term emission variability is seen. This could also be successfully reproduced by the hot companion model of Hummel, like for ϕ Per, indicating 59 Cyg to be another Be + sdO binary. The identification of such features shall result in selection criteria for further Be + sdO systems to concentrate time-consuming monitoring campaigns on promising candidates only. This should permit reliable future estimates of the fraction of Be stars, possibly having spun-up through binary evolution.

References

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