

# Mass-ejection events in Be stars triggered by coupled nonradial pulsation modes

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**Abstract.** Be stars (for an in-depth review see Rivinius, Carciofi & Martayan 2013) rotate at  $\geq 80\%$  of the critical velocity and are multi-mode nonradial pulsators. Magnetic dipole fields are not detected, and binaries with periods less than 30 days are rare. The name-giving emission lines form in a Keplerian decretion disk, which is viscously re-accreted and also radiatively ablated unless replenished by outbursts of unknown origin.

Months-long, high-cadence space photometry with the BRITE-Constellation nanosatellites (Pablo *et al.* 2016) of about 10 early-type Be stars reveals the following (cf. Baade *et al.* 2016a, Baade *et al.* 2016b):

- Many Be stars exhibit 1 or 2 so-called  $\Delta$  frequencies, which are differences between two nonradial-pulsation (NRP) frequencies and much lower (mostly less than 0.1 c/d) than the parent frequencies. The associated light curves are roughly sinusoidal. The amplitudes can exceed that of the sum of the parent amplitudes.
- Conventional beat patterns also occur.
- Amplitudes of both  $\Delta$  and beat frequencies can temporarily be enhanced. Around phases of maximal amplitude the mean brightness is in- or decreased, and the scatter can be enhanced.
- During high-activity phases (outbursts), broad and dense groups of numerous spikes arise in the power spectra. The two strongest groups often have a frequency ratio near 2. The phase coherence seems to be low.
- Time coverage (less than half a year) is not yet sufficient to infer whether two  $\Delta$  or beat frequencies can combine to cause long-lasting (years) superoutbursts (cf. Carciofi *et al.* 2012).

From these observations it is concluded:

- The variable mean brightness and the increased  $\Delta$ -frequency amplitude and scatter trace the amount of near-circumstellar matter.
- Increase or decrease of mean brightness is aspect-angle dependent (pole-on vs. equator-on).
- Increased amounts of near-circumstellar matter are due to rotation-assisted mass ejections caused by coupled NRP modes.
- Observations do not constrain the location of the coupling (atmosphere or stellar interior).
- Broad frequency groups do not represent stellar pulsation modes but circumstellar variability.
- Be stars later than B5 are less active and may in some cases even behave differently.

**Keywords.** stars: emission-line, Be; stars: mass loss; stars: oscillations

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## References

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