Stars and their variability observed from space
C. Neiner, W. W. Weiss, D. Baade, R. E. Griffin, C. C. Lovekin, A. F. J. Moffat (eds)

ULTRAVIOLET VARIABILITY OF B, BE, AND B[E] STARS

I. Krtičková[1] and J. Krtička[1]

Abstract. We study the ultraviolet variability of evolved B[e], Be, and B stars from our Galaxy and from the Magellanic Clouds. We use IUE observations to derive fluxes of individual stars in the selected bands in the near-UV and far-UV regions. We diagnose the variability in the lines and the total flux variability. We discuss the origin of the UV light variability of studied stars. We detected pulsations in B[e] star HD 50138, LBV-type variations in HD 34664, and constant luminosity for a group of B[e] supergiants.

Keywords: stars: early-type, stars: emission-line, Be, stars: variables: general, stars: oscillations

1 Introduction

The study of stellar variability in non-optical domains is complicated by the lack of suitable data. Here we show how the archival ultraviolet (UV) spectra of B stars can be used to study their variability.

We used UV fluxes $F(\lambda)$ observed by IUE to construct the broad-band fluxes $F_c = \int_0^\infty \Phi_c(\lambda) F(\lambda)\,\mathrm{d}\lambda$. Here $\Phi_c(\lambda)$ is a Gauss function centered on wavelength c. We selected $c = 1500$ Å to study the flux in the far-UV region and $c = 2175$ Å and $c = 2500$ Å for the near-UV region. To describe the variations of emission lines as a whole, we integrated the flux above and below the continuum and derived the total flux in emission lines F_{em}.

2 LBV-type variations in HD 34664 and pulsations in B[e] star HD 50138

The UV fluxes from HD 34664 (LHA 120-S 22) significantly decreased between MJD 45 000 and 48 000 (Fig. 1, see also Shore 1990). The decrease is stronger in the far-UV than in the near-UV. This can be explained by the change of the effective temperature. Such variations are typical for LBV stars. The total emission-line flux decreased in HD 34664 during the IUE observations. This also corresponds to the decrease of the effective temperature. The decrease of the emission-line flux during the period of constant broad-band flux after MJD 48 000 indicates that the emission lines and continuum originate in different regions.

The IUE fluxes of HD 50138 (V743 Mon) are variable with the period 1.194 ± 0.006 d (see Fig. 2). Borges Fernandes et al. (2012) detected line profile variations in this star with a period significantly shorter than the rotational period of 3.6 d. These variations are attributed to pulsations. To our knowledge, this is the first detection of pulsations in B[e] stars.

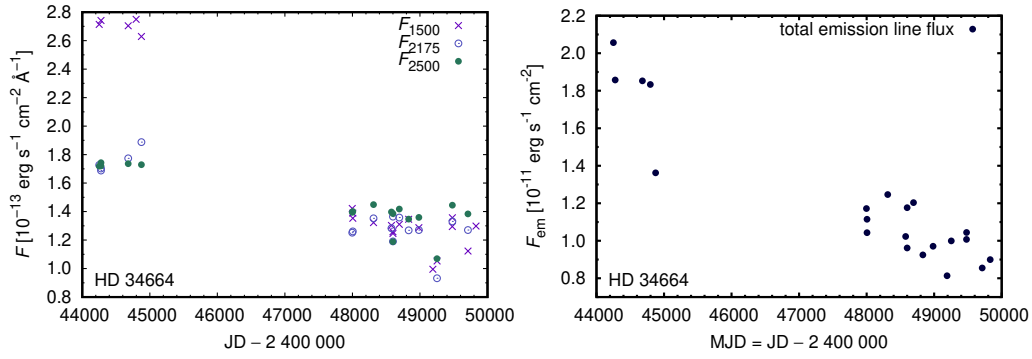

Fig. 1. Variations in B[e] star HD 34664. **Left:** Long-term flux variations. **Right:** Total emission line flux variations.

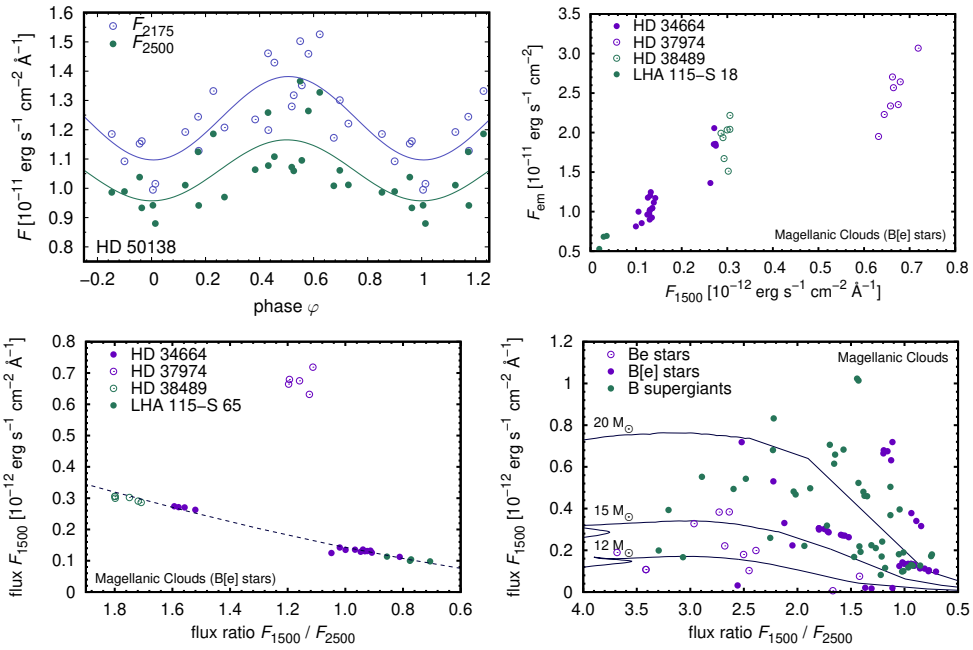

Fig. 2. Top Left: Pulsations in HD 50138. **Top Right:** Relation between the emission-line and the far-UV fluxes for B[e] stars. **Bottom Left:** Correlation between the far-UV flux and the time variable flux ratio for selected B[e] supergiants. **Bottom Right:** UV variant of the color-magnitude diagram for B supergiants from the Magellanic Clouds.

3 General relations between fluxes

The far-UV and emission-line fluxes correlate for the Magellanic Cloud B[e] stars (Fig. 2). This most likely results from geometrical causes. With larger disk column density (or for disks seen edge-on) the continuum flux is more absorbed and becomes lower. However, line emitting regions of the envelope are visible even when the disk is seen edge-on; consequently, the emission-line flux is nonzero even for very low continuum fluxes.

Be stars and B[e] supergiants occupy different parts of the flux vs. flux ratio diagram in Fig. 2, while B supergiants are distributed more uniformly with enhanced density in two perceptible branches. Similarly, B[e] stars divide into different possible groups. Comparison with evolutionary tracks shows that the studied stars are in a post main-sequence stage with typical initial mass of $10 - 30\,M_\odot$.

There is a correlation between the flux and flux ratio for a group of B[e] supergiants. The relation can be fitted by model-atmosphere emergent fluxes assuming constant luminosity and variable temperature and radius (dashed line in Fig. 2). From this it follows that these stars have the same luminosity of about $(1.9\pm0.4)\times10^5\,L_\odot$.

4 Conclusions

We have studied UV variability of B-type stars (Krtičková & Krtička 2018). We detected LBV-type variations in HD 34664 and pulsations of B[e] star HD 50138 with the period 1.194 d. The correlation of fluxes implies the luminosity $1.9 \times 10^5\,L_\odot$ for a group of B[e] supergiants suggesting their similar origin.

This work was supported by grant GA ČR 18-05665S.

References

Borges Fernandes, M., Kraus, M., Nickeler, D. H., et al. 2012, A&A, 548, A13
Krtičková, I. & Krtička, J. 2018, MNRAS, 477, 236
Shore, S. N. 1990, IAU Circ., 5005, 1

[1] Department of Theoretical Physics and Astrophysics, Masaryk University, Brno, Czech Republic