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Mass-outflow from the active symbiotic binary BF Cyg during its 2015 and 2017 bursts

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Abstract. In this contribution we present observations of the symbiotic star BF Cygni during its current active phase. Our photometric monitoring indicated 1-mag bursts during 2015 and 2017 on the time-scale of weeks with gradual fading to the pre-outburst level for more than 1 year. During these events, our spectra show signatures of a variable mass-outflow and formation of a highly-collimated bipolar mass ejection.

Key words: stars: binaries: symbiotic – individual: BF Cygni

1. Introduction

Symbiotic stars are the widest interacting binaries with orbital periods of, typically, a few years. They consist of a red giant and a white dwarf (WD) accreting from the giant's wind. According to behaviour of their long-term optical light curves we distinguish between the so-called quiescent and active phases. The latter are characterized by a few magnitudes brightening with signatures of a mass-outflow on the time-scale from months to years (Kenyon, 1986).

BF Cygni is an eclipsing symbiotic binary with the orbital period of ∼757 days, consisting of a hot WD accreting from the wind of an M5III giant companion. A historical light curve shows three types of eruptions: a slow symbiotic nova outburst (in 1895), Z And-type outbursts (in 1920, 1989) and short-term orbitally-dependent flares (e.g. Skopal et al., 1997, and references therein).

2. Observations

Our observations were carried out at the Stará Lesná observatory of the Astronomical Institute of the Slovak Academy of Sciences. Multicolour photometry was carried out with the photoelectric photometer (till January 2016) and CCD detectors at the foci of 0.6 and 0.18 m telescopes. The Echelle medium-resolution spectroscopy ($R \approx 11000$) was obtained with another 0.6 m telescope. The spectra were dereddened with $E_{\rm B-V} = 0.35$ mag. Basic treatment was done using the *IRAF*-package software. The spectra were converted to fluxes with the aid of the (near-)simultaneous $(U)BVR_{\rm C}I_{\rm C}$ photometry corrected for emission lines.

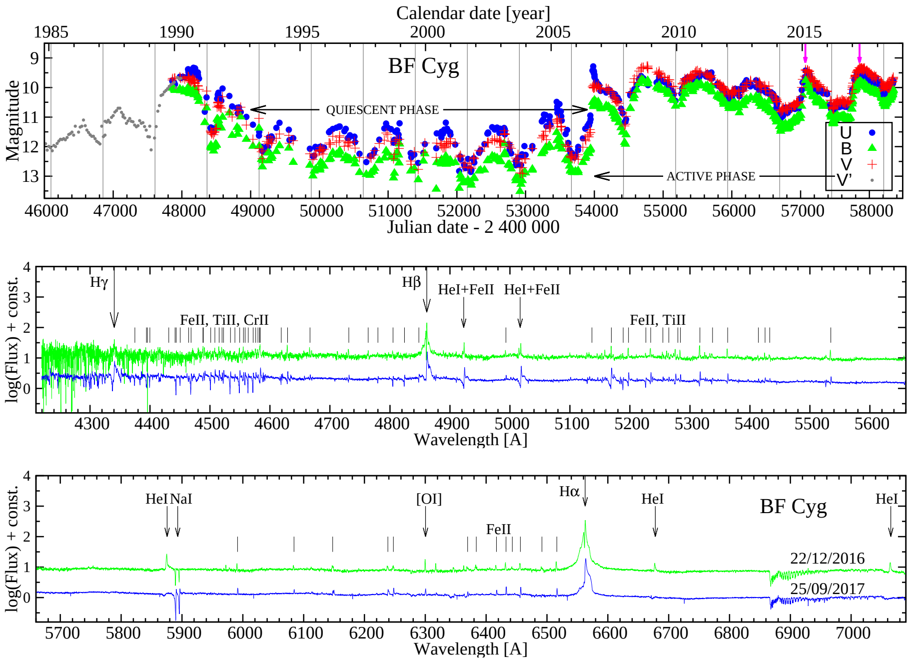

Figure 1. Top: UBV light curves of BF Cyg from its 1989 outburst. Vertical lines represent times of the spectroscopic conjunctions with the giant in front according to the ephemeris $JD_{\rm sp.conj.} = 2\,451\,395.2 + 757.2 \times E$ (Fekel et al., 2001). The 2015 and 2017 flare-like bursts are marked by vertical arrows. Part of the visual light curve V' prior to the 1989 outburst was taken from Leibowitz & Formiggini (2006). Bottom: Comparison of the spectrum from the beginning of the 2017 burst (green line) and that after its maximum (blue line). The most pronounced lines are marked by arrows.

3. Results

Figure 1 shows the UBV light curves of BF Cyg from its 1989 outburst, throughout the following quiescence until the last 2006 outburst, after which the star persists in an active phase to date (2018.8). The quiescent light curve is characterized by the wave-like orbitally-related variations, the nature of which was originally ascribed to the reflection effect (e.g. Kenyon, 1986), but later suggested to be caused by apparent variation of the emission measure of a partially optically thick symbiotic nebula due to the orbital motion (Skopal, 2001). Dur-

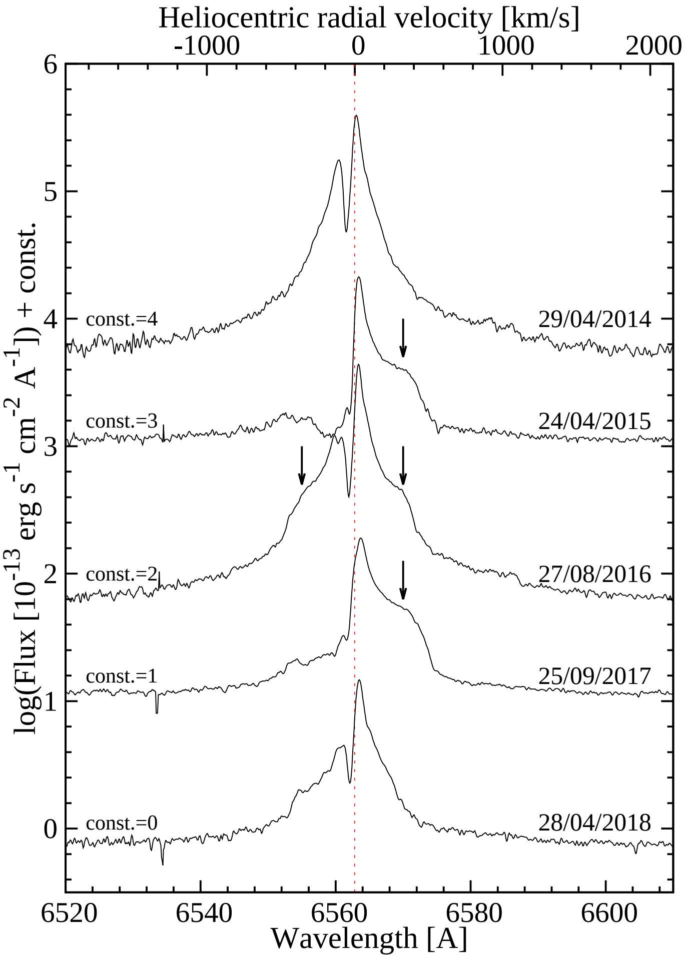

Figure 2. Variation in the Hα profile before and during the 2015 and 2017 bursts. Satellite emission components are marked by arrows.

ing active phases, a cool disk-like pseudophotosphere expanding from the central star creates around the WD (Skopal, 2005). As a result, profiles of minima (eclipses) reflect the geometry of the hot component pseudophotosphere, which can be different at different levels of the activity. For example, during the 1989 outburst of BF Cyg, we observed a rather narrow and deep minimum (eclipse), while during the current activity the minima are much more complex in the profile (see Fig. 1).

At the beginning of 2015 and 2017, BF Cyg showed small 1-mag bursts that peaked at $V \sim 9.3$ with following gradual decline to the pre-outburst brightness lasting for $\sim$1 year. Our spectroscopic observations indicate an increase of the mass-outflow during both the 2015 and 2017 bursts. Around the light maximum, blue-shifted absorption component developed in the profiles of most of spectral lines. They indicate a mass-outflow at a few times $100\,\mathrm{km\,s^{-1}}$. Because the orbital inclination of BF Cyg is high, this can be ascribed to the expansion of the cool pseudophotosphere concentrated at/around the equatorial plane. In addition, a strong satellite emission component developed at the red side of hydrogen lines, while during the decline, satellite components developed on both sides of the line (Fig. 2). Such the evolution suggests formation of a highly-collimated bipolar mass ejection from BF Cyg as during the 2009-2012 period (see Skopal et al., 2013).

4. Conclusion

During the 2015 and 2017 bursts, the enhanced mass-outflow was indicated by development of P Cyg profiles and satellite emission components in hydrogen lines. These observational events could be caused by expansion of the equatorially concentrated ejection and the bipolarly-collimated outflow – jets.

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