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X-RAY EMISSION OF INTERACTING WIND BINARIES IN CYG OB2

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Abstract. Cyg OB2 #5, #8A, and #9 are binary or multiple massive stars in the Cyg OB2 association displaying several peculiarities, such as bright X-ray emission and non-thermal radio emission. Our X-ray monitoring of these stars reveals the details of their behaviours at high energies, which can be directly linked to wind-wind collisions (WWCs). In addition, the X-ray emission of Cyg OB2 #12, an evolved massive star, shows a long-term decrease, which could hint at the presence of a companion (with associated colliding winds) or indicate the return to quiescence of the star following a recent eruption.

1 Introduction

Massive stars lose large amounts of material during their lifetime. In systems composed of several massive stars, these winds collide generating hot plasma which emits X-ray. Only an X-ray monitoring can ascertain the origin of the X-rays as the WWC emissions vary with orbital phase. The first massive stars detected in the X-ray range (Cyg OB2 #5 , #8A, #9 and #12) have continued to be observed at high energies over the years, and we present here the results of our monitorings (Cazorla *et al.* 2013, Nazé *et al.* 2012).

2 Observations and results

We used a dataset comprising 7 XMM-*Newton* and 6 Swift observations as well as archival ROSAT and Suzaku exposures. Absorbed optically-thin thermal plasma models were used to fit the extracted spectra. At first, unconstrained fittings of the XMM-*Newton* data were performed, but non-varying parameters were then fixed and fitting re-done.

Cyg OB2 #5 was recently found to be a quadruple system (Kennedy *et al.* 2010), consisting of a 6.6 d period eclipsing binary, a tertiary star in a 6.7 yrs

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orbit around the inner binary system, and a fourth objet, 0.9" to the NE of the binary. The X-ray emission can be fitted with two thermal components, with constant temperatures and ratio between the normalization factors. Changes in the X-ray emission indicate that X-rays arise in the WWC between the binary and the third star, as is the varying radio emission. Moreover, the shapes of the variations allowed us to reject some orbital solutions proposed for this triple system. To improve the orbit knowledge, we have begun to study the reflex motion of the binary, i.e. light time effects, delaying the eclipses, and systemic velocity changes.

Cyg OB2 #8A is a binary with a 21.9d period and a radiative WWC (De Becker *et al.* 2006, Blomme *et al.* 2010). Our work enlarges the phase coverage of the orbit and confirms previous results: a slight temperatures increase at apastron, maximum absorption when the star with strongest wind is in front, and maximum flux at an intermediate phase. The analysis of the behaviour of the normalization factors reveals that the strength of the cooler components varies with density whereas that of the hotter component varies with shock strength. It should be noted that the flux variations are asymmetric, displaying the hysteresis predicted by hydro models (Pittard & Parkin 2010).

Cyg OB2 #9 is a binary with a 860d period, an eccentricity of 0.7, and is known as a non-thermal radio emitter. In the X-ray domain, Cyg OB2 #9 closely follows the expectations for an adiabatic WWC, i.e. $L_X \propto 1/D$: there is no crash of the collision zone on one of the two stars, and the collision remains mostly adiabatic in nature even when the stars are at periastron, which renders the system exceptional. Moreover, it was found that the temperature of the hottest plasma decreased by 25% at periastron, which can be explained by radiative braking.

The B-hypergiant Cyg OB2 #12 is one of the optically brightest stars in the Galaxy and an LBV candidate, though it lacks some of the typical characteristics of such stars (Clark *et al.* 2012). The best-fit was achieved with two thermal components with fixed temperatures and ratio between normalization factors. The overall flux has been decreasing during the last decade, which could reflect either the aftermath of an LBV eruption or the fading of the emission of an adiabatic WWC in a long-period binary (after periastron). Archival ROSAT and ASCA data indicate a brightening of Cyg OB2 #12 in the 1990s, consistent with the second scenario; the binary period would then not be shorter than 24 yrs.

References

Blomme, R., De Becker, M., Volpi, D., & Rauw, G. 2010, A&A, 519, A111

Cazorla, C., Nazé, Y., Rauw, G. 2013, A&A, submitted

Clark, J. S., Najarro, F., Negueruela, I., *et al.* 2012, A&A, 541, A145

De Becker, M., Rauw, G., Sana, H., *et al.* 2006, MNRAS, 371, 1280

Kennedy, M., Dougherty, S. M., Fink, A., & Williams, P. M. 2010, ApJ, 709, 632

Nazé, Y., Mahy, L., Damerdji, Y., *et al.* 2012, A&A, 546, A37

Pittard, J. M., & Parkin, E. R. 2010, MNRAS, 403, 1657