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X-ray emission from interacting wind massive binaries: A review of 15 years of progress

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Abstract

Previous generations of X-ray observatories revealed a group of massive binaries that were relatively bright X-ray emitters. This was attributed to emission of shock-heated plasma in the wind–wind interaction zone located between the stars. With the advent of the current generation of X-ray observatories, the phenomenon could be studied in much more detail. In this review, we highlight the progress that has been achieved in our understanding of the phenomenon over the last 15 years, both on theoretical and observational grounds. All these studies have paved the way for future investigations using the next generation of X-ray satellites that will provide crucial information on the X-ray emission formed in the innermost part of the wind–wind interaction.

Keywords: Stars: early-type; Binaries: spectroscopic; X-rays: stars; Stars: mass-loss

1. Introduction

Early-type stars of spectral type OB or Wolf–Rayet (WR) feature powerful, highly supersonic stellar winds that are driven by the radiation pressure in numerous spectral lines. These winds combine large mass-loss rates and wind velocities and thus they vehicle important quantities of kinetic power. When two such stars are bound together by gravity in a binary system, their winds interact and part of the kinetic energy is converted into heat. This interaction gives rise to a number of observational signatures that span a wide range of the electromagnetic spectrum, from radio waves to the γ-ray domain. In this review, we focus on one of the most spectacular observational consequences of colliding winds: the X-ray emission that is produced by the shock-heated plasma in the wind interaction zone (see Fig. 1).

Two years before the first detection of X-ray emission from massive stars, Prilutskii and Usov (1976) and Cherepashchuk (1976) proposed that collisions between the wind of one component of a massive binary system and either of the wind, photosphere or magnetosphere of the companion star should produce strong X-ray emission. Observations with *EINSTEIN*, and later on with *ROSAT*, revealed that single and binary early-type stars are moderate X-ray emitters. However, for the binary systems, the observed flux level turned out to be significantly lower than expected from early theoretical considerations. Still, it was found that many of the brighter X-ray sources among massive stars were binary systems, and that, on average, massive binary systems had a larger L_X/L_{bol} ratio than single massive stars. This conclusion held for binaries hosting Wolf–Rayet stars (Pollock, 1987) as well as for systems of spectral-type O + O (Chlebowski and Garmany, 1991). Moreover, the level of X-ray emission from some of these

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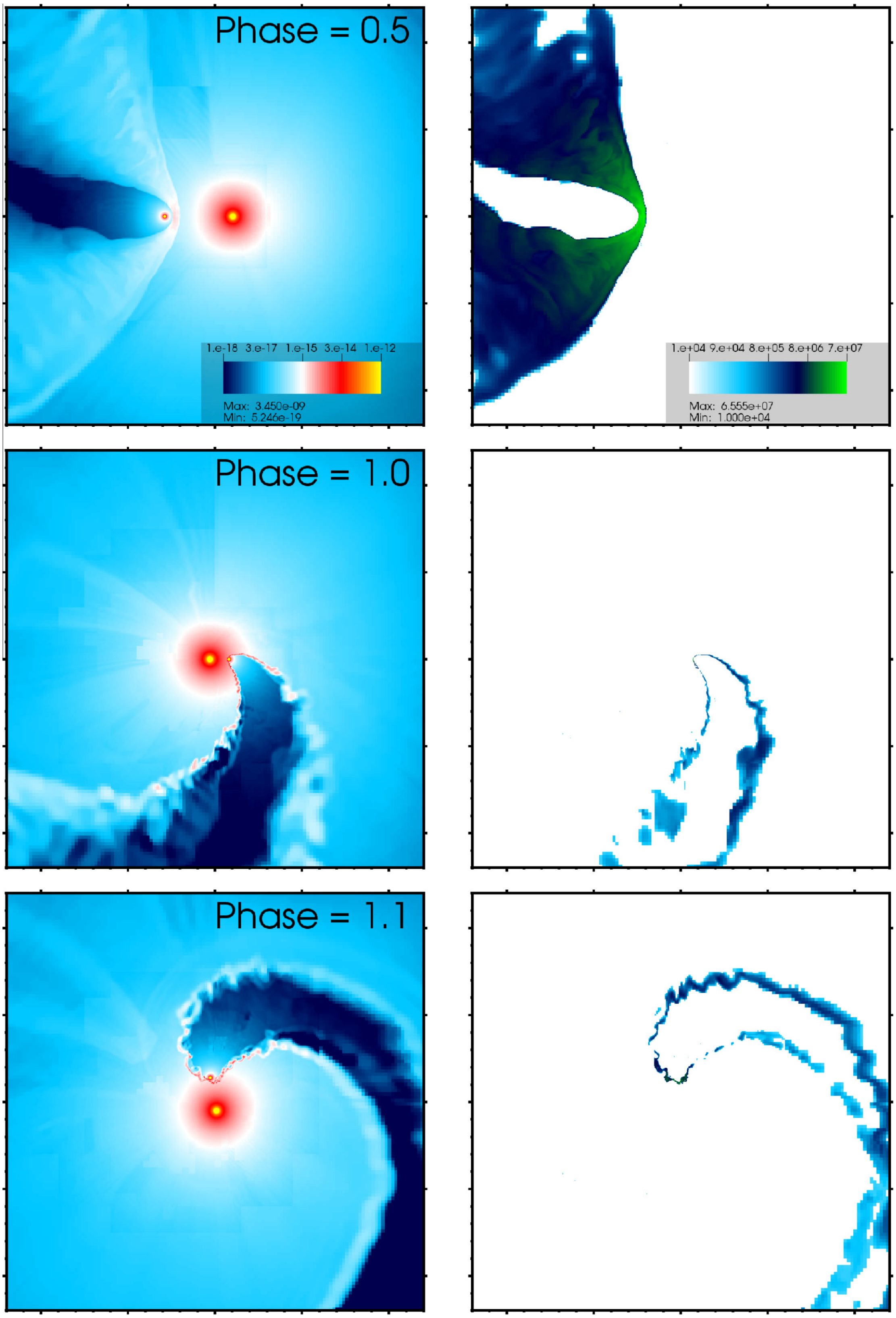

Fig. 1. 3-D hydrodynamic simulation of the wind–wind interaction in WR 22 including the effect of radiative acceleration from Parkin and Gosset (2011). Left: gas density in the orbital plane at three different orbital phases. Right: temperature of the gas in the orbital plane. The WR star is the star with the stronger wind. Each plot covers a region of 1.2×10^{14} cm on one side. Credit: Parkin, E.R., & Gosset, E., A&A, 530, A119, 2011, reproduced with permission ©ESO.