Investigating the X-ray emission from the massive WR+O binary WR 22 using 3D hydrodynamical models

E. R. Parkin(1,2) and E. Gosset(1)

(1) Institut dâ€™Astrophysique et de Geophysique, Universite de Liege
(2) Research School of Astronomy and Astrophysics, Mount Stromlo Observatory, Australian National University

Aims. We examine the dependence of the wind-wind collision and subsequent X-ray emission from the massive WR+O star binary WR 22 on the acceleration of the stellar winds, radiative cooling, and orbital motion.

Methods. Three dimensional (3D) adaptive-mesh refinement (AMR) simulations are presented that include radiative driving, gravity, optically-thin radiative cooling, and orbital motion. Simulations were performed with instantaneously accelerated and radiatively driven stellar winds. Radiative transfer calculations were performed on the simulation output to generate synthetic X-ray data, which are used to conduct a detailed comparison against observations.

Results. When instantaneously accelerated stellar winds are adopted in the simulation, a stable wind-wind collision region (WCR) is established at all orbital phases. In contrast, when the stellar winds are radiatively driven, and thus the acceleration regions of the winds are accounted for, the WCR is far more unstable. As the stars approach periastron, the ram pressure of the WRâ€™s wind overwhelms the O starâ€™s and, following a significant disruption of the shoc non-linear thin-shell instabilities (NTSIs), the WCR collapses onto the O star. X-ray calculations reveal that when a stable WCR exists the models over-predict the observed X-ray flux by more than two orders of magnitude. The collapse of the WCR onto the O star substantially reduces the discrepancy in the 2 âˆ’ 10 keV flux to a factor of â‰ƒ 6 at Ï† = 0.994. However, the observed spectrum is not well matched by the models.

Conclusions. We conclude that the agreement between the models and observations could be improved by increasing the ratio of the mass-loss rates in favour of the WR star to the extent that a normal wind ram pressure balance does not occur at any orbital phase,
potentially leading to a sustained collapse of the WCR onto the O star. Radiative braking may then play a significant role for the WCR dynamics and resulting X-ray emission.

Reference: Accepted for publication in A&A
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1104.2383

Comments: 16 pages, 11 figures

Email: parkin@mso.anu.edu.au