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The boundary layer in compact binaries

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Abstract

Context. Disk accretion onto stars leads to the formation of a boundary layer (BL) near the stellar surface where the disk makes contact with the star. Although a large fraction of the total luminosity of the system originates from this tiny layer connecting the accretion disk and the accreting object, its structure has not been fully understood yet. Aims. It is the aim of this work to obtain more insight into the BL around the white dwarf in compact binary systems. There are still many uncertainties concerning the extent and temperature of the BL and the rotation rate of the white dwarf. Methods. We perform numerical hydrodynamical simulations, where the problem is treated in a one-dimensional, radial approximation (slim disk). The turbulence is described by the α parameter viscosity. We include both cooling from the disk surfaces and radial radiation transport. The radiation energy is treated in a one-temperature approximation. Results. For a given M our results show a strong dependence on the stellar mass and rotation rate. The midplane and the effective temperature rise considerably with increasing stellar mass or decreasing stellar rotation rate. Our simulations also show that the radiation energy and pressure are indeed important in the BL. However, some models show a low optical depth in the BL, making it necessary to find a better representation for optically thin regions. Conclusions. The combination of a high mass and a small radius, characteristic of white dwarfs, can lead to an enormous energy release in the BL, provided the WD rotates slowly. Since the radial extent of BLs is typically very small (about 0.02 to 0.05 R*), this leads to surface temperatures of a few hundred thousand Kelvin. All of our models showed subsonic infall velocities with Mach numbers of <0.4 at most. © ESO, 2013.

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Keywords

Accretion, accretion disks, Binaries:close, Hydrodynamics, Methods: numerical, White dwarfs