

W40a Wind-Disk Interaction in Roche-Lobe Overflowing High-Mass X-ray Binaries

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High-mass X-ray binaries (HMXBs) exhibit two dominant accretion modes: wind-fed accretion in supergiant systems and disk-fed accretion in Be/X-ray binaries and Roche-lobe overflowing (RLOF) systems. While the importance of stellar winds in wind-fed systems is well established, winds could also exert significant dynamical influence in disk-fed HMXBs.

RLOF HMXBs such as Cen X-3 are relatively rare, consisting of a compact object accreting from a supergiant donor. Recent high-resolution X-ray spectroscopy has revealed strong phase-dependent absorption, clumpy structures, and Fe line variability, suggesting that the wind may interact dynamically with the disk. However, no hydrodynamic study has been carried out to investigate the wind-disk interaction in these systems.

In this work, we numerically study this interaction. As a first step, we place an accretion disk around the neutron star and launch a stellar wind from the surface of the supergiant donor. We discuss how the wind ram pressure and its low specific angular momentum modify the outer disk structure, distort the velocity field, and truncate the outer radius. These simulations provide the first quantitative evaluation of wind-driven perturbations on accretion disks fed by RLOF.

This study also serves as a preparatory step toward fully self-consistent simulations that will follow both the RLOF stream and the stellar wind. Such models will allow us to study the competition between wind-fed and RLOF-fed mass supply and to clarify the origin of spectral variability in RLOF HMXBs.