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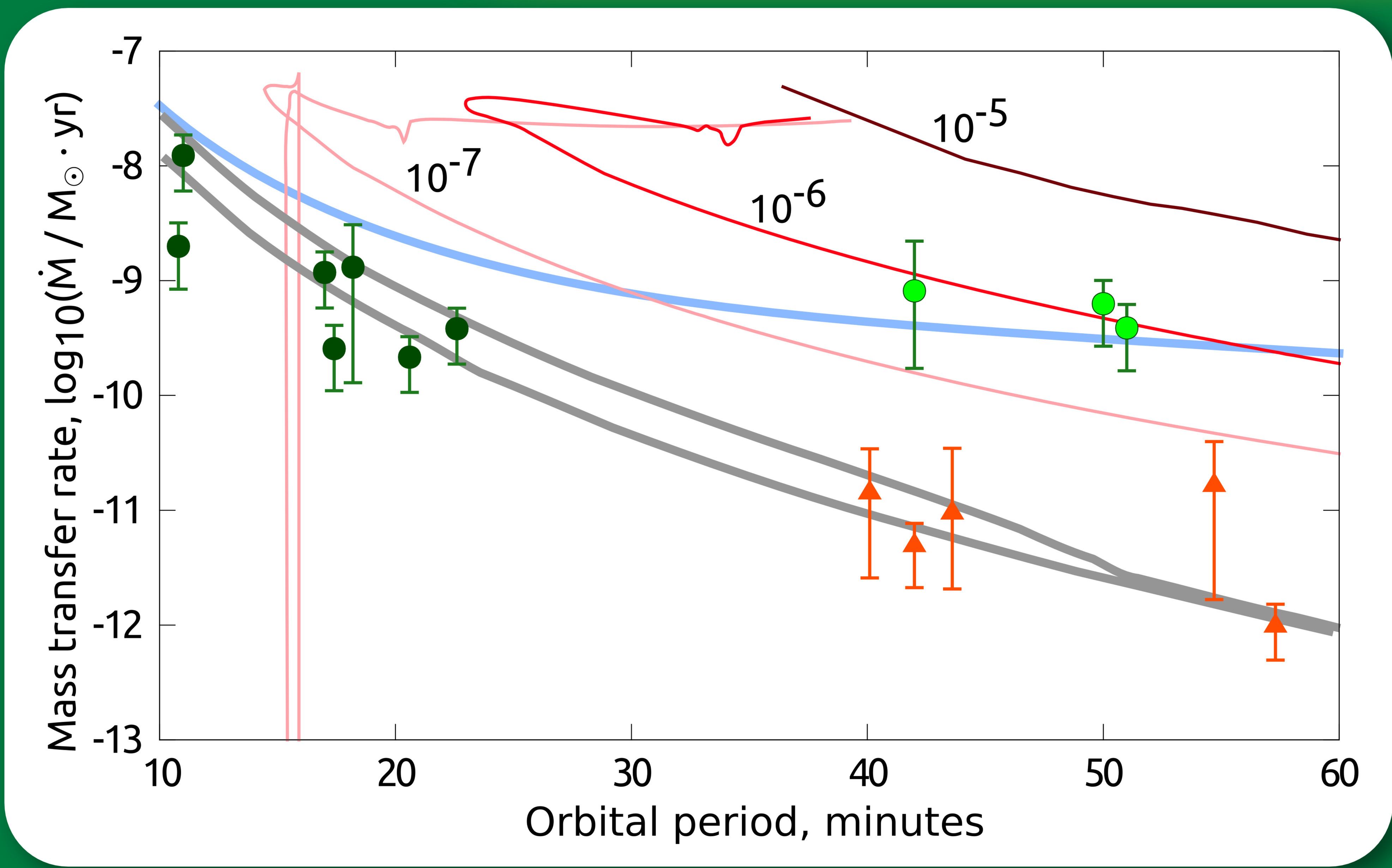
UCXB with high luminosity: a key for a new scenario

Pavlovskii, K.[1]; Ivanova, N.[1]

Ultra-compact X-ray binaries (UCXB) are accreting systems with periods less than 1 hour, which qualifies them to contain a degenerate donor-companion. One would expect such systems to have the easiest theoretical explanations, compared to other possible donors. Nonetheless, so far, theory failed to predict high mass transfer rates in several well observed UCXBs. In this contribution, we explain the puzzle.

4U 1626-67, 4U 0614+09, 4U 1916-053: slow and furious

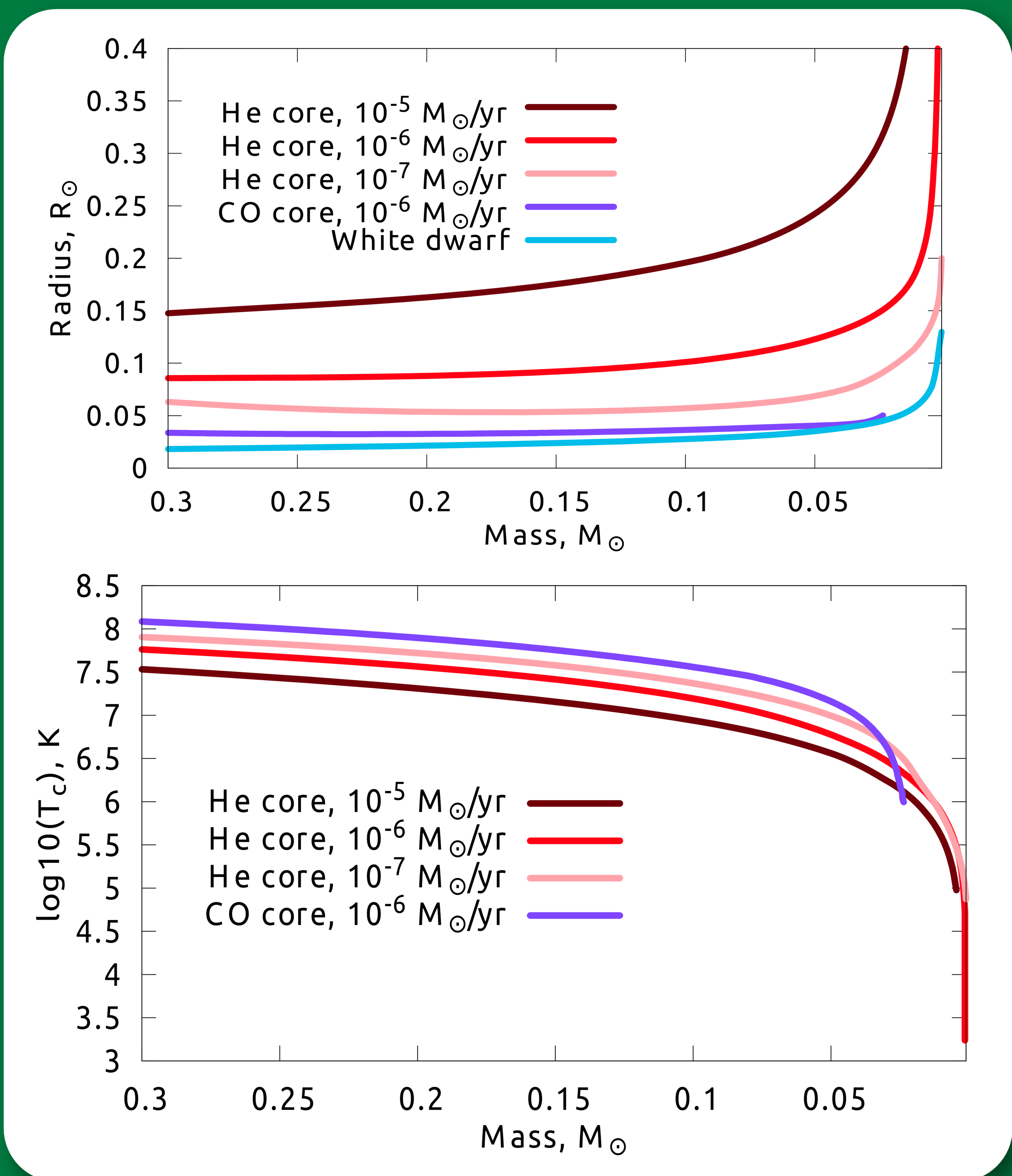


White dwarf (WD) donors have a problem!

- Gravitational wave radiation cannot provide such high MT rate even if WD donor has finite entropy.
- Tidal torque provided by a circumbinary disk (CBD) can provide a strong angular momentum loss that can trigger higher mass transfer rates. However, to explain the observed MT rates, the fraction of mass ending in CBD has to exceed the one predicted by model calibrated on cataclysmic variables (Shao, Y. and Li, X.-D. 2012) by 10 times.

▲Periods and mass transfer rates for UCXBs with different donors and mechanisms of angular momentum loss. Thick lines: partially degenerate WD donors (grey), WD donors evolving under the action of tidal torque (blue). Thin lines: He remnants formed with different mass loss rates indicated on the diagram in units of $M_\odot$/yr that evolve under GW radiation. Observational data for persistent sources are shown with green circles (light green for sources with anomalously high mass transfer rates) and for transient sources with orange triangles.

Partially degenerate He remnant can be inflated enough to reproduce the observed MT rate



▲Radii and central temperatures of He and CO remnants obtained from 5 M☉ star with different rates of mass loss.

A naked He star donor formed in a common envelope (CE) event can be much larger than a white dwarf of the same mass (depending on its final entropy). Evolving under gravitational wave radiation only, such remnant can provide observed mass transfer rates without even invoking a necessity for a CBD.

Observed accretion disk abundances do not necessarily require white dwarf donor

Observed variations in He abundances in accretion disks can be explained by different durations of He core burning that took place in donor before or after the start mass transfer. Depending on the post-CE orbital separation and on the mass and entropy of He remnant, mass transfer can start when the donor either:

1. has not yet started He burning;
2. is going through He burning;
3. has already completed He burning.

In case ❶ (4U 1916-053) the observed accretion disk is nitrogen-rich, in case ❷ (4U 1626-67, 4U 0614+09) it is C/O rich and in case ❸ the donor is less likely to be inflated enough to provide the observed mass

[1] University of Alberta, Dept. of Physics, 11322-89 Ave, Edmonton, AB, T6G 2E7, Canada; e-mail: **nata.ivanova@ualberta.ca**

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