PROPERTIES OF THE MASS STREAM – ACCRETING MATTER INTERACTION IN TWO DOUBLE WHITE DWARFS

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Points of research

We investigate the mass transfer properties at the evolutionary stage after the mass transfer being started, in two Double White White Dwarfs binary stars – CR Boo and V 803 Cen. The interacting processes between the close components have an effect on the established formation.

- AM CVn stars objects: short period binaries; helium-rich accreting material (Podsiadlowski et al. 2003, Solheim 2010);
- The mass transfer is considered to be realized via the Roche-lobe overflow (equations and criteria by March et al. 2004, Nelemans et al. 2001);
- solutions of the mass transfer stability by the dynamical stability criteria.;
- the accretion efficiency of two objects is estimated. The obtained values are very low.

Basic equations

Through the Kepler's law (Frank et al. 2002):

$$4\pi^2 a^3 = G(M_1 + M_2)M_\circ P^2$$

The rate of angular momentum loss (J) of a binary system with a circular orbit due to gravitational wave radiation (GWR) is (Landau & Lifshitz 1971):

$$\left(\frac{\dot{J}}{J}\right)_{GWR} = -\frac{32}{5}\frac{G^3}{c^5}\frac{M_1 M_2(M_1+M_2)}{a^4}$$

The rate of mass transfer driven by GWR (Paczynski 1967, Tutukov & Yungelson 1979):

$$\left(\frac{\dot{M}_2}{M_2}\right) = \left(\frac{\dot{J}}{J}\right)_{GWR} \times \left[\frac{\zeta(M_2)}{2} + \frac{5}{6} - \frac{M_2}{M_1}\right]^{-1}$$

Objects data. Results

Accretion efficiency (η_{acc}):

η_{acc} - expresses the amount of energy gained from matter with mass m, in units of its mass energy.

$$L_{acc} = \frac{GM\dot{M}}{R}$$

CR Boo

DWD, AM CVn

M1 = 0.6 M⊙

M2 = 0.06 M⊙

q= 0.101 (Isogai et al. 2016)

Porb ~ 1500s ~4.7533 x 10^{-5}yr

a = 3.26 x 10^7m

η_{acc} (CR Boo) = 1.68 x 10^{-4} → ~ 0.06%

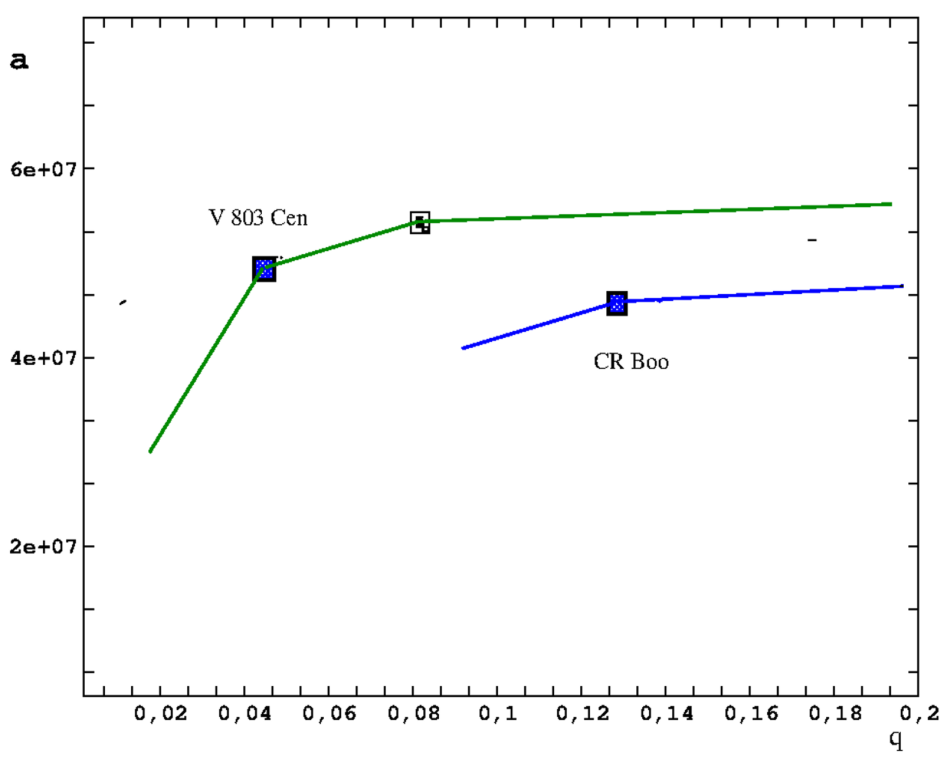


Figure shows the relation between ***q*** (mass ratio) and ***a*** (the distance between objects). The blue squares point the values, at which the direct accretion into the primary is observed, for CR Boo and V 803 Cen. Further changes in ***q*** may lead to the disc formation.

V 803 Cen

DWD, AM CVn, HeCV

M1 = 1.2 M⊙

M2 = 0.02 ÷ 0.05 M⊙

q= 0.03 ÷ 0.041

Porb ~ 1596.4s ~ 5.05 x 10^{-5}yr (Patterson et al. 2000)

a = 5.6 x 10^7m

Accretion efficiency (η_{acc}):

η_{acc} - a useful measure that illustrates the power of accretion as an energy generator (Kolb 2010).

$$L_{acc} = \eta_{acc}\dot{M}c^2$$

η_{acc} (V803 Cen) = 3.37 x 10^{-5} →~0.003%

CR Boo

Stability condition	Q= [1.052 x 10^{-20}] >0
Mass transfer rate	$\dot{M}_2$ = 2.72 x 10^{-9} M⊙ yr^{-1}
Roche lobe	R_L = 6.74 x 10^6

V 803 Cen

Stability condition	Q= [2.105 x 10^{-20}] >0
Mass transfer rate	$\dot{M}_2$= 1.63 x 10^{-8} M⊙ yr^{-1}
Roche lobe	R_L = 7.47 x 10^6

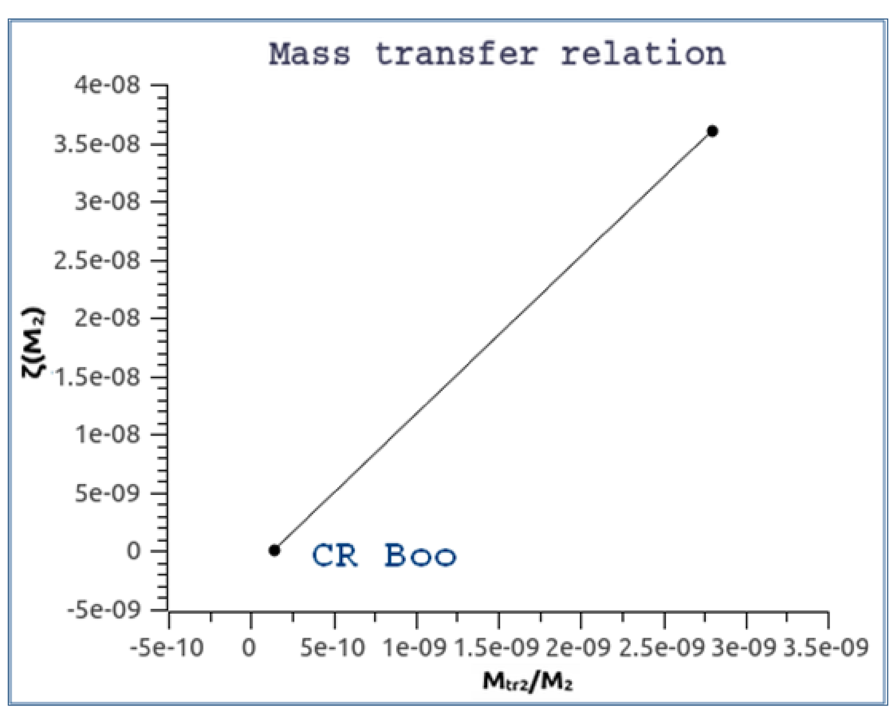
Mass transfer stability criteria:

For the mass transfer to be stable, the term in brackets Q, from eq. 3, must be positive:

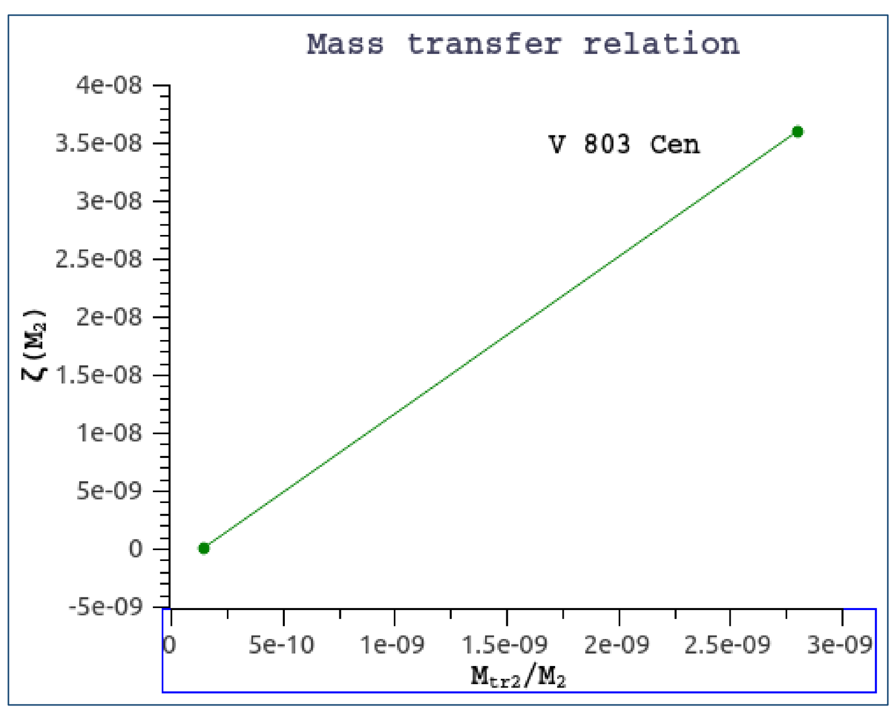
$$\left[\frac{\zeta(M_2)}{2} + \frac{5}{6} - \frac{M_2}{M_1}\right] > 0$$

$$\zeta == \frac{d\ln R_2}{d\ln M_2}$$

CR Boo



V 803 Cen



Further evolutionary path of the objects

at the stable mass transfer:

- R_2 ---> R_L

  $R_{L1} = 0.462a\left(\frac{M_1}{M_1+M_2}\right)$
- M_2 decreases, M_1 increases;
- disc may forms;

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