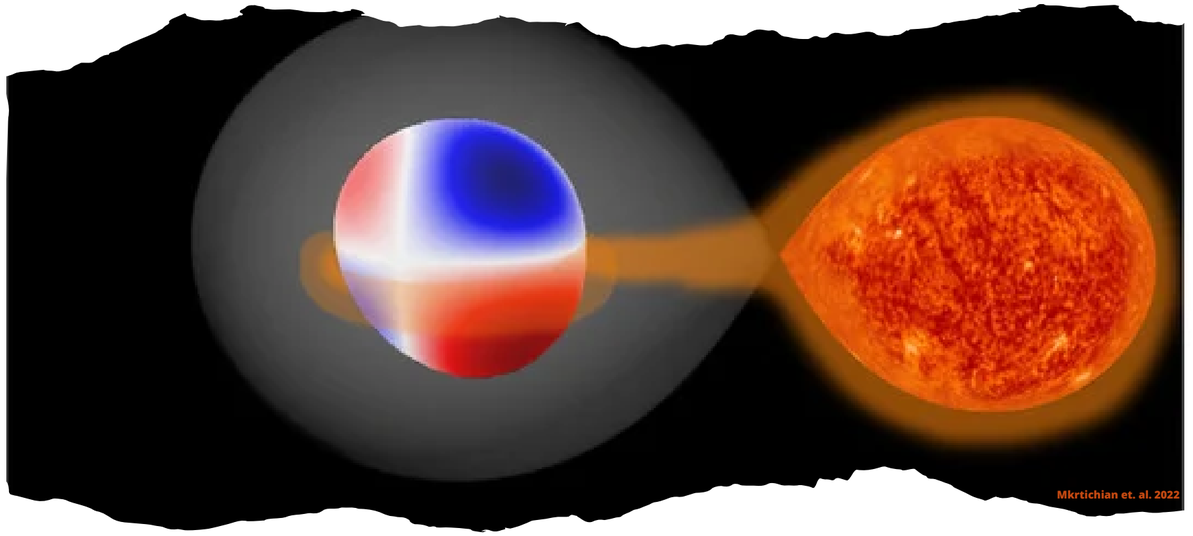
Investigation on possible mass transfer-pulsation relation

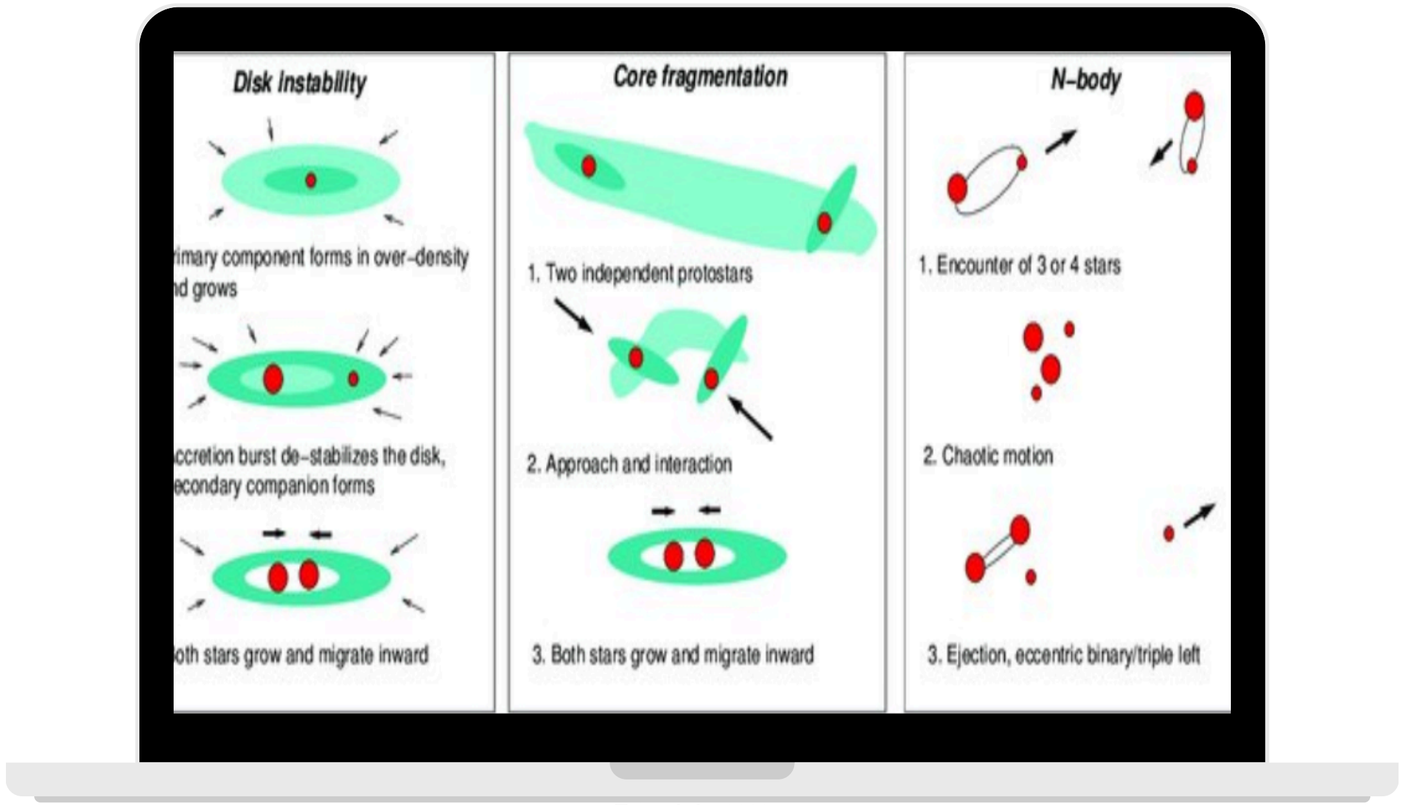


Filiz Kahraman Aliçavuş

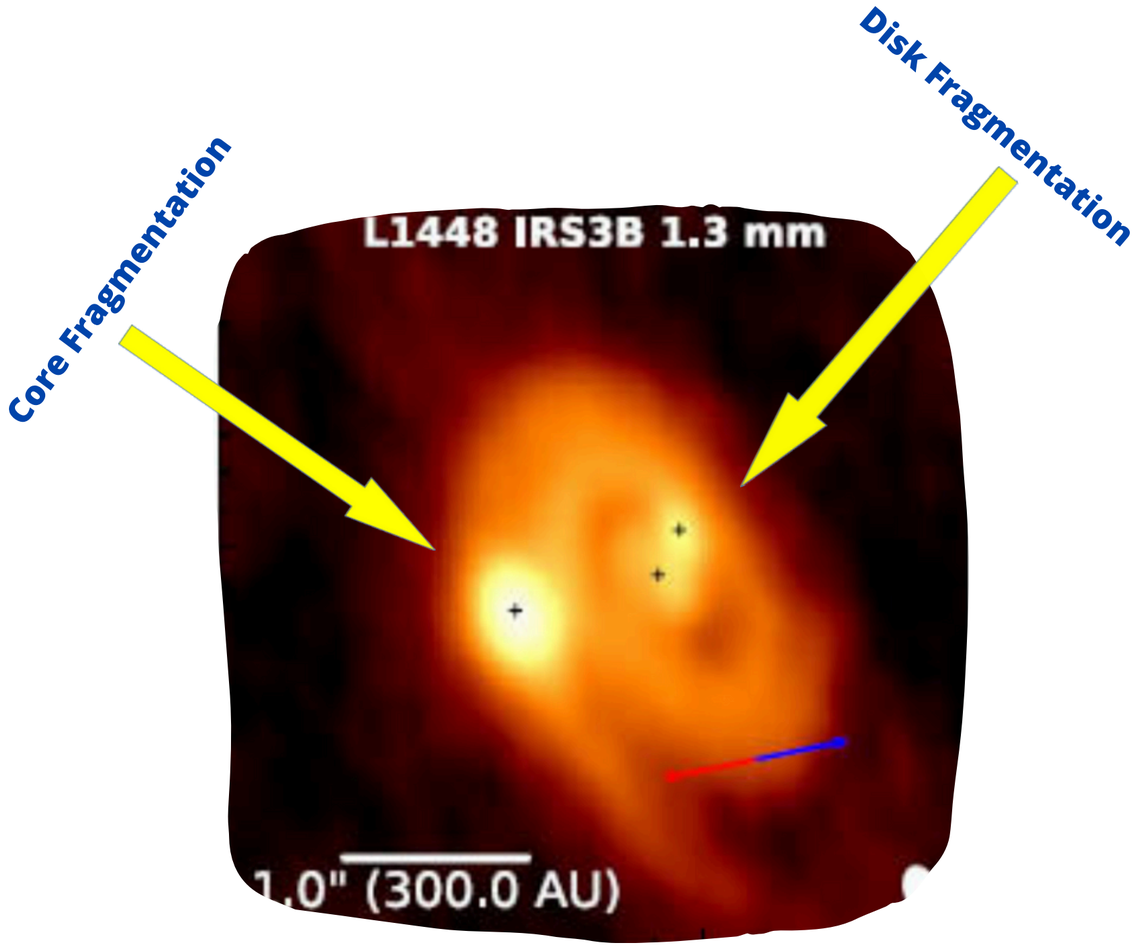
Çanakkale Onsekiz Mart Üniversity, Faculty of Science

2024

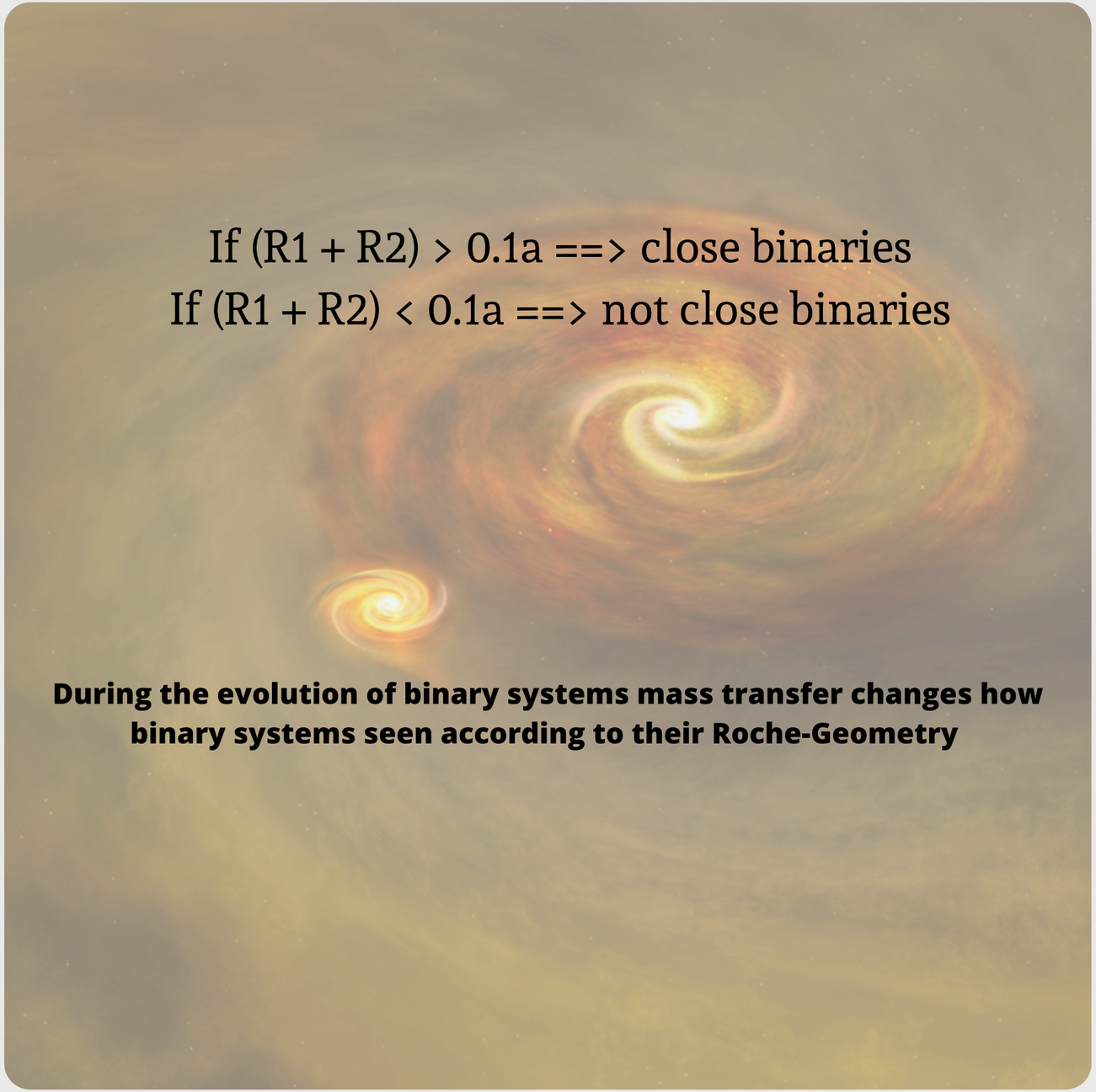
Binary Stars



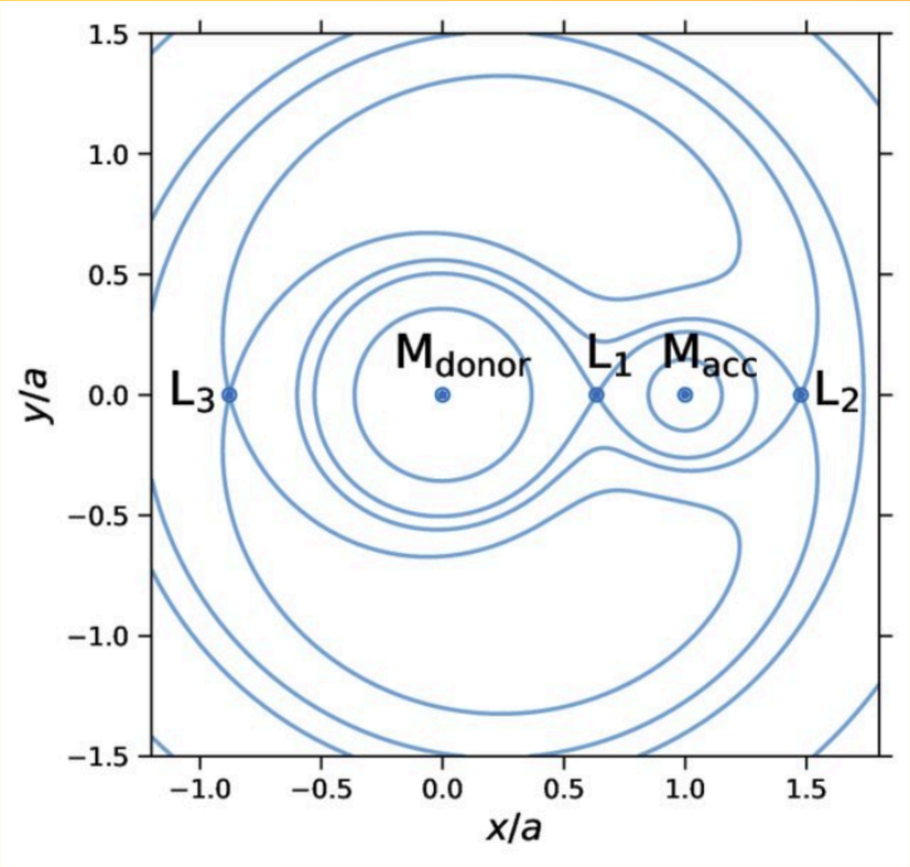
Tokovinin, 2021



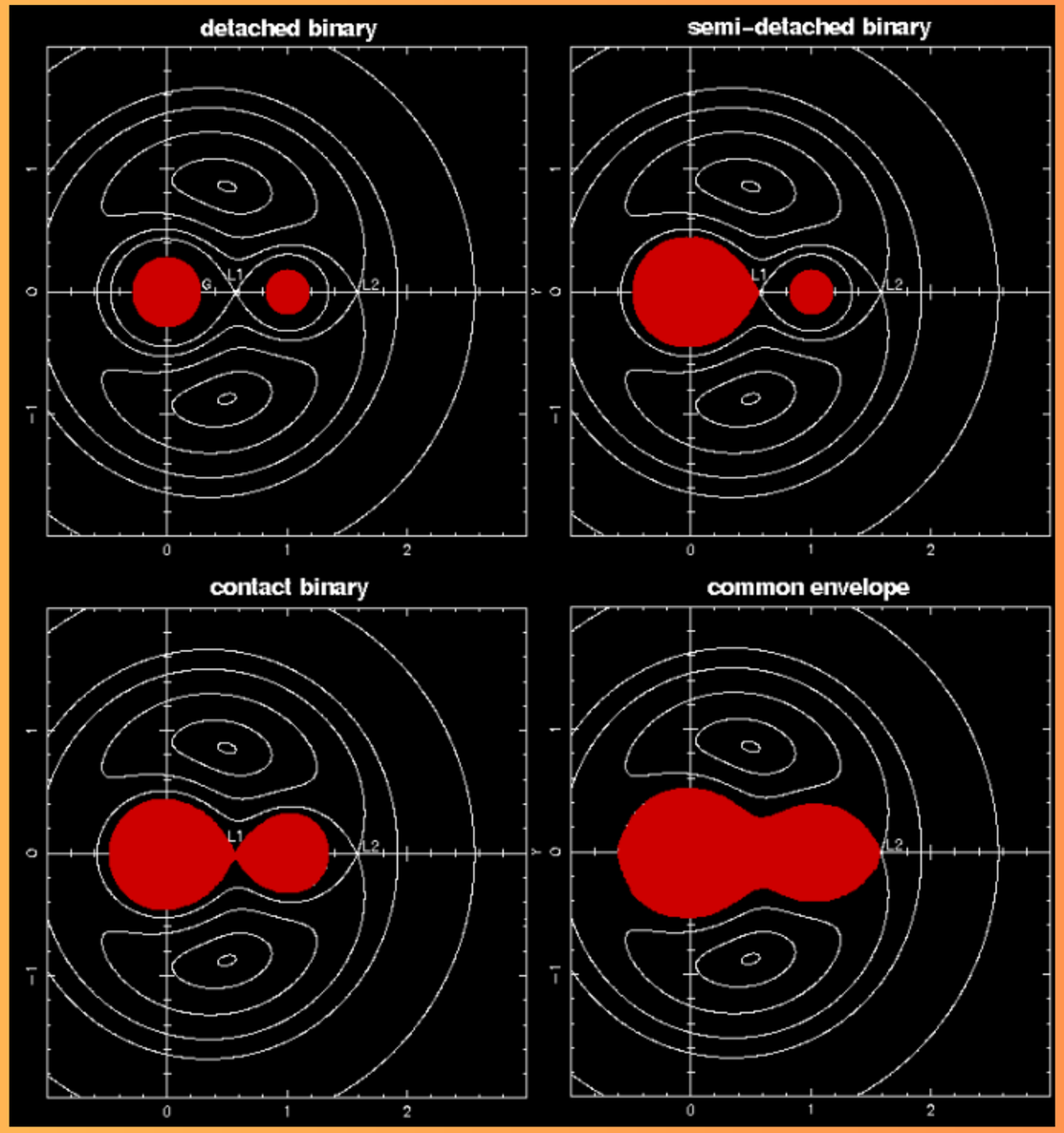
Tobin et al. 2018



Tofflemire, 2016



Equipotential lines of the Roche potential for a binary consisting of stars with mass ratio q = 0.26 and binary separation a. The equipotential lines passing through Lagrangian points L 1 , L 2 , and L 3 are shown (Misra et al., 2020)



http://www.vikdhillon.staff.shef.ac.uk

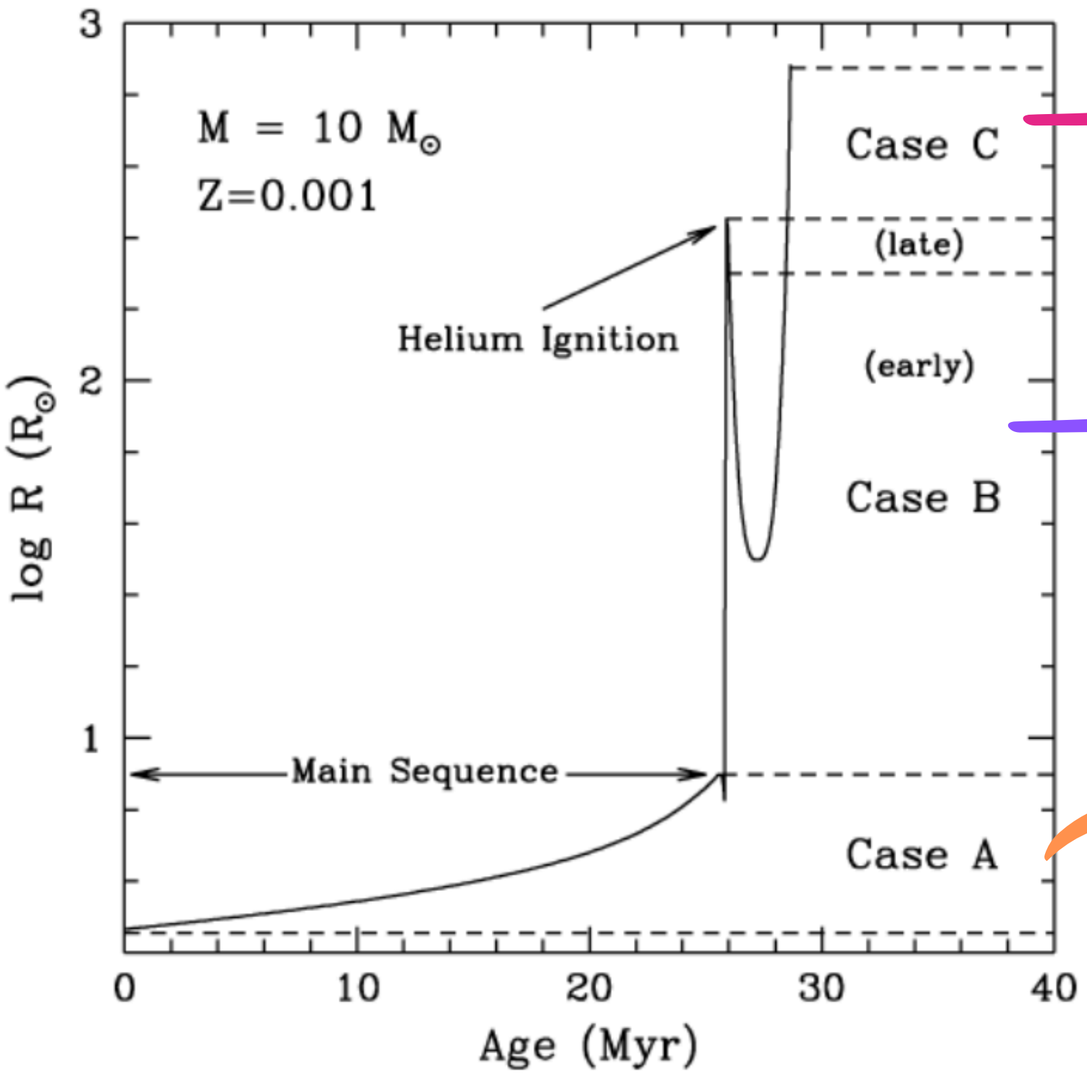
Mass Transfer

Mass transfer can exist

Star expands and fills its Roche-Lobe

Orbit shrinks until Rstar < RL

Orbital evolution, because of magnetic breaking, and so on...



Pfahl et al. 2002

"**Case C:** The initial orbital period exceeds 100 days so that there is sufficient volume for a star to evolve through to the supergiant without hindrance"

"**Case B:** The initial orbital period lies in the range of several days to about 10 days, so that a star will reach its Roche lobe during the rapid transition phase between the main-sequence and red-giant stage. When the mass loss is interrupted by core-helium ignition in the red giant then the mass transfer refers to case B."

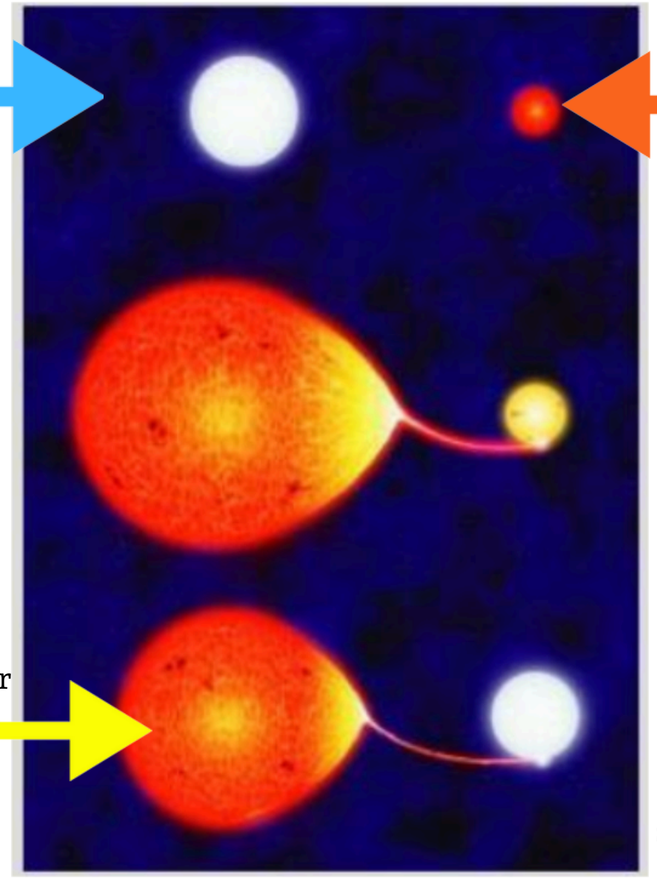
"**Case A:** the initial orbital period is short enough for a star to reach its Roche-lobe at some time during its expansion across the main sequence as a normal core hydrogen-burning star."

Hilditch, 2012

Algols

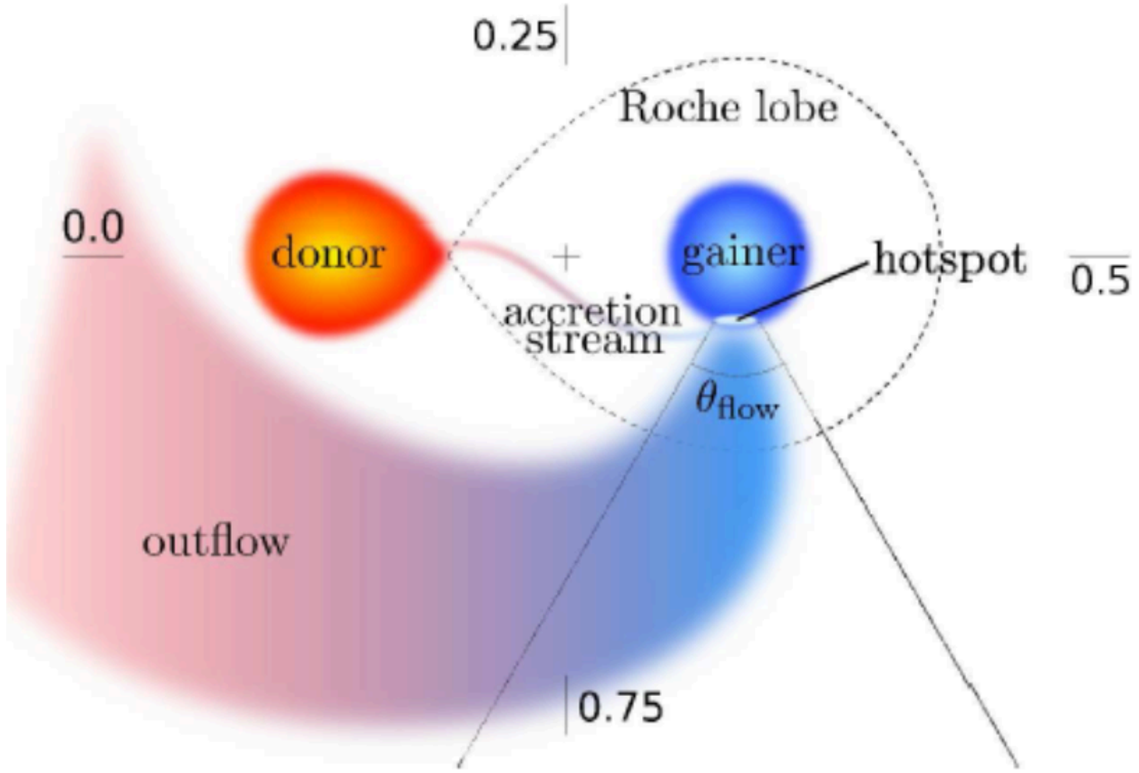
Initially massive star

Initially less massive star



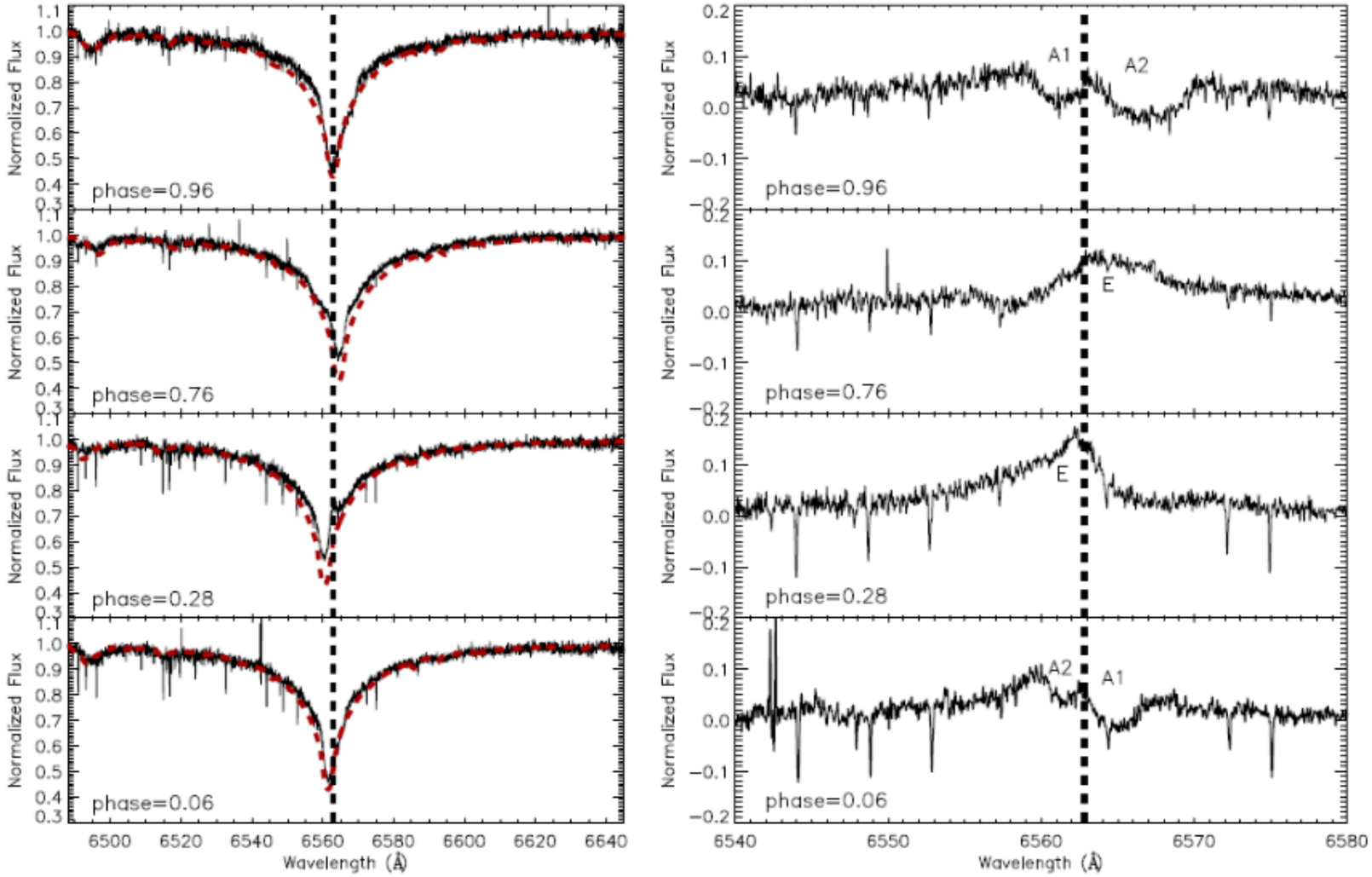
At the end massive star becomes less massive but more evolved.

Short period, semi-detached binary system wih a main-sequence B-A type star and less massive evolved companion which transfers mass onto massive star



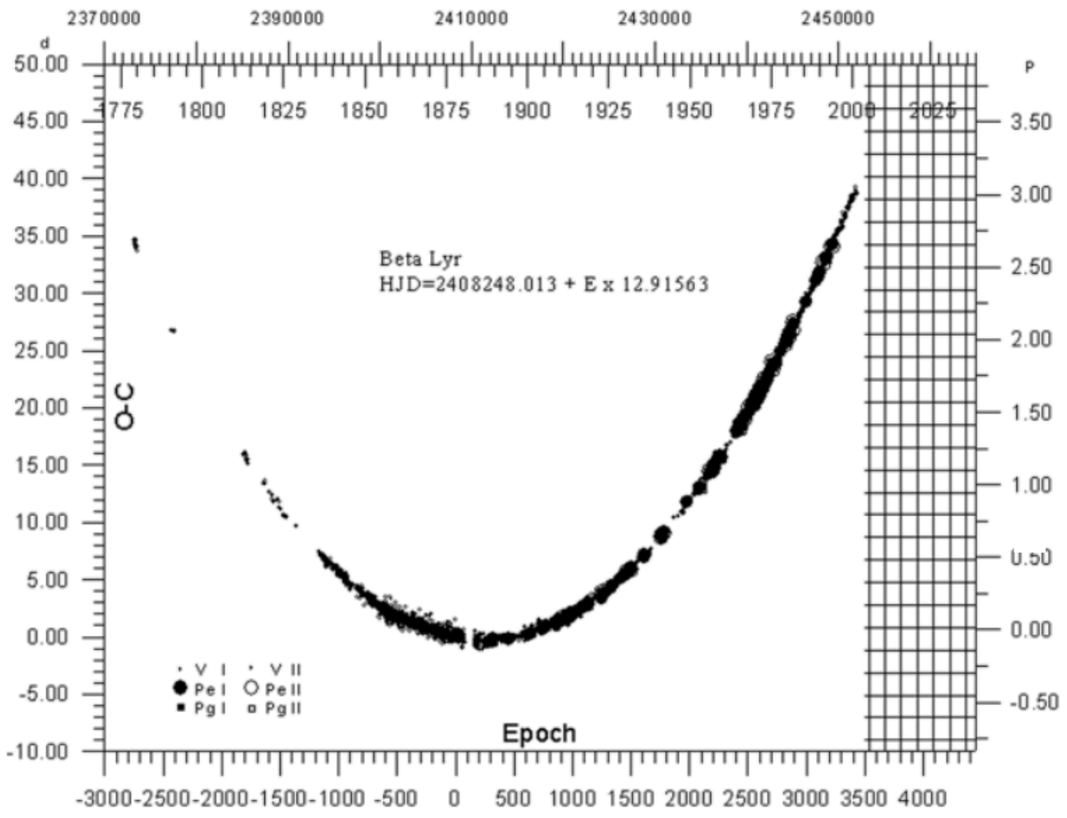
Algol: Mass transfer

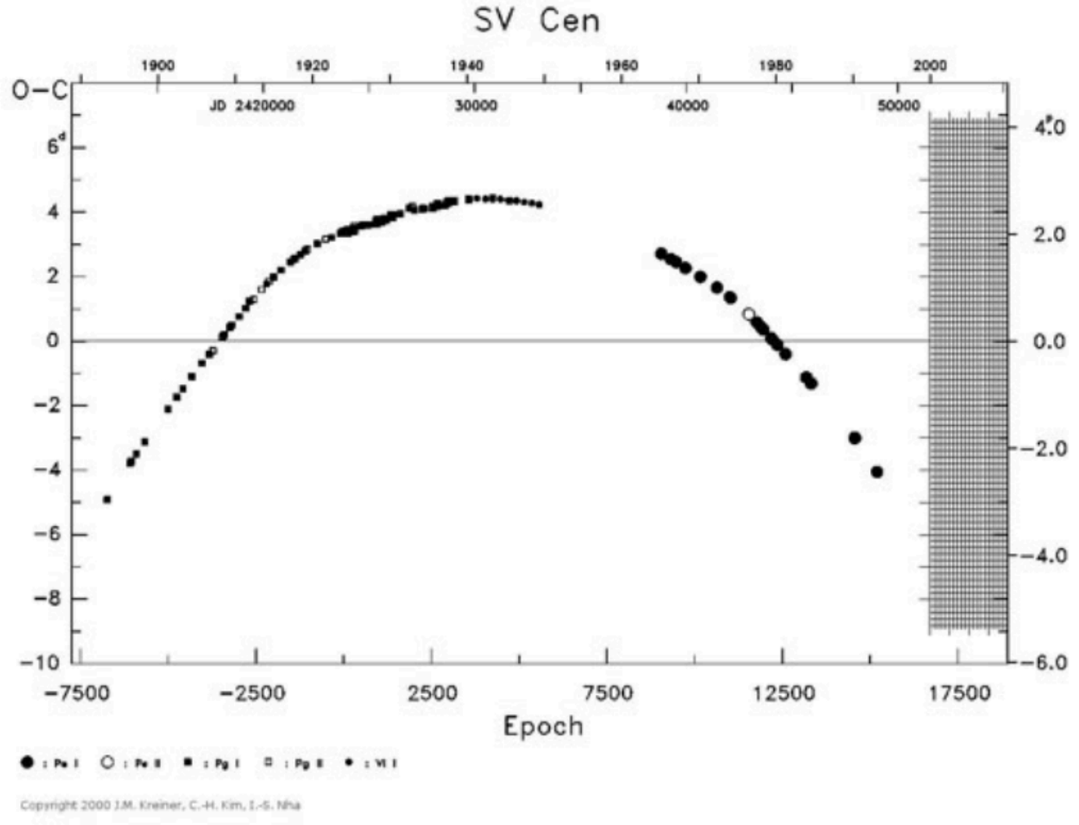
Effect of Mass transfer



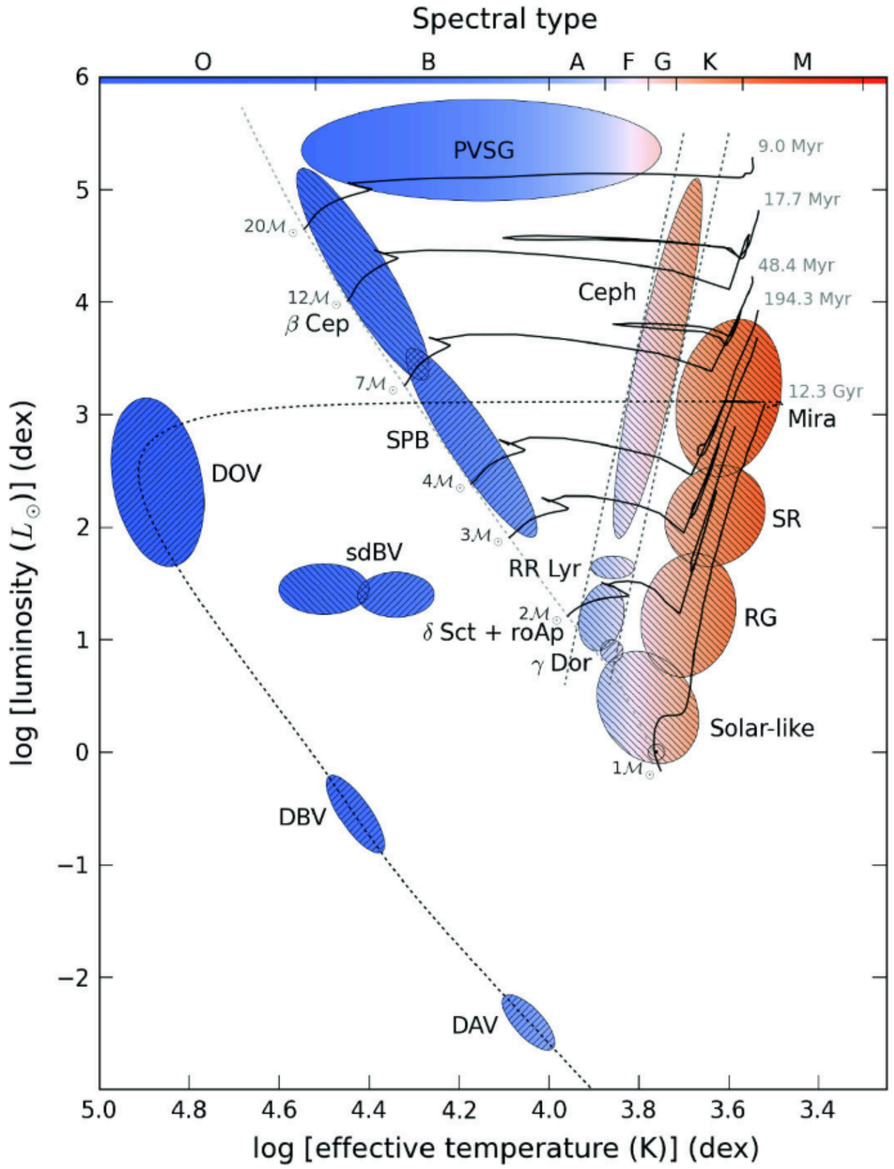
Kahraman Alicavus et al. 2021

Effect of Mass transfer



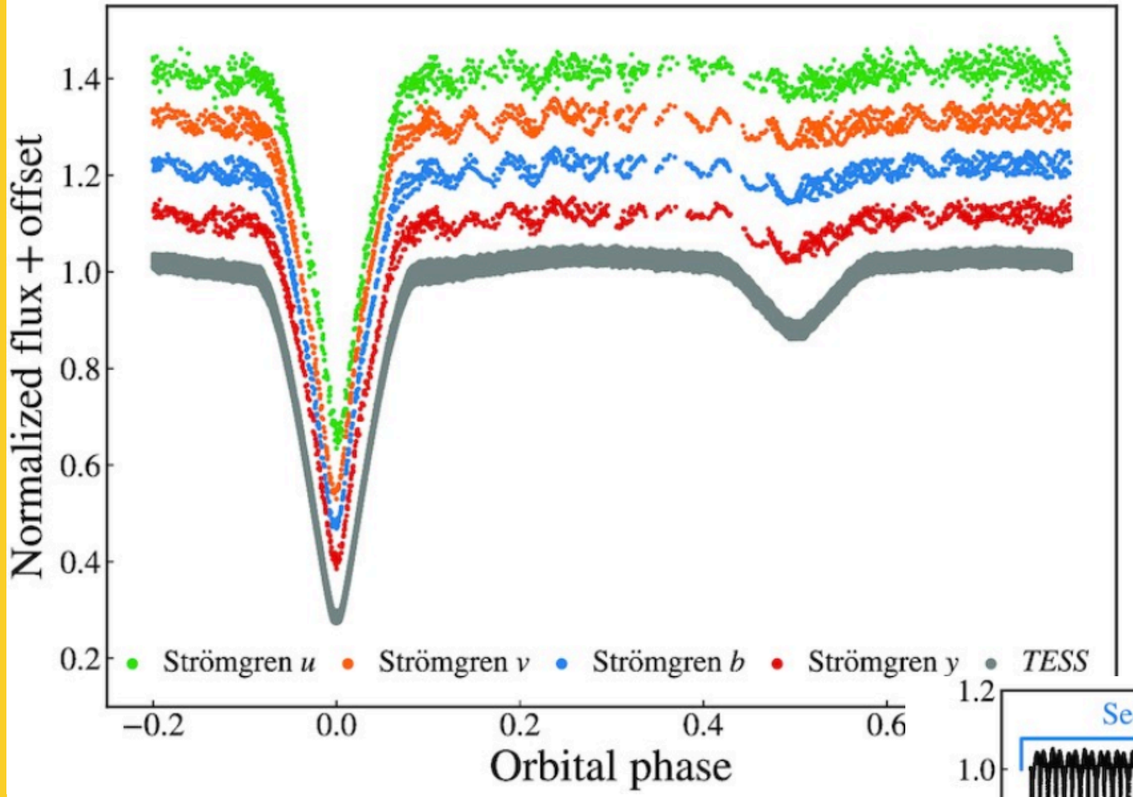


Pulsating Algols



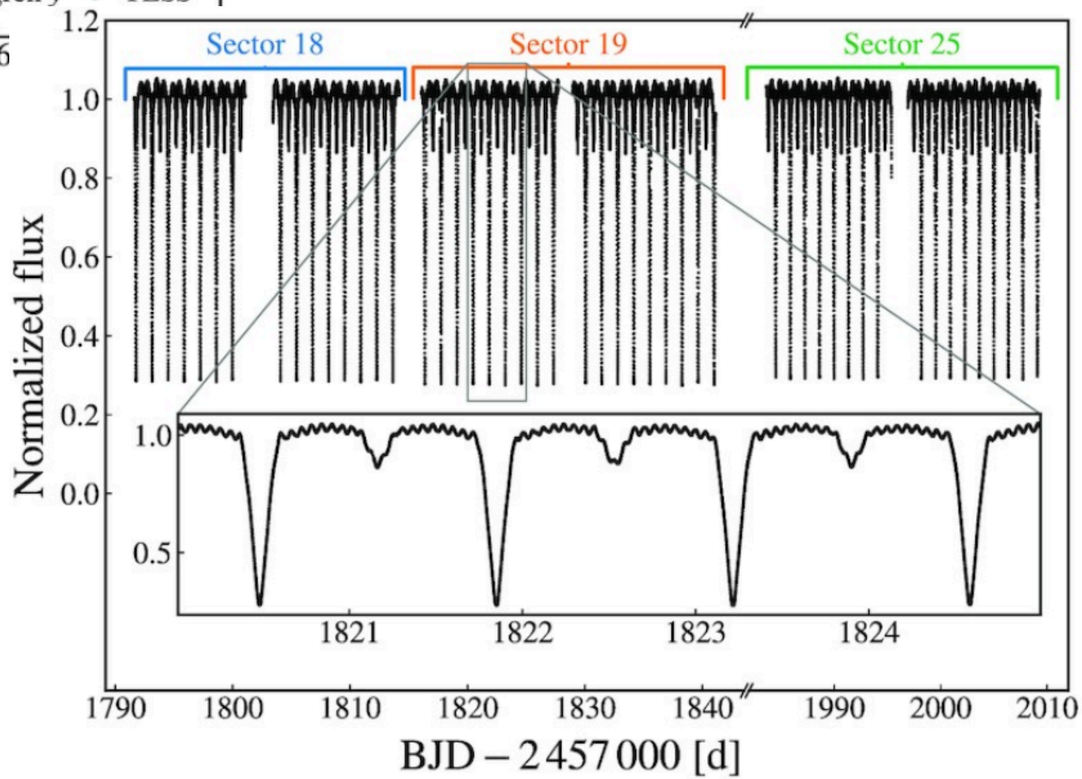
Bowman et. al. 2017

Pulsating Algols



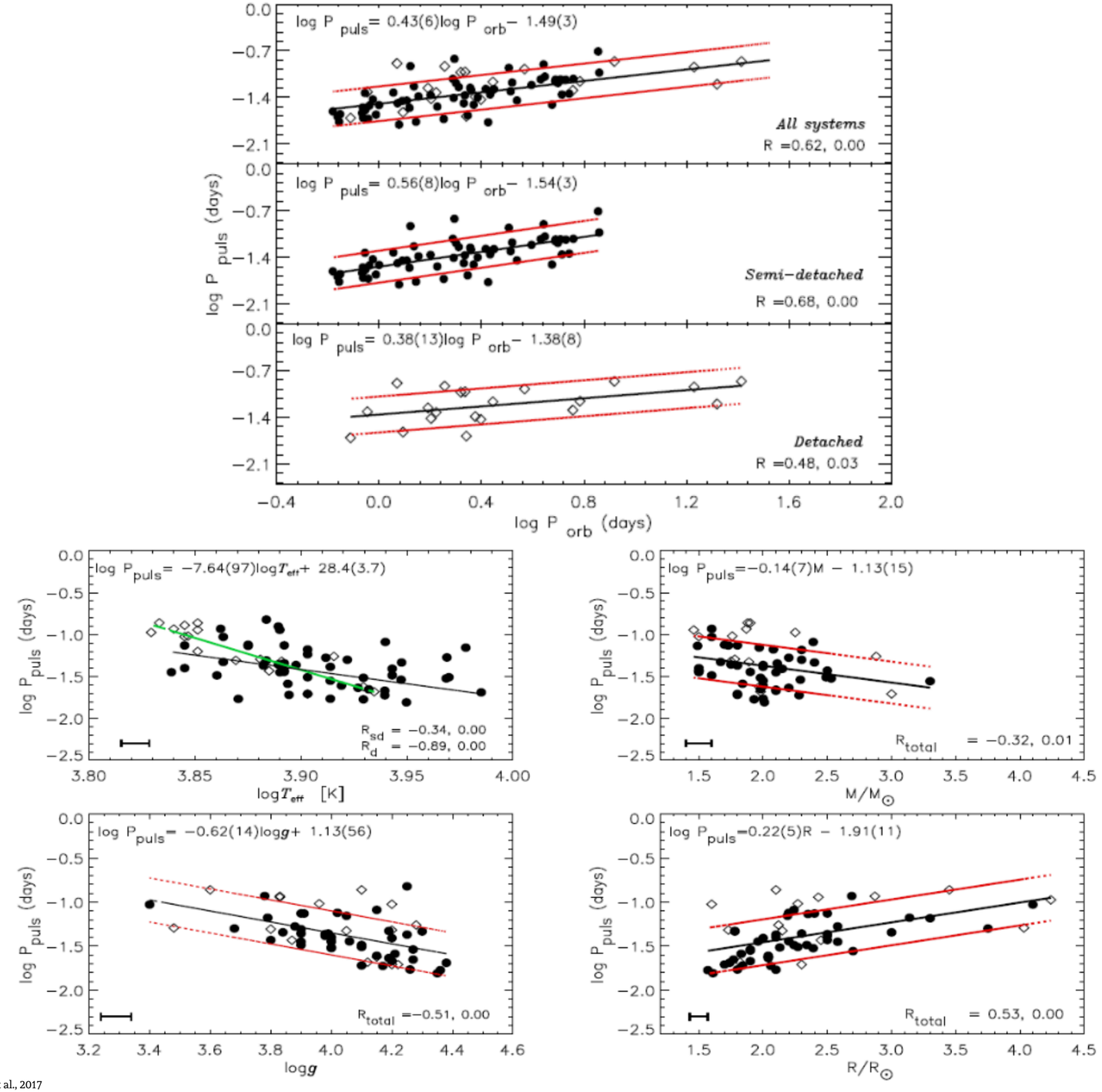
AB Cas

(Tempesti, 1971)



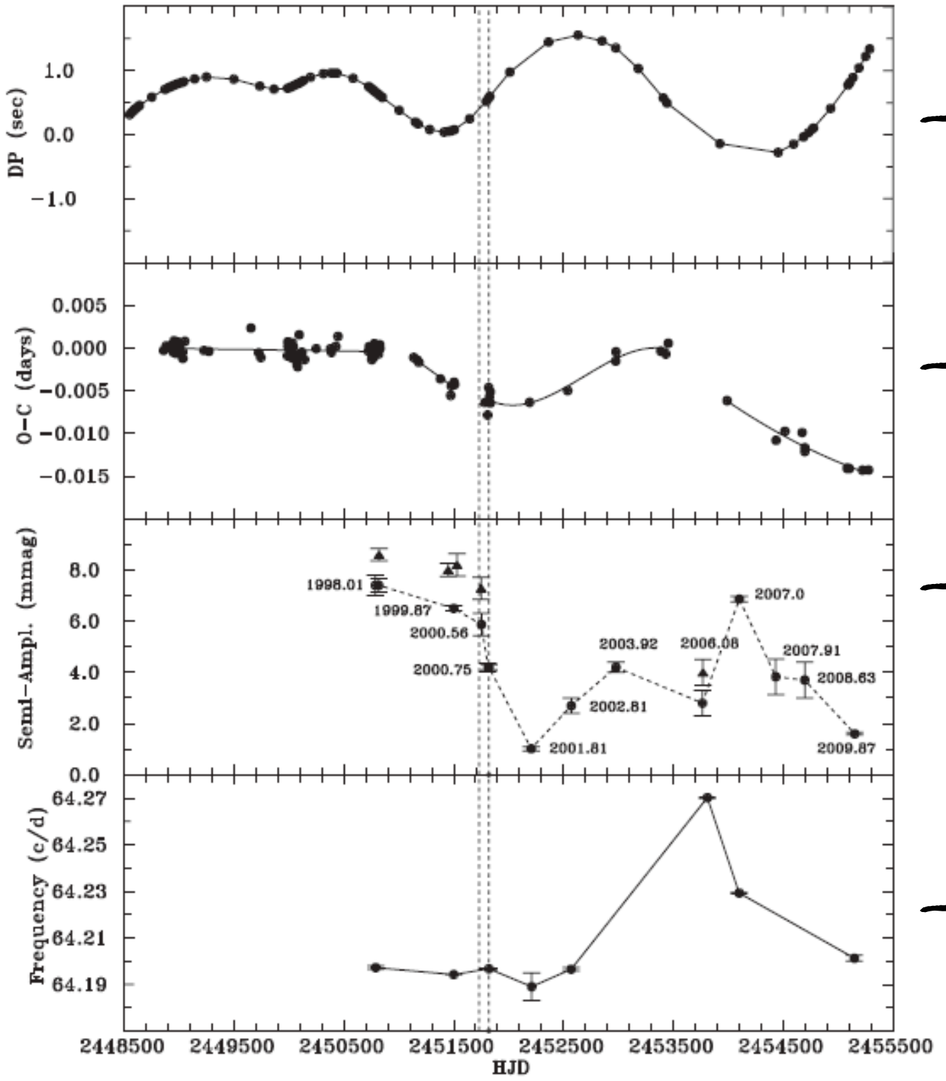
Miszuda et al. 2022

Delta Scuti type pulsations in Algols and other binaries



Kahraman Alicavus et al., 2017

Mass transfer effect on pulsations



→ Variations of the orbital period

→ O–C times of minima

→ Pulsation amplitudes in the B (filled triangles) and V, y (filled circles) bandpasses

→ The frequency variations of the principal oscillation mode

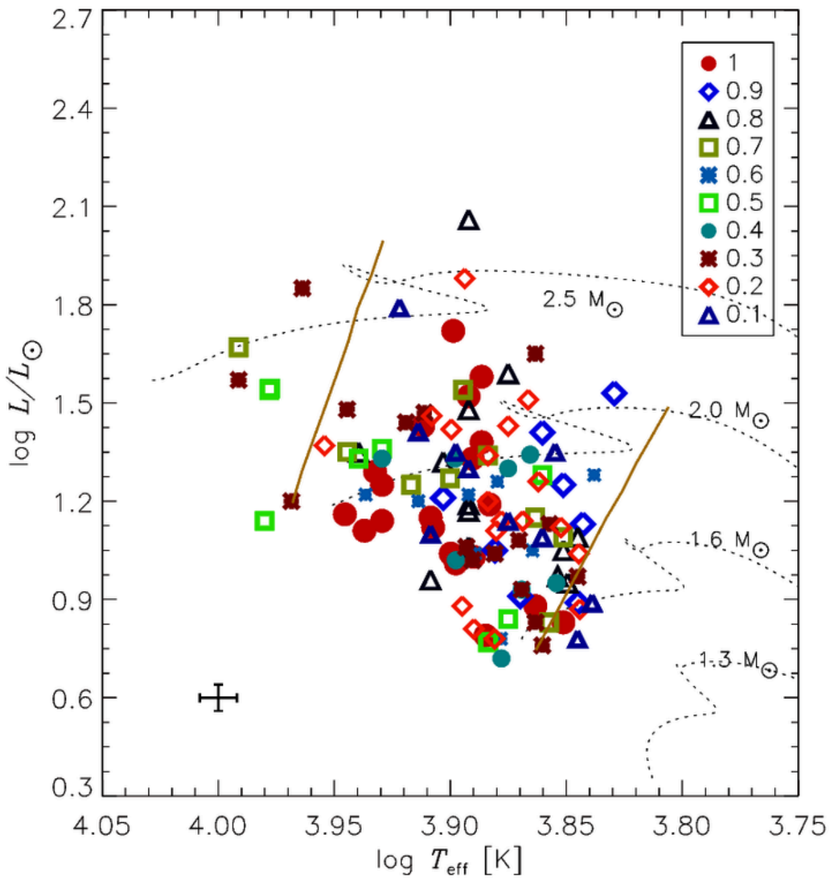
Mkrtichian et al., 2018

Our Investigations

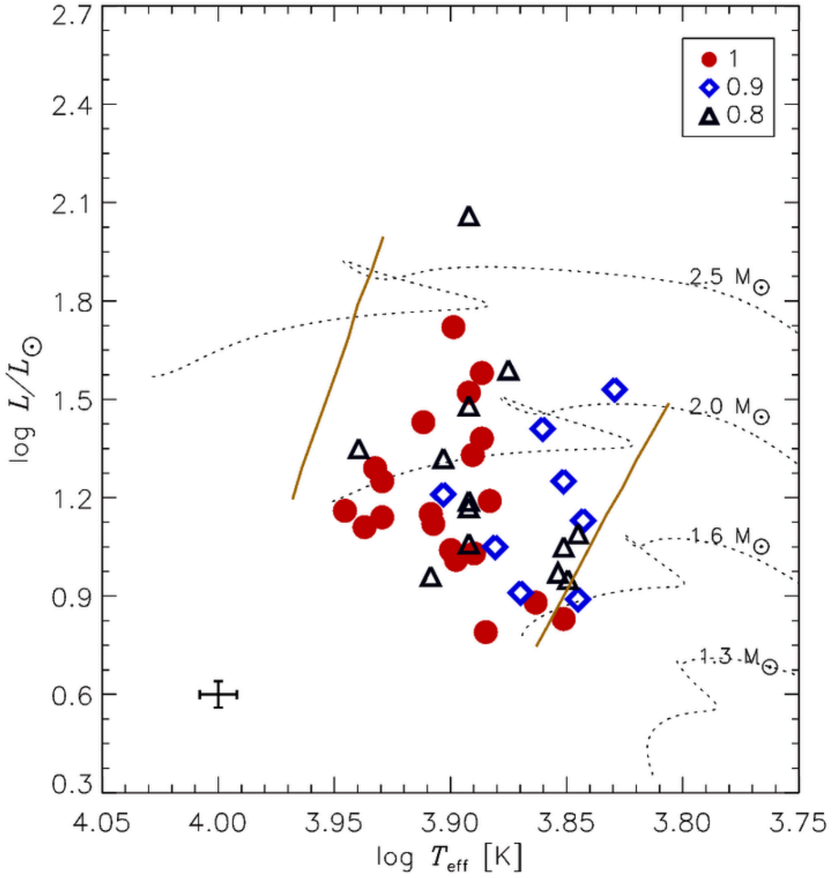
- We collected around 420 Eclipsing binaries containing at least one Delta Scuti component (232 detached, 174 semi-detached)
- Give a sensitivity factor by asking the following questions

1. Is there Radial velocity solution?
2. Were Teff values determined with a spectral analysis (such as disentangling)? We consider SED analysis as well.
3. Does the system have binary modelling with Space-based data?

Our Investigations

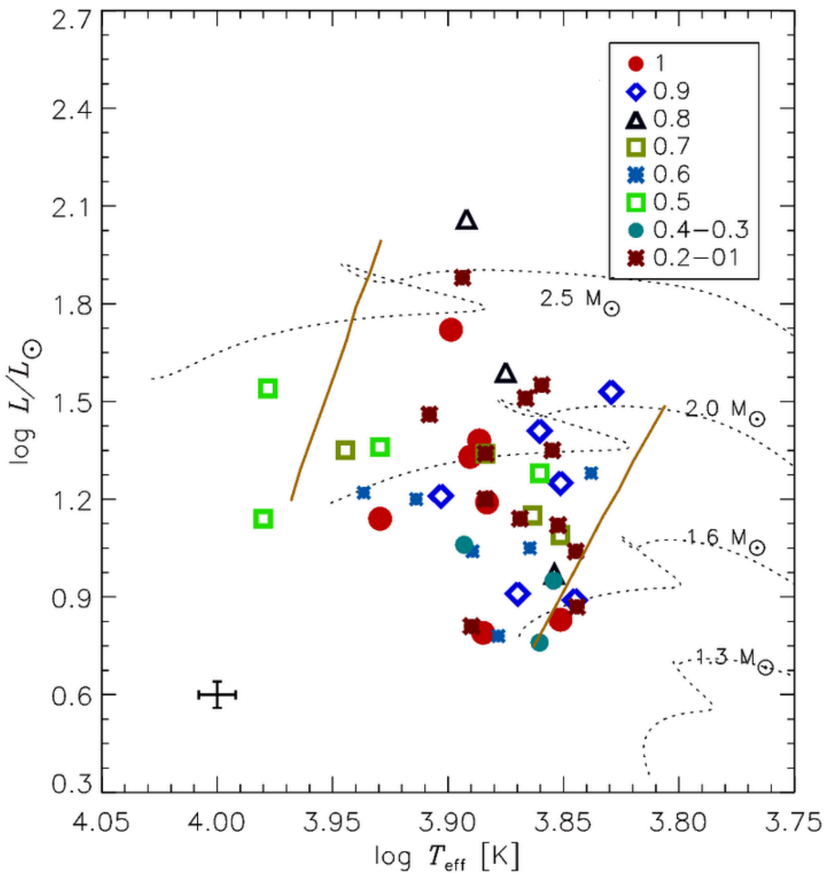


All systems

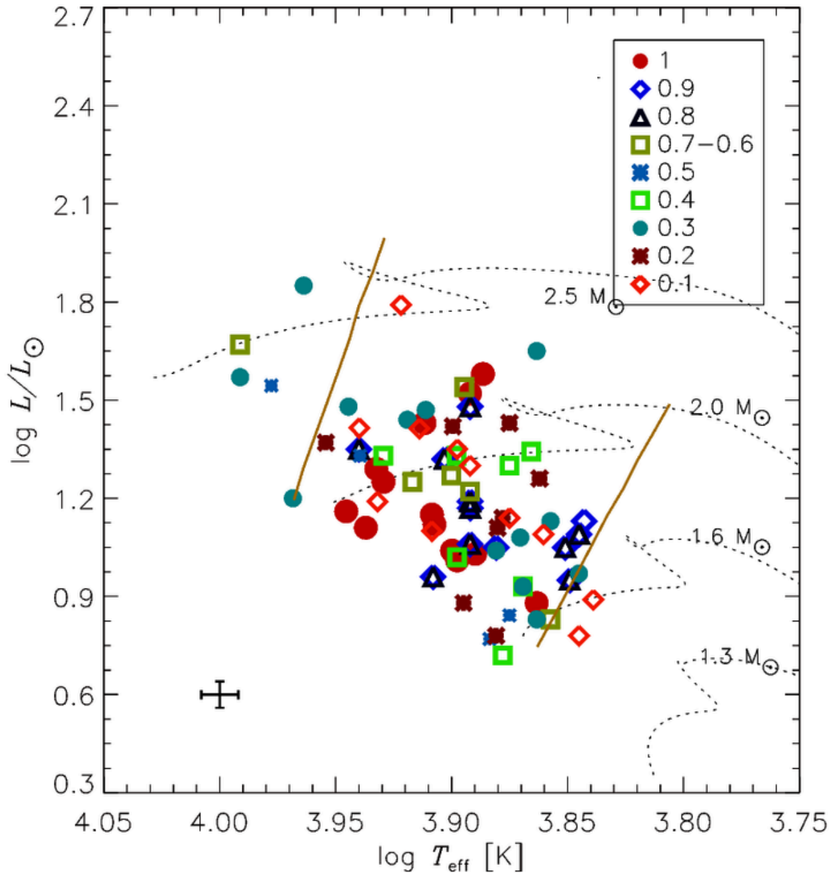


The systems have sensitivity factor over 0.8

Our Investigations

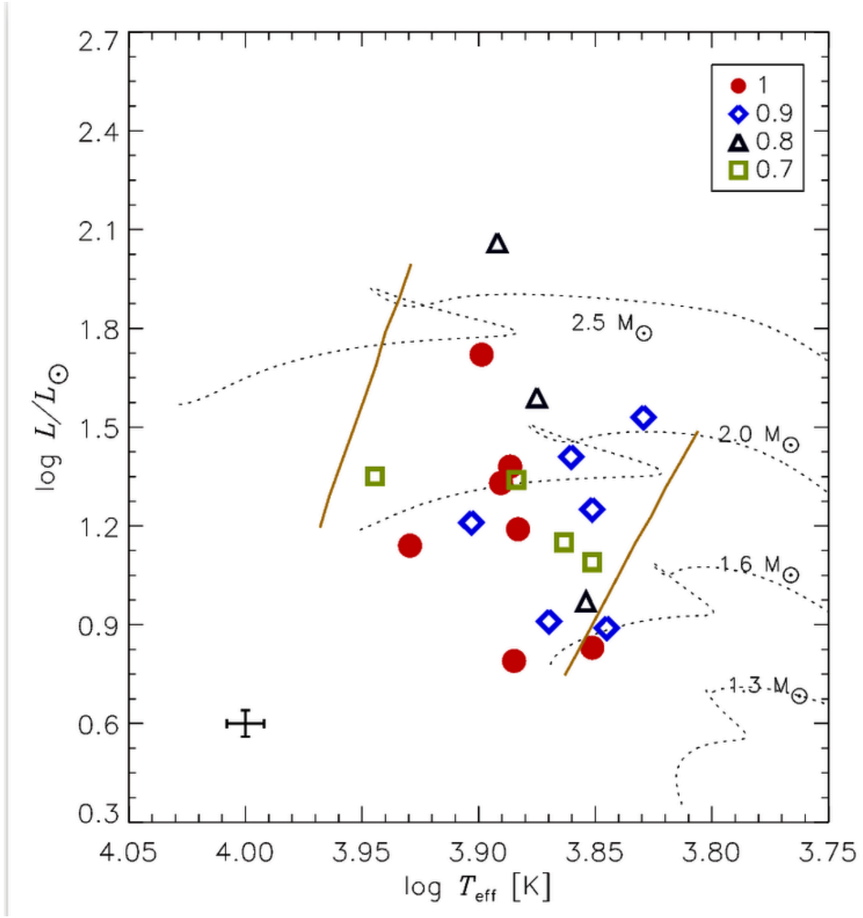


Detached systems

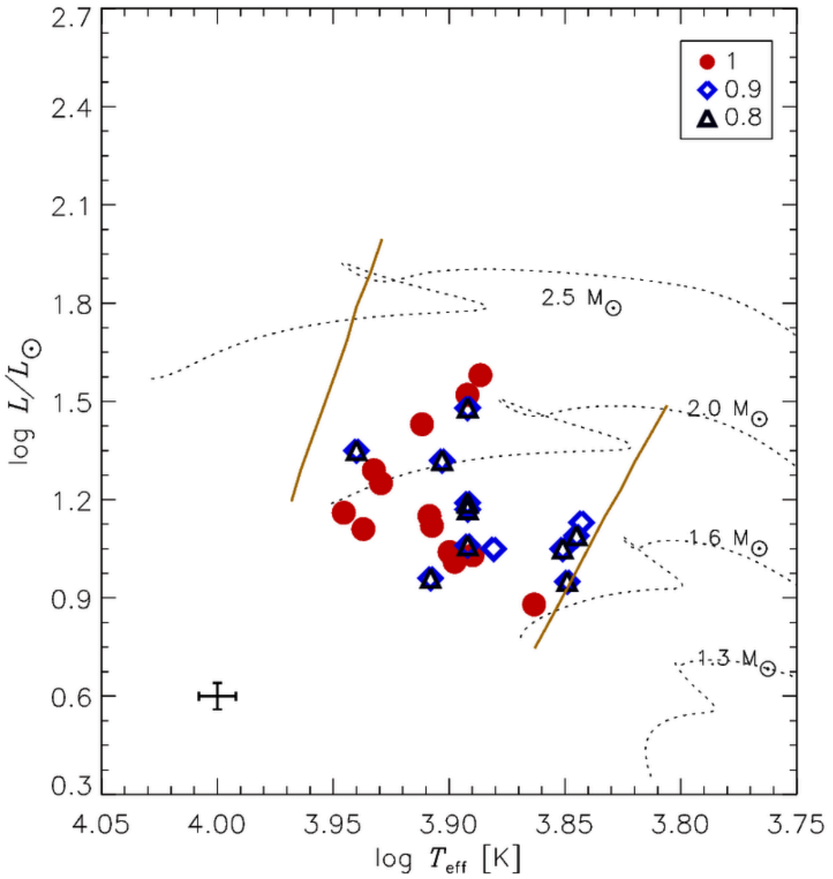


Semi-detached systems

Our Investigations



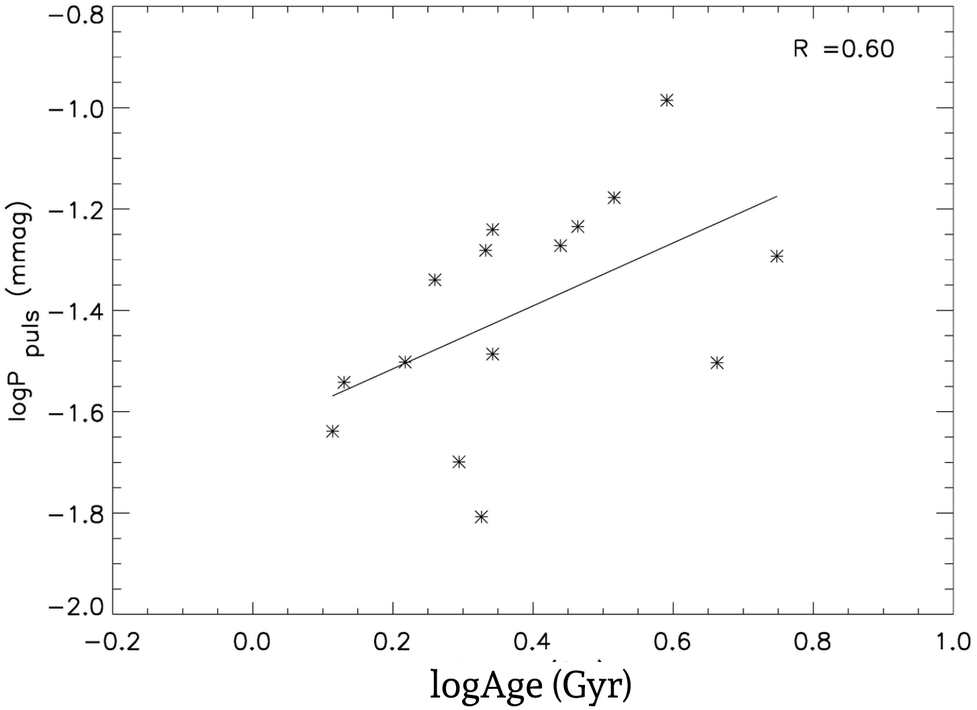
Detached systems

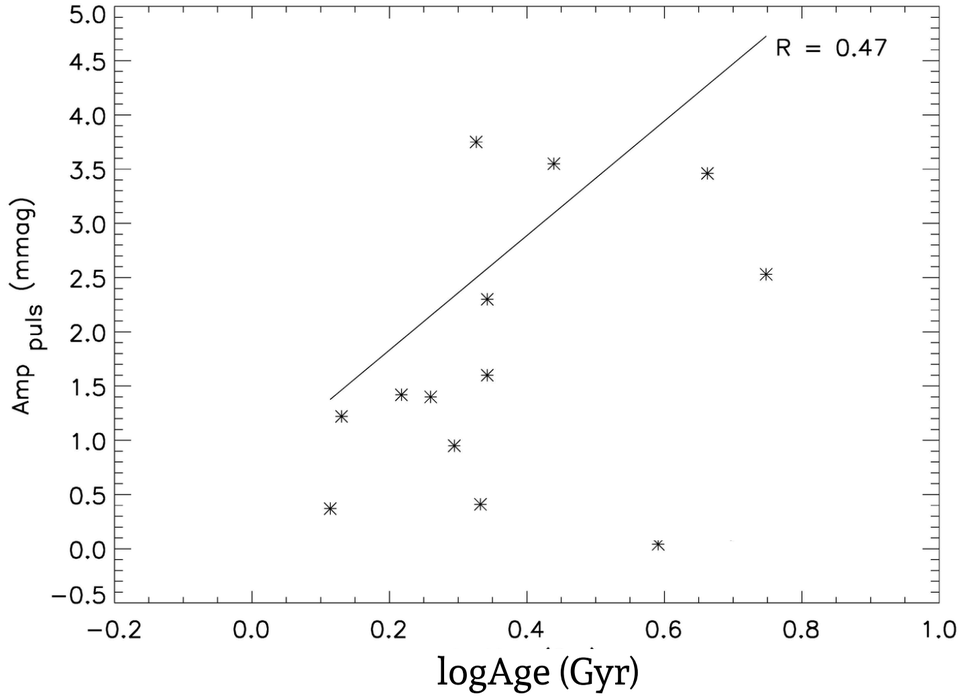


Semi-detached systems

Our Investigations

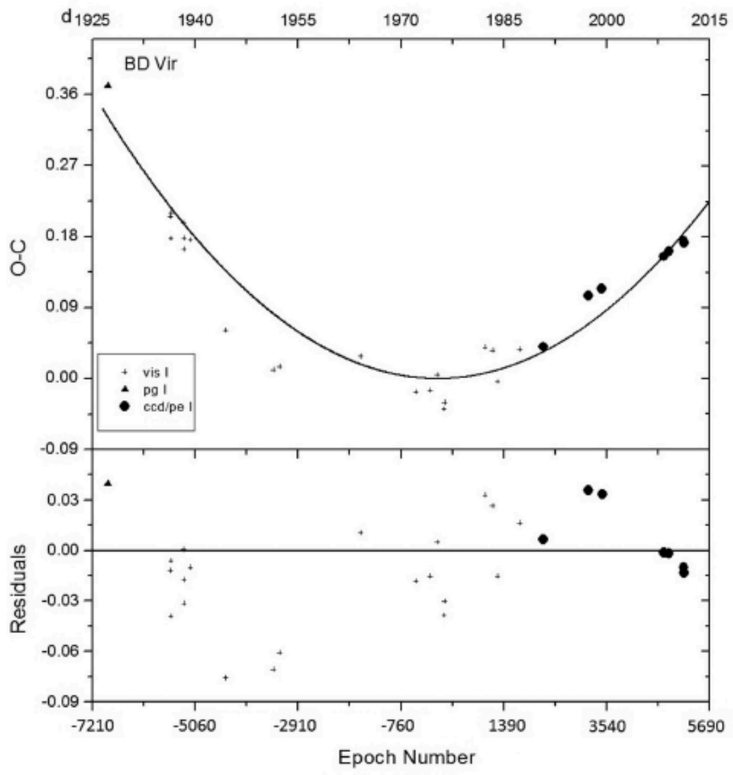
Semi-detached systems

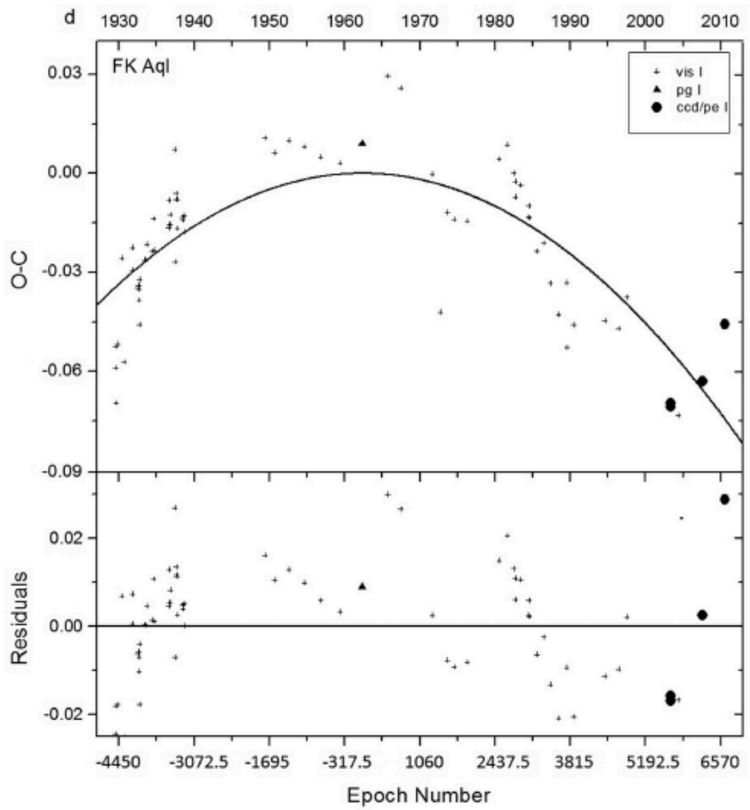




“Modules for Experiments in Stellar Astrophysics (MESA)” binary module (Paxton vd. 2013; 2015)

How can we see the effect of mass-transfer ?





$$\frac{\dot{P}}{P} = \frac{3(M_2 - M_1)}{M_1 M_2}\dot{M}_2$$

(i) If non-conservative mass transfer is the dominant mechanism and then the orbital period of the binary system increases,

$$\beta > \frac{c_1}{c_1+c_2}.$$

(ii) If mass-loss from the system is the dominant mechanism and then the orbital period of the binary system decreases,

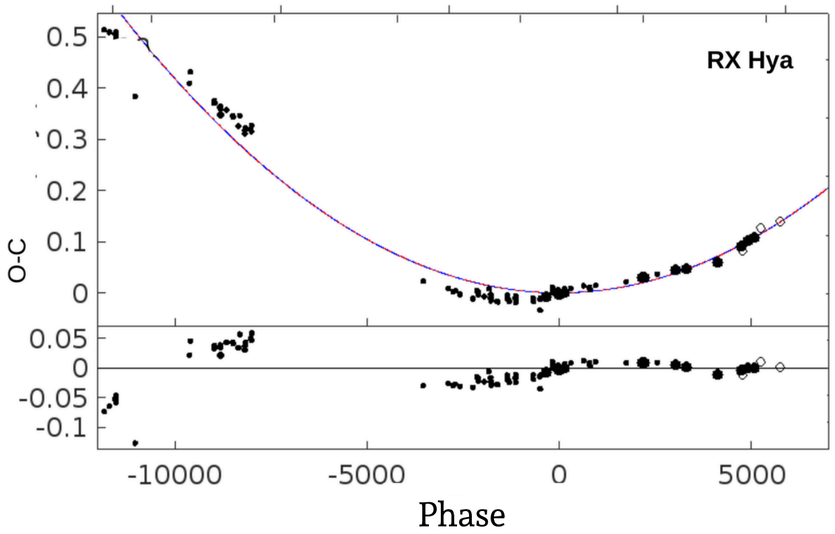
$$\beta < \frac{c_1}{c_1+c_2}.$$

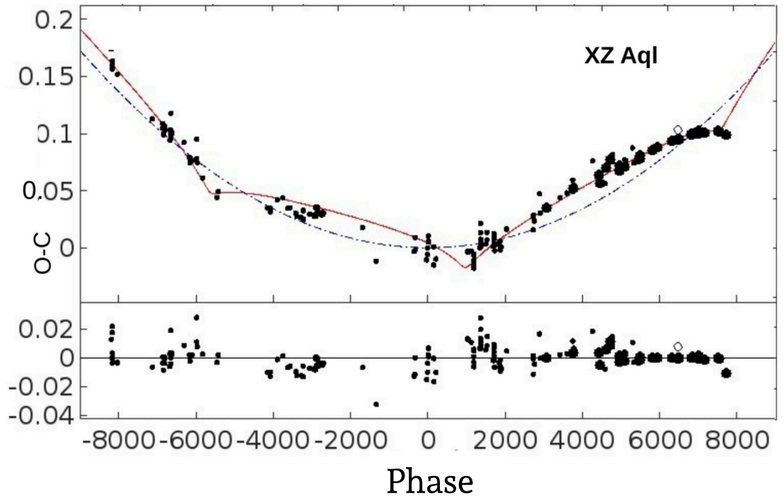
Erdem & Oztürk, 2014

We searched for Algols including Delta Scuti variables
and exhibiting positive parabolic variation
in its O-C diagram

Found only 17 systems

O-C Analysis

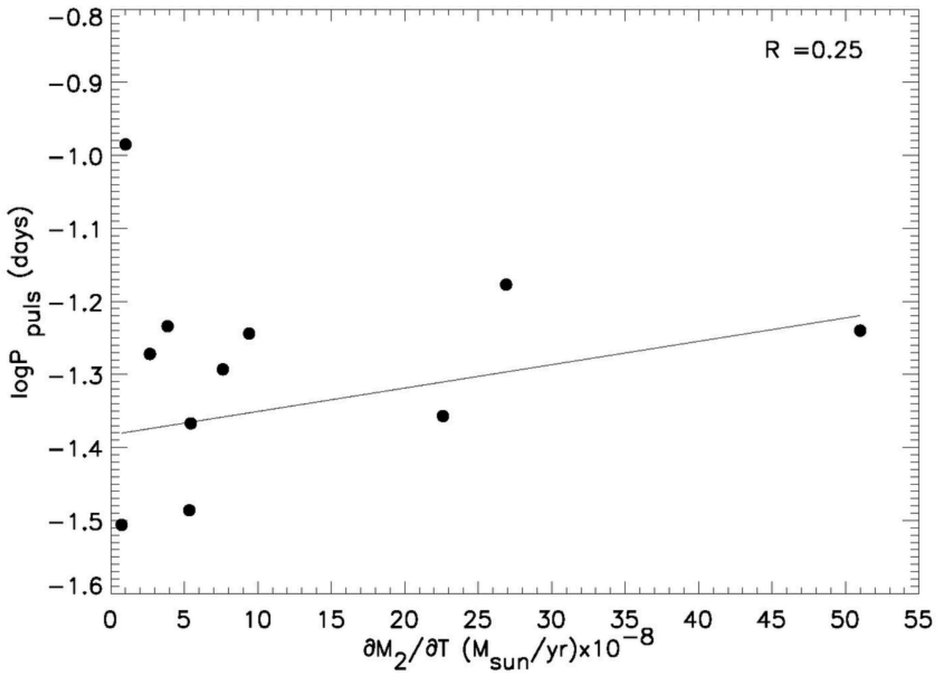


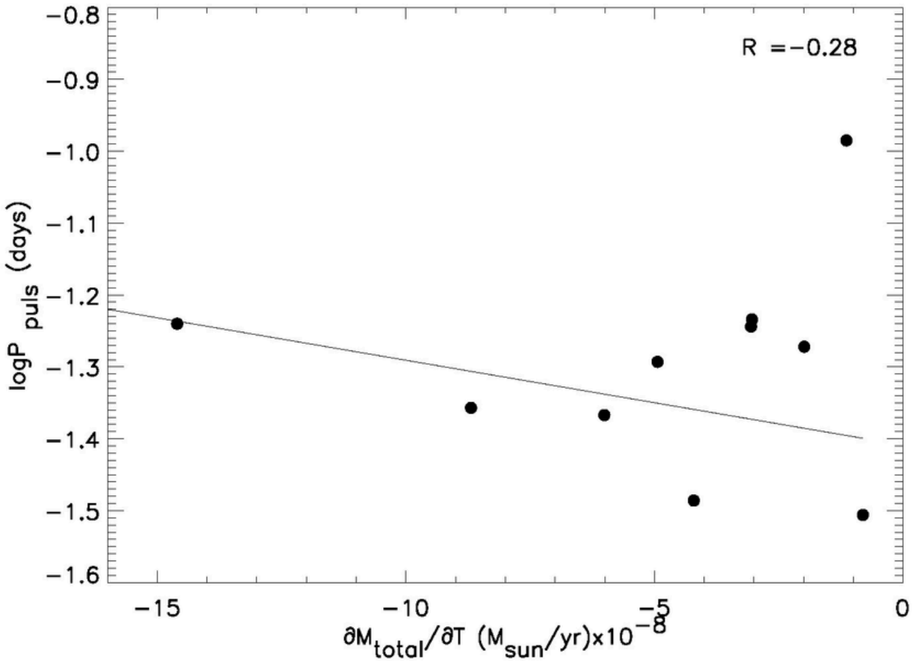


Data taken from O-C Gateway, Paschke & Brat, 2006

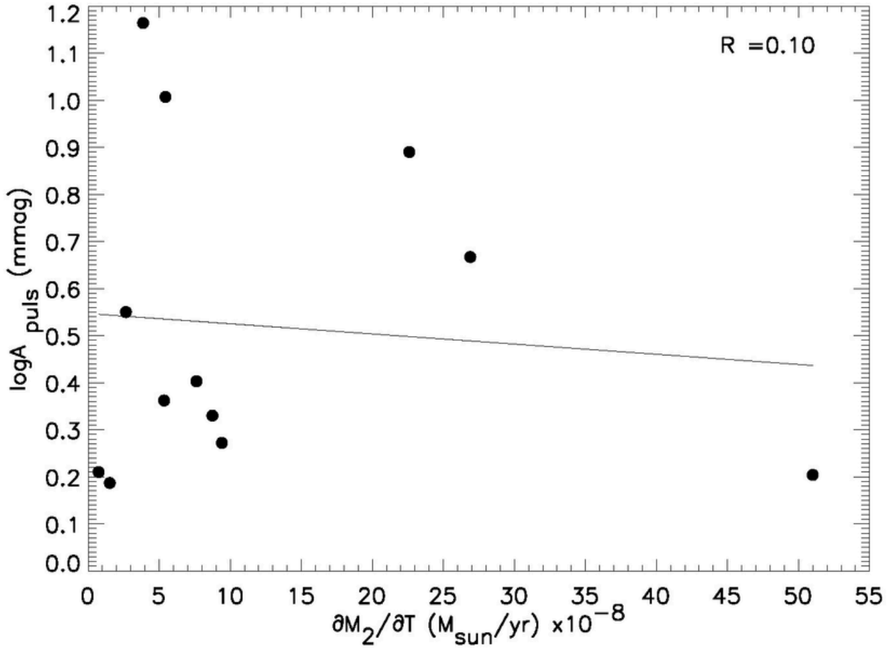
Mass transfer and loss amount were calculated using the equations given by Erdem and Öztürk (2014) for conservative and non-conservative configurations

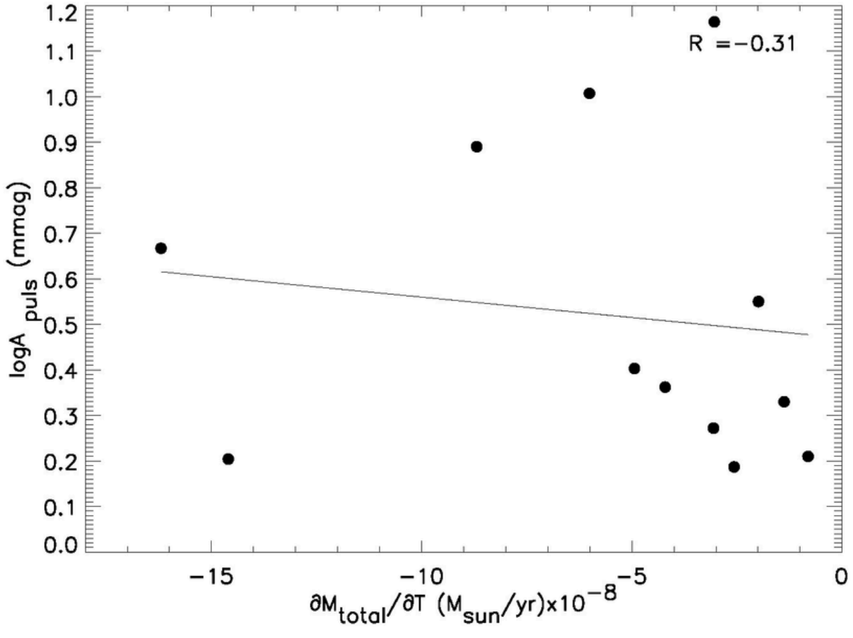
Results


R =0.25
logP puls (days)
−0.8
−0.9
−1.0
−1.1
−1.2
−1.3
−1.4
−1.5
−1.6
0
5
10
15
20
25
30
35
40
45
50
55
∂M2/∂T (Msun/yr)x10−8


R =−0.28
logP puls (days)
−0.8
−0.9
−1.0
−1.1
−1.2
−1.3
−1.4
−1.5
−1.6
−15
−10
−5
0
∂Mtotal/∂T (Msun/yr)x10−8

Results


R =0.10
logA puls (mmag)
∂M2/∂T (Msun/yr) x10−8


R =−0.31
logA puls (mmag)
∂Mtotal/∂T (Msun/yr)x10−8

Future plans

Increase the number of targets

Trace the effect of mass transfer on the pulsation frequency spectra


THANK YOU
FOR LISTENING