Angular Momentum evolution of Contact binaries

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Introduction

Configuration of Binary Star:

A contact binary is a system of two stars that are so close to each other that the distance between them is smaller than their combined radii. There are three configuration of binary stars: Detached, Semi-detached and Contact binaries. Various scenarios of contact binary evolution have been proposed in the past, giving hints of (sometimes contradictory) evolutionary sequences connecting A- and W-type systems. Based on mass-radius and color-luminosity diagrams, Hilditch,King & McFarlane (1988) and Hilditch (1989), as well as other investigators, suggest that W UMa-type stars of A-type are more evolved than W-type. These stars are close binaries of spectral types F, G, or K that share a common envelope of material and are thus in contact with one another. Evolution of the stars in these systems is driven by angular momentum via stellar wind and the physical principle of RLOF. The stellar models incorporate the orbital and stellar parameters of these systems. The comprehensive and detailed stellar modules of various astrophysical processes involved in binary stellar evolution are lacking and su er many theoretical uncertainties associated with mass transfer and orbital evolution, especially in the domain of low mass stars (Pols 1994; Nelson & Eggleton 2001). Then, we present the theoretical models of mass transfer in these systems and determine its stability. As noted by Stepien (2004) a model of a W UMa systems with the currently less massive component being the more evolved one. Such a model is conceptually very close to that used to explain the Algols. In general we use a polytrope for approximation that used to represent the equation of state of gas inside stars. A poly-trope is stellar model which assume that the pressure is a function of density and it is independent of temperature. To validate the theoretical predictions of these systems we use the catalogue of Yildiz (2014).

Objective of the study

In this study, we discuss the physical and geometrical parameters of the components of W UMa contact binaries. Our sample is based mainly on the list of contact Binaries, which is given by

Specific Objectives

- Investigating the A-type W UMa systems
- Determining the W-type W UMa systems and
- To make the statistical analysis on the parameters of this catalog and compared their results with theoretical predictions.

Data

- The objects listed in the catalog are divided into two main catagories, i.e. A-type systems, and W-type systems.
- We consider the 100 W UMa systems from the catalog which are A-type and W-type systems. We considered that the orbital and stellar parameters of W UMa systems is to examine the orbital evolution and internal structure of these systems by using the Angular momentum evolution and polytropic models, respectively.
- For the systems, this catalog gives the following information: orbital period, the masses of the components, M_a and M_d, mass ratio, semi-major axis of the systems. Where, the orbital angular momentum, radii and the mass ratio (which is given by $q=M_d/M_a$, where M_a, M_d are masses of the accretor and the donor components, respectively) were calculated from this catalog.

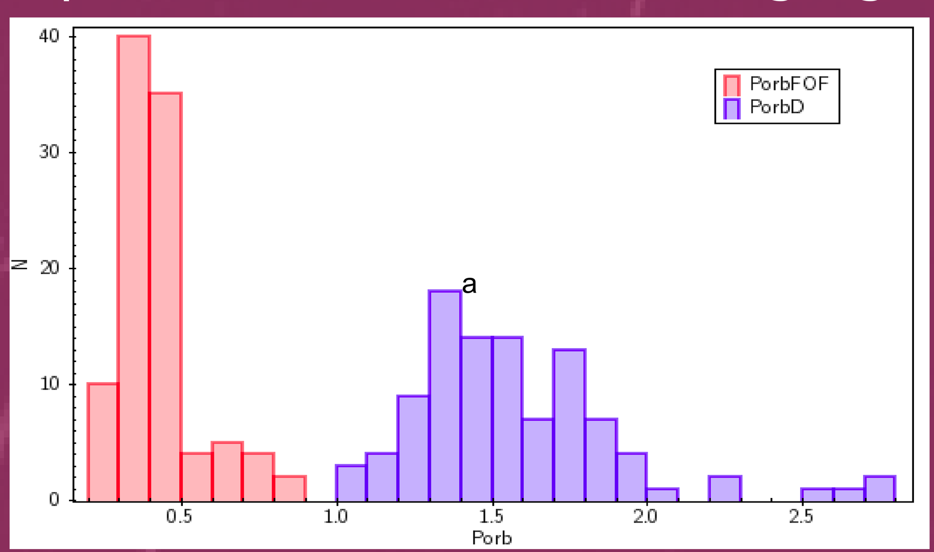
$$J_{orb}(a) = \left(\frac{q\sqrt{GM^3a}}{(1+q)^2}\right) \quad and \quad a^3 = GM\left(\frac{P_{orb}}{2\pi}\right)^2$$

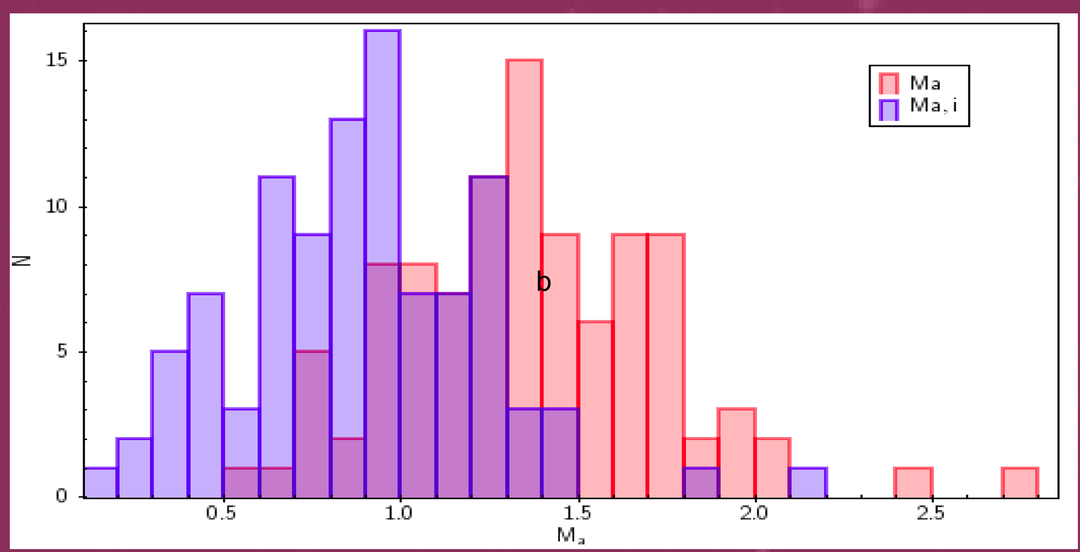
In a polytropic stellar model, the pressure is given by:

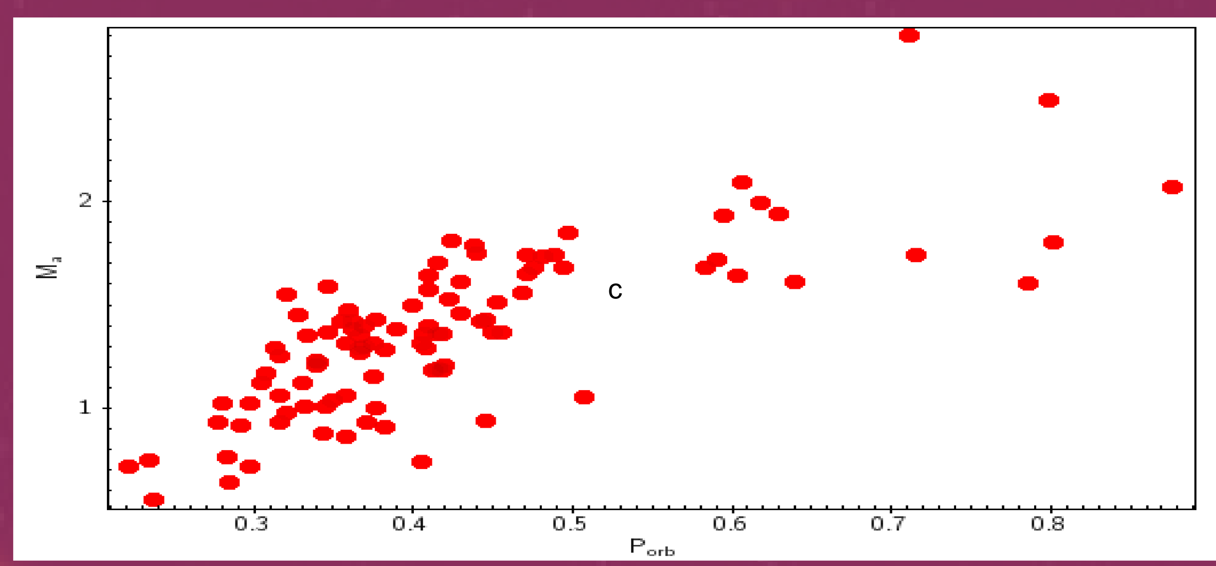
$$P = K\rho^{1+\frac{1}{n}}$$

Distributions of Stellar and Orbital Parameters

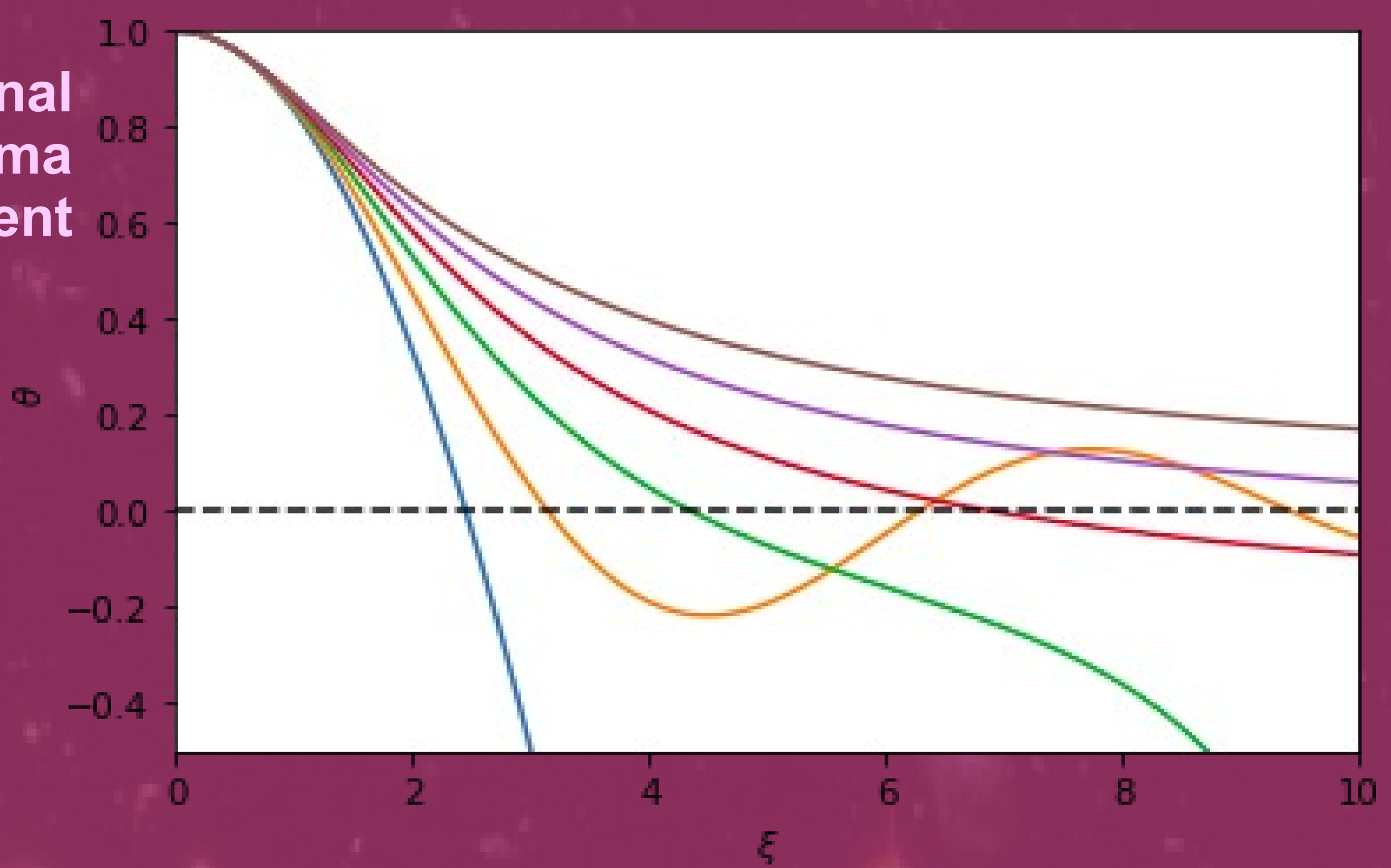
- The distribution functions for P_{orb}, M_a, for selected systems which are presented in the following figures "a", "b" and "c".

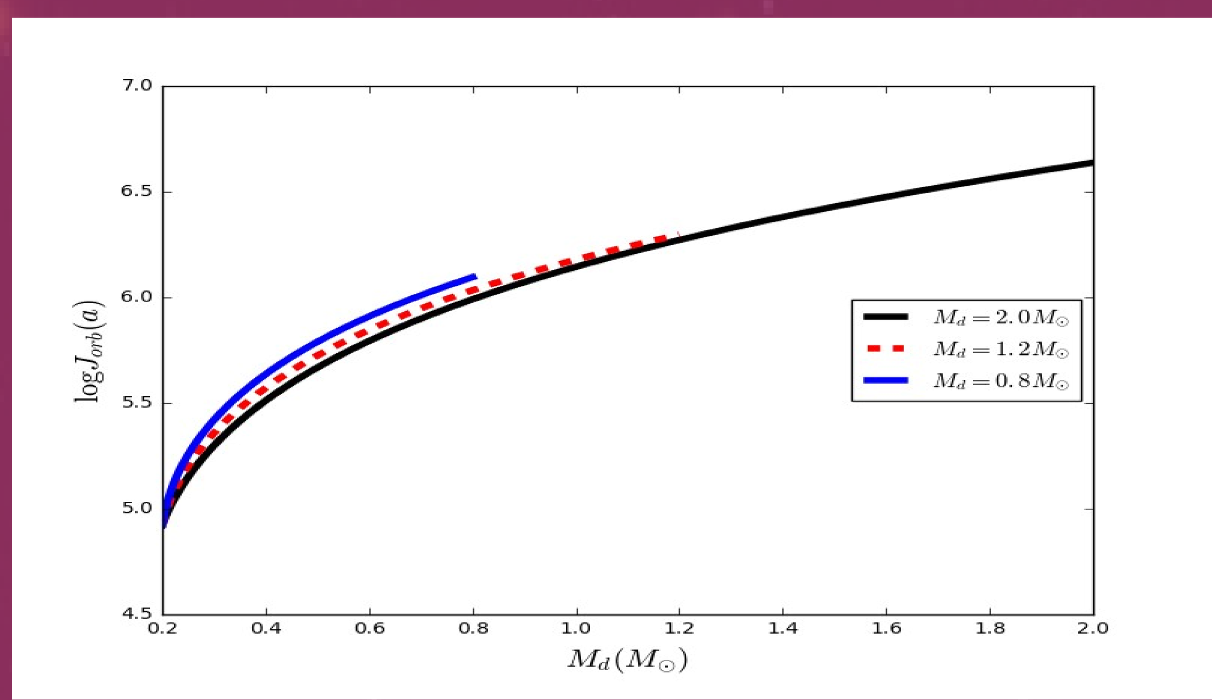






Results of internal structure of tars in W Uma systems with different polytropic index.





Results of angular momentum evolution of both A-type and W-type W UMa systems.

Summary

We have studied the internal structure of stars in W UMa systems and its orbital evolution by using the binary stellar evolution Models. In our results, the numerical solution has been designed to ensure angular momentum conservation at all times and the polytropic models determine the internal structure of A- and W- type of W UMa systems.
Results for rapid mass transfer have been computed and show remarkable agreement with the binary stellar evolution models of the dynamical mass transfer in these systems.

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References

1. Hilditch R. W., King D. J., McFarlane T. M., 1988, MNRAS, 231, 341.
2. Nelson, C.A., Eggleton, P.P. 2001, ApJ, 552, 664
3. Stępień K., 2004, IAU Symp., 219, 967.
4. Yildiz M, 2014, MNRAS 437, 185-194