Evolutionary paths in stellar merging candidates

Georgia Loukaidou[1] & Kosmas Gazeas[1]

[1] *National and Kapodistrian University of Athens, Department of Astrophysics, Astronomy and Mechanics*

Abstract

This poster presents the photometric results on 10 low temperature contact binary systems. The aim of this research is to determine the orbital and physical parameters of these systems and investigate the progenitors of stellar mergers. Evolutionary status of these components is studied with the aid of correlation diagrams and by comparing their parameters with those of a uniform sample of contact binaries, obtained accurately by a combined spectroscopic and photometric method. The extracted physical parameters (mass, radius and luminosity) describe the environmental circumstances, in which stellar components exist and evolve through angular momentum loss or mass transfer processes.

Data Selection

The sample of targets is chosen due to their ultra short orbital period ($< 0.26\ d$), some of which exceed the orbital period cut-off of 0.22 d described by Rucinski 2007 and 2008 . A sample of 54 short orbital period systems is mentioned by nor2011, as a result of the SWASP sky survey. These binary systems, also known as LMCBs (Low Mass Contact Binaries), are on the verge of a final coalescence, as a result of continuous mass and angular momentum loss.

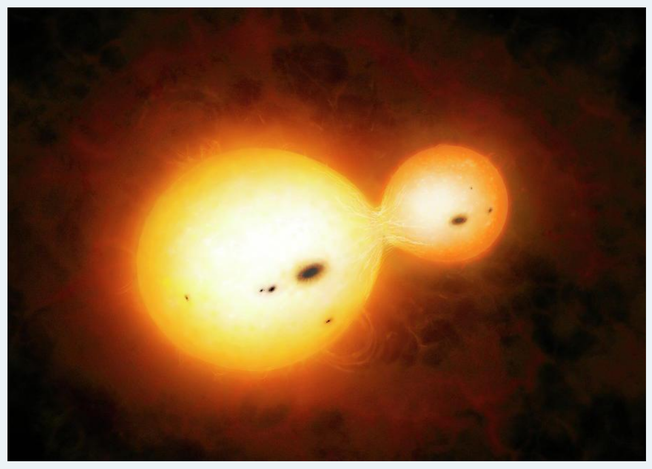
System	Type
1SWASP J003033.05+574347.6	A
1SWASP J004050.63+071613.9	W
1SWASP J052036.84+030402.1	A
1SWASP J055418.43+442549.8	W
1SWASP J080150.03+471433.8	A
1SWASP J093012.84+533859.6	A
1SWASP J133105.91+121538.0	A
1SWASP J173003.21+344509.4	A
1SWASP J174310.98+432709.6	W
1SWASP J220734.47+265528.6	A

Table Characterization to A and W type.

Observations

All these systems were observed from the SWASP survey photometrically in one photometric band (or with no filter), while no spectroscopic observations have been performed in order to determine their spectroscopic mass ratio. Six out of ten systems were observed during a time period spanning from January 2013 till September 2015 with the 40cm f/8 telescope at the University of Athens Observatory and an SBIG ST10 XME CCD camera, equipped with a set of B,V,R,I (Bessell) filters. The rest of the systems are observed with the 2.3m Aristarchos telescope at Helmos Observatory and 1.2m telescope at Kryoneri Astronomical Station (both from the National Observatory of Athens).

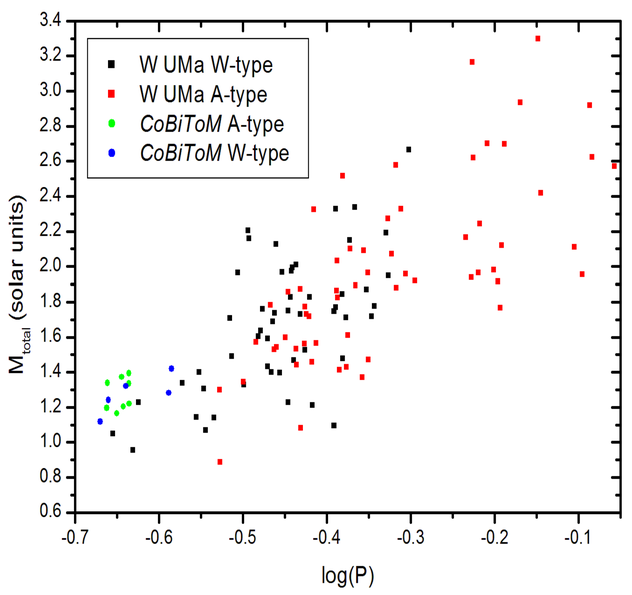
CoBiToM



Binaries Towards Merging (CoBiToM) Project is an observing program, which was initiated in 2012 at the University of Athens Observatory. It is focusing in investigating the evolution of contact binaries which are one step before their coalescence. Such systems are either those with ultra short orbital period or those with extremely low mass ratio. The aim of this observing contact binaries Contact Towards Merging (CoBiToM) Project

Light Curve Analysis & Modeling

In order to determine the parameters for the eclipsing components of all objects, a modeling analysis has been held with PHOEBE software (Prša & Zwitter 2005), which is built upon the Wilson & Devinney code (Wilson & Devinney 1971). A contact configuration was used in the modeling process, as both Roche lobes were overfilled as the light curves indicated so with their continuous variation of brightness. In order to determine the temperature of the primary star (T_1), we used the spectral type versus temperature calibration published by N.Cox (2000). All the other parameters such as inclination (i), temperature of the secondary (T_2), the gravitational potential ($\Omega_{1,2}$), and luminosity ($L_{1,2}$) were adjusted as free parameters. The albedo and gravity darkening coefficients were set at their theoretical values for convective envelope configuration.



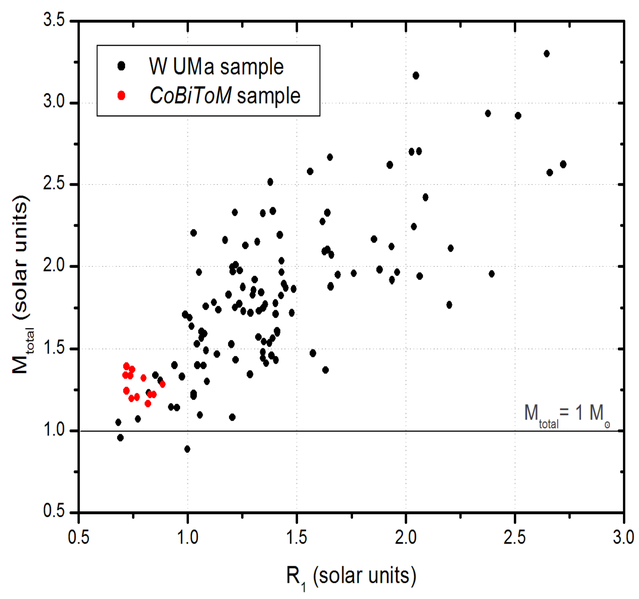


Figure 1. Left side: A and W type binary systems.Right side: Total masses of both stellar components in 112 systems of W UMa and CoBiToM projects.

Correlation diagrams are made in order to provide sustainable results and relations between the plotted physical parameters.Thereafter it is possible to lead into solid conclusions, especially in cases when the evolutionary processes are not yet clarified. In the correlation diagrams shown above, the absolute physical parameters of our targets are plotted along with an other sample of 112 contact binary systems from Gazeas & Niarchos (2006).

Conclusion

We provide 4-band photometry with better quality, essential for stellar models in 10 LMCBs. The number of these systems is very limited and today we know very few about stellar systems that they are very close to merging. Related studies on stellar merging are numerous up to date. However, such coalescence has been observed only once so far in the well known case of V1309 Sco. In addition to this, there are several peculiar cases of fast rotating stars such as the variables FK Com, HD 199178 & UZ Lib, which can possibly be a result of merging in contact binaries. Optical sky surveys (SWASP, OGLE, ASAS) have discovered several eclipsing systems with very short orbital periods, which are potential candidates.

References

Gazeas K.D., Niarchos, P.G., Zola S., Kreiner J.M., Rucinski S.M., 2006, AcA, 56, 127 (Paper VI)

Norton et al., 2011, A & A, A90, 528

Prša A. & Zwitter T., 2005, ApJ, 628:426-438

Rucinski S., 2007, MNRAS, 393-396, 382

Rucinski S. & Prribulla T., 2008, MNRAS, 1831-1835, 388

Wilson R.E. & Devinney, E.J., 1971, ApJ, 166, 605

Acknowledgements

This research is co-financed by Greece and the European Union (European Social Fund-ESF) through the Operational Programme "Human Resources Development, Education and Lifelong Learning" in the context of the project "Strengthening Human Resources Research Potential via Doctorate Research" (MIS-5000432), implemented by the State Scholarships Foundation (IKY).