Fundamental Parameters of New Low-Mass Eclipsing Binaries

Iglesias Marzoa, R.[1], López-Morales, M.[2], Arévalo Morales, M.J.[1], Torres, G.[3], Lázaro Hernando, C.[1], Tamazian, V.S.[4] & Szentgyorgyi, A.[3]

[1] *Dept. de Astrofísica. Universidad de La Laguna; Instituto de Astrofísica de Canarias, La Laguna, Tenerife, Spain*
[2] *Hubble Fellow. Carnegie Institution of Washington, Department of Terrestrial Magnetism, Washington D.C., USA*
[3] *Harvard-Smithsonian Center for Astrophysics, Cambridge MA, USA*
[4] *Observatorio Astronómico Ramón María Aller, Universidade de Santiago de Compostela, Santiago de Compostela, Spain*

Email contact: rim@cca.iac.es

Introduction

In recent years significant efforts have been made to observationally measure the main physical parameters of stars with M < 1 $M_{\odot}$. The comparison of those physical parameters to evolutionary models allow us understand the underlying physics that establishes the structure and drives the evolution of low-mass stars. The new data have revealed discrepancies between the Mass-Radius relation predicted by the models and the observed data. The main discrepancy is that the measured radii are generally larger than what the models predict. This effect appears to be related to the presence of strong magnetic fields in the stars and also metallicity (Berger et al. 2006, Lopez-Morales 2007, Chabrier et al. 2007).

The best source of precise mass and radius measurements are double lined, detached, eclipsing binaries (DDEBs). Specifically, we can derive the stellar masses and radii with errors of ~1-2%, by measuring the radial velocities and light curves of DDEBs. Although statistics have improved, the number of known low-mass DDEBs is still small and, for some systems, the measured masses and radii still have large error bars, and they cannot constrain evolutionary models rigorously. Thus, it is necessary to obtain a larger sample of well-studied low-mass DDEBs to improve our knowledge of the fundamental parameters of very low-mass stars.

In this poster we present a new project to derive accurate masses and radii of eleven new DDEBs, by measuring their optical (VRI) and near-infrared (JK) light curves, and radial velocities curves.

Observations

Our program contains 14 Northern Hemisphere binaries (Dec > -9 deg). Eleven of them are new objects, identified from large-scale photometric databases (NSVS, OGLE, SWASP). The other three are the well studied systems CU Cnc, YY Gem and GU Boo, for which we will focus on their near-IR light curves.

The orbital periods of the binaries are between 0.37 and 8.66 days, their individual masses between 0.25 and 0.7 $M_{\odot}$, and their apparent magnitudes between V = 9.1 and 13.7 (see Table 1).

For the VRI and JK light curves measurements we are using the CAMELOT camera at IAC80 (0.80-m) telescope and the CAIN camera at infrared Carlos Sanchez (1.5-m) telescope, both at the Observatorio del Teide in the Canary Islands (Spain). For the radial velocities measurements we are using the new high precision spectrograph TRES (Tillinghast Reflector Echelle Spectrograph) on the 1.5-m telescope at Mt. Hopkins Observatory, Arizona.

To fit the data we are using Wilson-Devinney (1971), BINAROCHE (Lázaro et al. 2001), and an implementation of two-dimensional cross-correlation algorithm TODCOR (Zucker & Mazeh 1994).

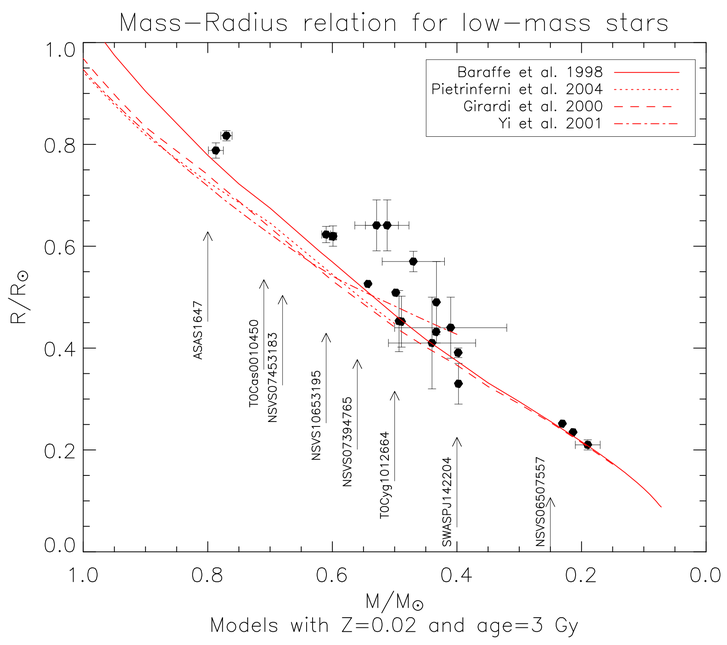

Figure 1. Mass-Radius relation below 1$M_{\odot}$. The lines show theoretical isochrone models by several authors, with Z=0.02 and age=3 Gyr. Black circles show the mass and radius from low-mass DDEBs studied to date, with their error bars. Vertical arrows show the estimated masses of the new objects in our program. Our set of binaries was chosen to cover a broad range in masses below 1 $M_{\odot}$. For clarity we only show the masses of the primaries.

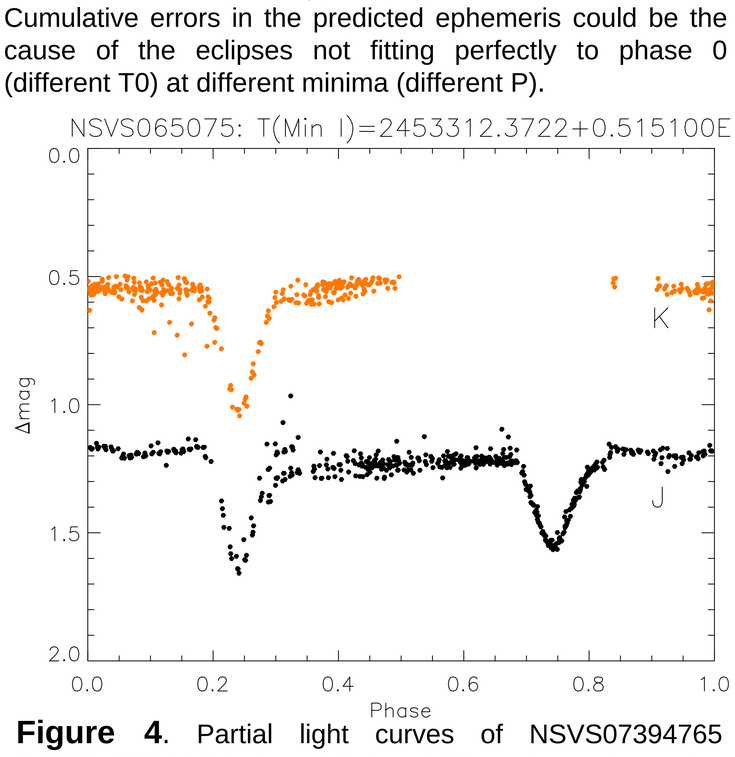

Figure 3. Partial light curves of ASAS1647 (~0.8+0.8 Msun) in J- and K-band. The ephemeris used to phase the data is shown on top, as obtained from literature. Cumulative errors in the predicted ephemeris could be the cause of the eclipses not fitting perfectly to phase 0 (different T0) at different minima (different P).

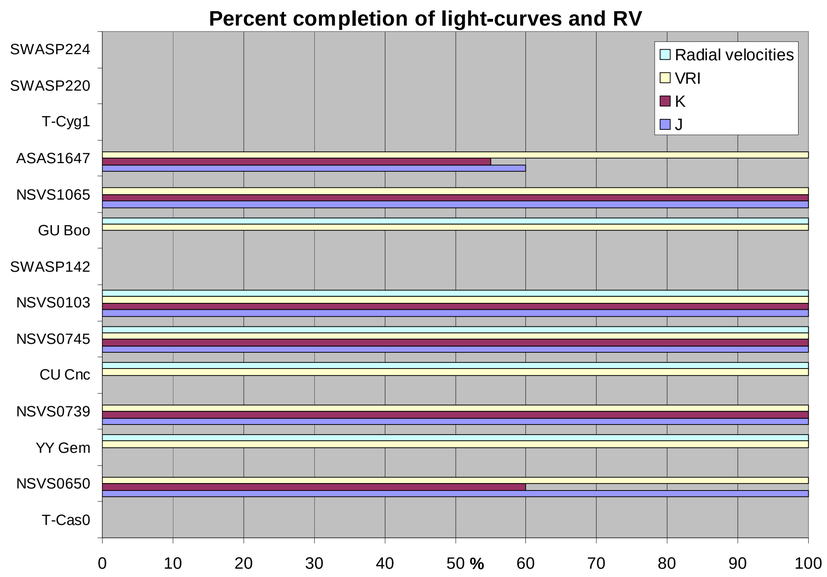

Figure 2. Current stage of our observing program. Several binaries already have complete RV curves and VRI light curves. Two of them have complete near-IR light-curves while the rest are still being observed. Observations of the non-completed binaries are currently underway. For clarity, names of the objects in the y-axis were abbreviated.

Figure 4. Partial light curves of NSVS07394765 (~0.65+0.56 $M_{\odot}$) in J- and K- band. The ephemeris used to phase the data is shown on top.

Summary

We present the first results of an extensive project to collect optical and near-infrared light curves and radial velocity curves of over a dozen low-mass, double-lined, detached eclipsing binaries in the Northern hemisphere. Most are new objects selected from photometric surveys, while three are previously known systems. Upon completion this project will provide over 20 new accurate mass and radius measurements of very low-mass stars.

Binary ID	V	J	J-K	P (days)	Ma+Mb	Reference
T-Cas0-10450	-	11.824	0.720	8.656	1.38	Devor et al (2007)
NSVS06507557	13.1	10.918	0.826	0.5150996	0.89	Coughlin & Shaw (2007)
YY Gem	9.1	6.073	0.837	0.8142822	1.2	Torres & Ribas (2002)
NSVS07394765	12.8	10.555	0.835	2.2656	1.12	Coughlin & Shaw (2007)
CU Cnc	12.2	7.509	0.906	2.771468	0.87	Ribas (2003)
NSVS07453183	13.2	11.300	0.692	0.366971	1.41	Coughlin & Shaw (2007)
NSVS01031772	12.6	9.692	0.914	0.3681414	1.04	López-Morales et al (2006)
1SWASPJ142004.68+390301.5	12.3	8.572	0.858	0.3693	0.8	López-Morales (private comm)
GU Boo	13.7	11.046	0.824	0.488728	1.21	López-Morales & Ribas (2005)
NSVS10653195	12.6	10.326	0.779	0.560721	1.28	Coughlin & Shaw (2007)
ASAS1647	-	11.134	0.791	0.503264	1.6	López-Morales (private comm)
T-Cyg1-12664	-	11.980	0.407	8.257	0.98	Devor et al (2007)
1SWASPJ220041.59+271513.5	11.9	8.556	0.832	0.5235	-	-
1SWASPJ224355.18+293647.6	13.0	9.892	0.837	0.4443	-	-

Table 1. Parameters of the binaries in our program. All objects show red colors and have orbital periods up to 8.66 days. The masses of the individual components cover a broad range of masses below 1 $M_{\odot}$.

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