Multiwavelength photometry of the young intermediate mass eclipsing binary TY CrA

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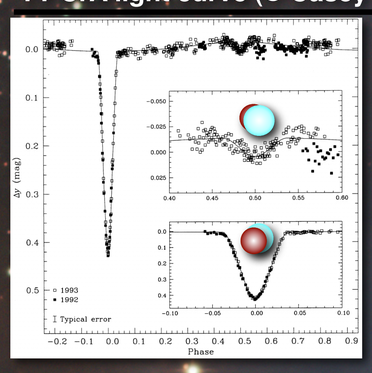
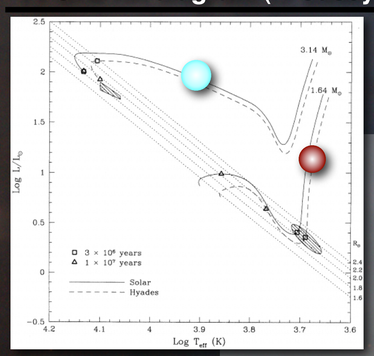
ABSTRACT Pre-main sequence (PMS) evolutionary models provide the chronology of early stellar evolution, however, they can differ widely in their mass predictions. Eclipsing binaries enable the most precise direct mass/radius determinations, and are, therefore, key objects to test these models. One of the handful of known PMS eclipsing binaries is a component of the spectroscopic triple TY CrA. Its secondary component is particularly interesting since it is a star of relatively high mass (1.64 $M_\odot$) which is still on the pre-main sequence. The eclipsing binary was analyzed in the optical wavelength range ≈10 years ago, however, the crucial secondary eclipse minimum is very shallow. Therefore, we are obtaining new photometry in both optical and near-IR bands. We will present first observations in *BVRI* which show that the secondary eclipse depth increases to about 0.1 mag in the *I* band. The increased eclipse depth with respect to other bands will help to better determine the colours and dimensions of the system. Furthermore, we will show and discuss first near-infrared observations of the primary eclipse. In addition to the light curves we are obtaining radial velocities in order to pin down the orbital parameters of the triple. Our first observations agree with the orbital parameters derived ≈10 years ago.

TY CrA light curve (© Casey et al., 1998)

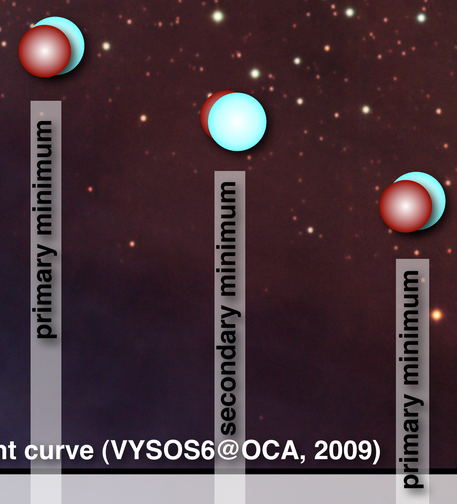


TY CrA HR diagram (© Casey et al., 1998)

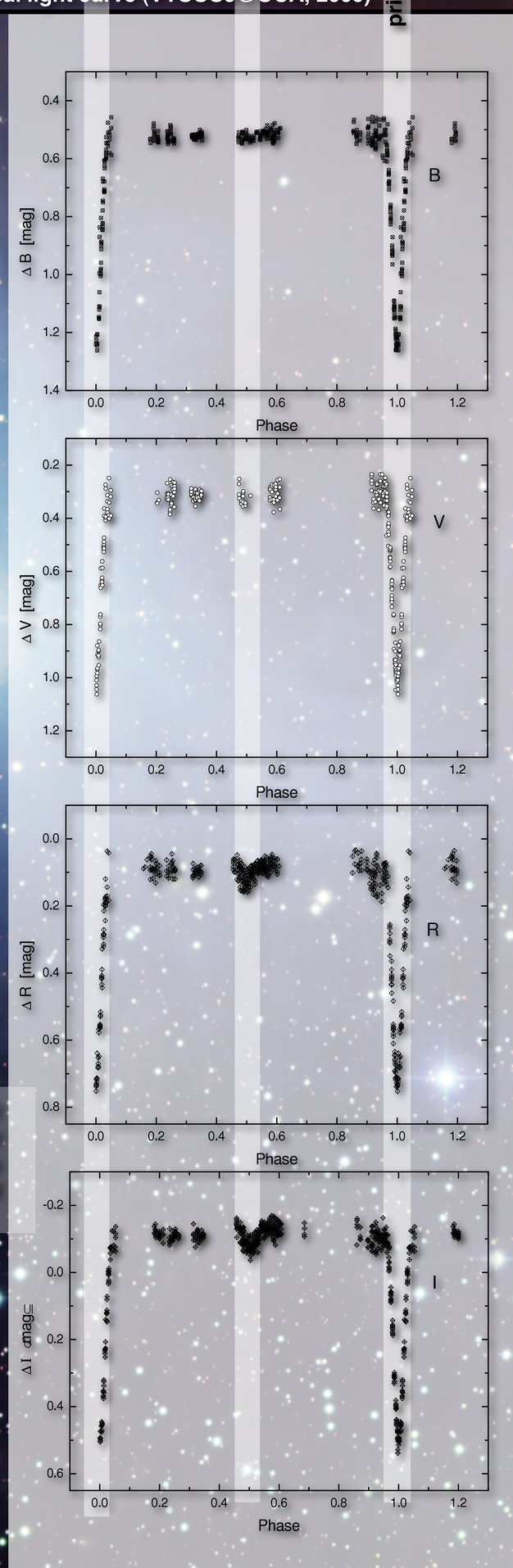


2MASS K band ↔ 2.2m/WFI *BVR* composite (© ESO)

TY CrA is a hierarchical triple, maybe even quadruple system, embedded in a reflection nebula in the Corona Australis star forming region. Two components form a massive eclipsing double-lined spectroscopic binary (eSB2) with an orbital period of almost 3 days. A third spectroscopic component is in a wide orbit around the eclipsing pair (Casey et al., 1995, *AJ* 109, 2156; Corporon et al., 1996, *A&A* 310, 228). A visual fourth component was detected by Chauvin et al. (2003, *A&A* 406, L51).

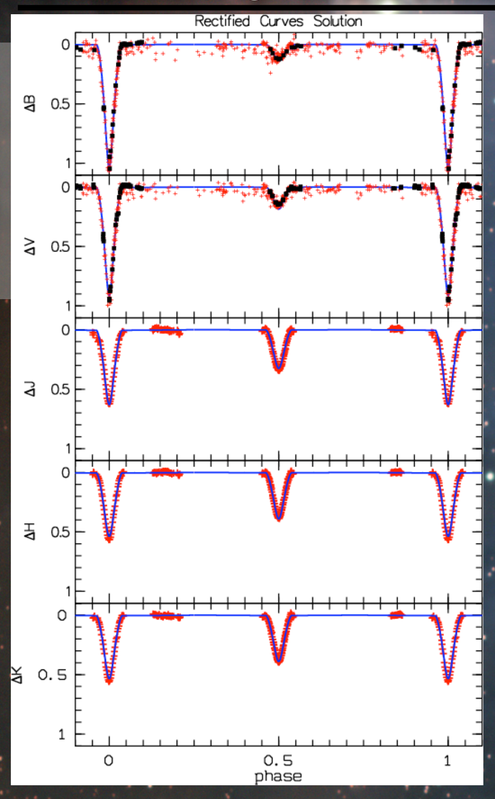


TY CrA optical light curve (VYSOS6@OCA, 2009)



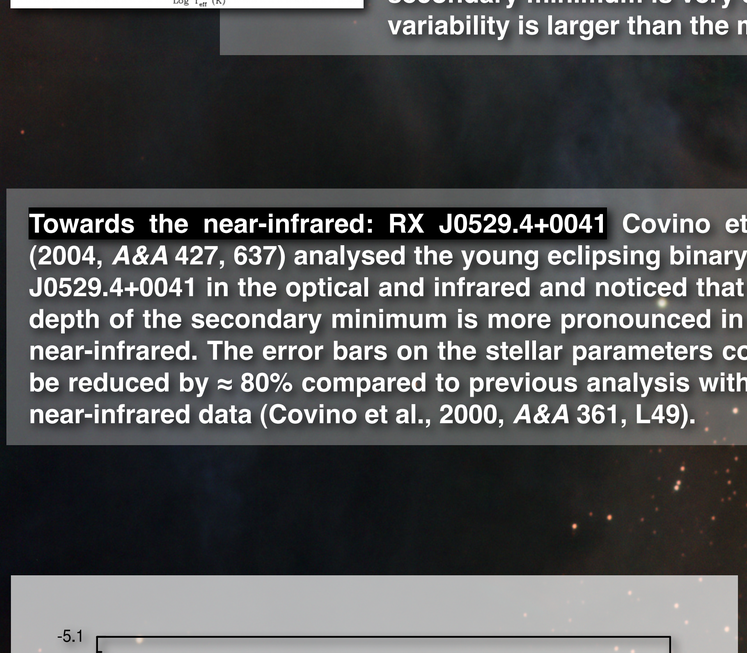
Previous work: Casey et al. (1998, *AJ* 115, 1617) obtained optical light curves of the eclipsing binary in *uvby* (upper left figure). They derived masses of 3.16±0.02 $M_\odot$ (primary component) and 1.64±0.01 $M_\odot$ (secondary component). The latter is particularly interesting since it has not yet reached the main sequence (left figure). Its properties are uncertain since the light curve analysis is challenging. The secondary minimum is very shallow (inset in upper left figure and the out-of-eclipse variability is larger than the measurement errors (Vaz et al., 1998, *A&AS* 130, 245).

RX J0529.4+0041 light curve (© Covino et al., 2004)



Towards the near-infrared: RX J0529.4+0041 Covino et al. (2004, *A&A* 427, 637) analysed the young eclipsing binary RX J0529.4+0041 in the optical and infrared and noticed that the depth of the secondary minimum is more pronounced in the near-infrared. The error bars on the stellar parameters could be reduced by ≈ 80% compared to previous analysis without near-infrared data (Covino et al., 2000, *A&A* 361, L49).

Goals: The goal of the present work is to analyse TY CrA in a way similar to Covino et al. (2004) and to get more precise secondary parameters by observations in the near-infrared.



TY CrA near-infrared light curve (SOFI@NTT, 2006)

New photometry of TY CrA: The primary minimum was observed in 2006 with SOFI at the ESO NTT (left figure). New optical data have been obtained in 2009 and 2011 with VYSOS6 at Observatório Cerro Armazones, Chile (right figure). Additional near-infrared photometry has been obtained in 2009-2011 with REM (La Silla) and ANDICAM (SMARTS, Cerro Tololo) and awaits analysis.

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First results: The minimum time derived from the SOFI light curves differs by 7 minutes from the ephemeris presented by Casey et al. (1998) which is indicative of additional components. We reproduced the stellar parameters derived by Casey et al. (1998) based on the 2009 VYSOS6 data using the methods of Pribulla et al. (2008, *MNRAS* 390, 798). It can be noticed that the secondary minimum already becomes more pronounced in the *R* and *I* band, compared to the *B* and *V* band (right figure).