CRTS J0552–0044: A young M3+M5 eclipsing binary in the 32 Ori Moving Group

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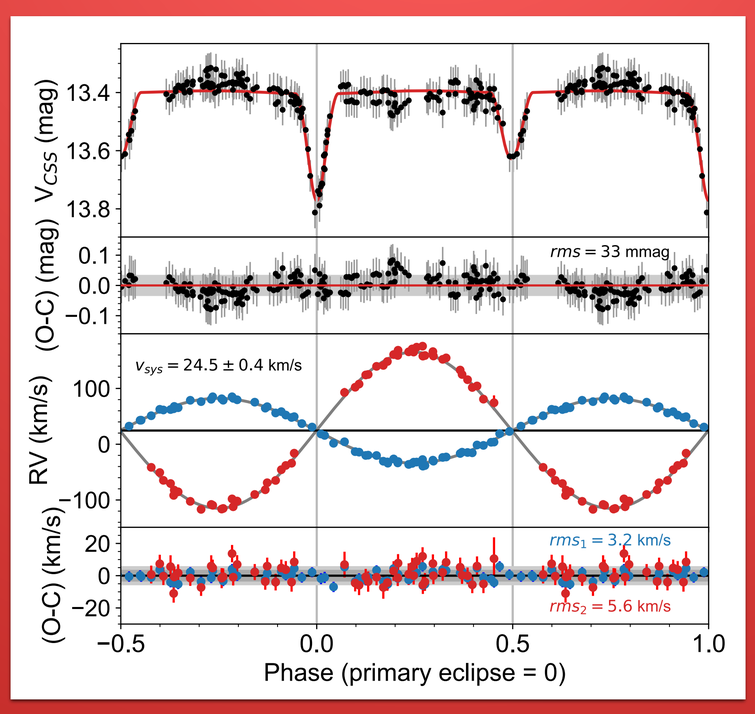
Eclipsing binaries are key tools to understanding the fundamental properties of low-mass stars. Here we characterise a rare, young M3+M5 eclipsing system whose components span the fully-convective boundary. CRTS J0552–0044 was catalogued as an EB by the Catalina Sky Survey (Drake+2014) and identified as a possible member of the nearby ~25 Myr-old 32 Ori Moving Group (Bell+2017). With new Gaia DR2 astrometry and the systemic velocity presented here, the star is a bona fide member at d = 103 pc.

Initial model

After obtaining 65 epochs of WiFeS R=7,000 radial velocities, we model the CSS V-band light curve and velocity curves using JKTEBOP (Southworth +2011, 2013). Given the poor quality of the CSS photometry, we adopt linear limb darkening relations for both stars. As the system's cross-correlation function was unresolved by WiFeS, we fit the secondary's Hα emission offset to obtain an RV for that component.



JKTEBOP fit to the CSS V-band light curve and WiFeS primary (blue) and secondary (red) velocities. The resulting system parameters are shown in the table below. Uncertainties were estimated from a Monte Carlo simulation around the best fit.

By the numbers…

Name	CRTS J055255.7–004426	
Period	0.8589711(3) d	
Mass	0.500(9) $M_\odot$	0.208(4) $M_\odot$
Radius	0.74(5) $R_\odot$	0.45(2) $R_\odot$
a	0.01576(9) au = 3.39(2) $R_\odot$	
e	0.006(4) (RV-only = 0.013)	
Distance	103.2 ± 0.6 pc (*Gaia* DR2)	
Age	24 ± 4 Myr (32 Ori MG)	

Want to know more?

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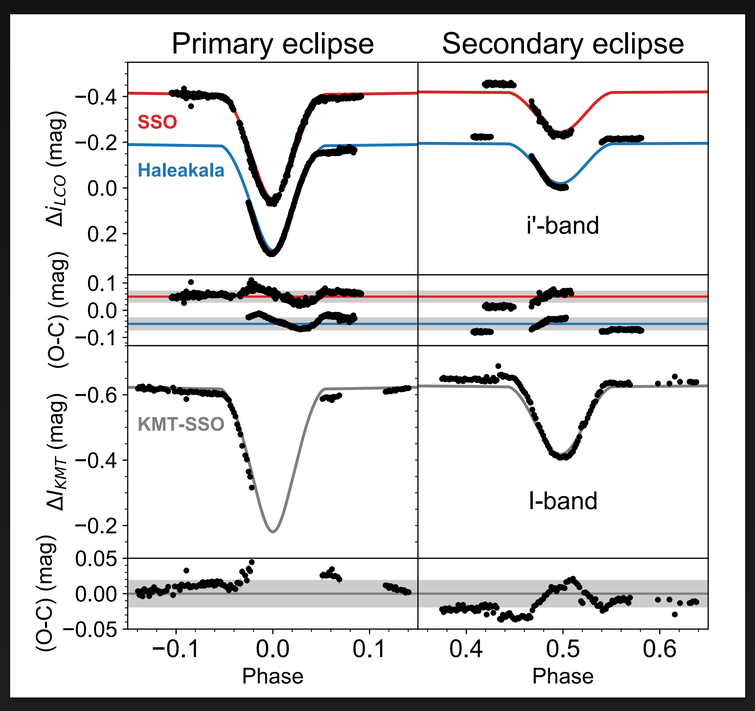
Follow-up photometry

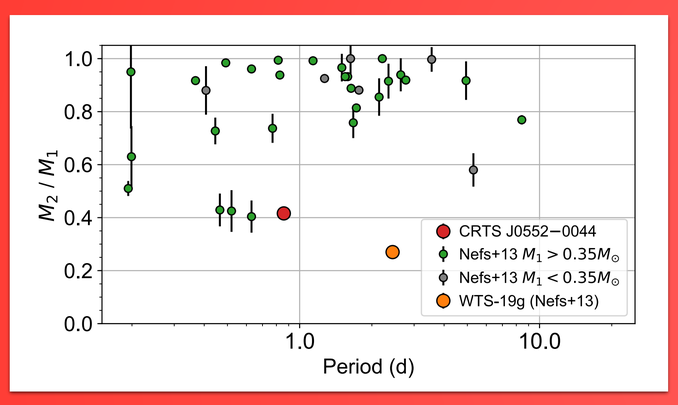
We are obtaining high-cadence photometry from the KMT-SSO, LCOGT 2-m and SkyMapper telescopes. These data already show that our initial light curve model requires refinement, and an updated model which simultaneously fits all available photometry and radial velocities is under construction.

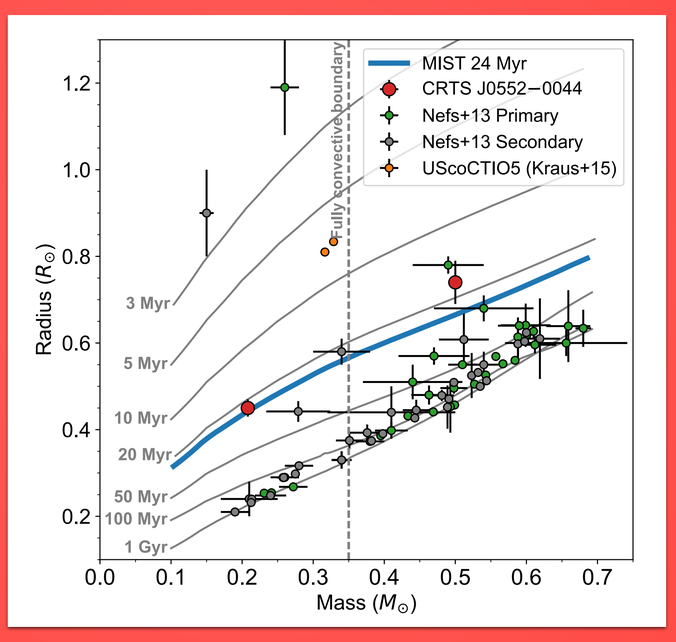


LCOGT and KMT photometry obtained during 2017 December—2018 April. The solid lines in each panel are the initial model, varying only the central surface brightness ratio (~eclipse depth) and flux zero point. The residual trends show that both the initial model and the nightly zero points can be refined.

CRTS J0552–0044 in context

Both components are highly inflated compared to main sequence M dwarfs of similar mass, and in Mass-Radius space the MIST isochrones (Dotter+16) imply an age of ~20 Myr for the system, as expected. The components span the ~0.35 $M_\odot$ fully convective boundary for M dwarfs, giving the system one of the lowest known mass ratios (q=0.4). Dynamical processing in the birth environment means low-q systems should be more abundant when young, and so CRTS J0552–0044 provides an important constraint on binary star formation and evolutionary models of low-mass stars.





Top: CRTS J0552–0044 compared to the M+M binary sample of Nefs+13. Two of the other q~0.4 systems are <150 Myr. Right: CRTS J0552–0044 compared to MIST v1.1 isochrones and the Nefs sample in Mass-Radius space.