APOGEE/Kepler Overlap Yields Orbital Solutions for a Variety of Eclipsing Binaries

(1) (2)

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Identifying promising stars for binary modeling

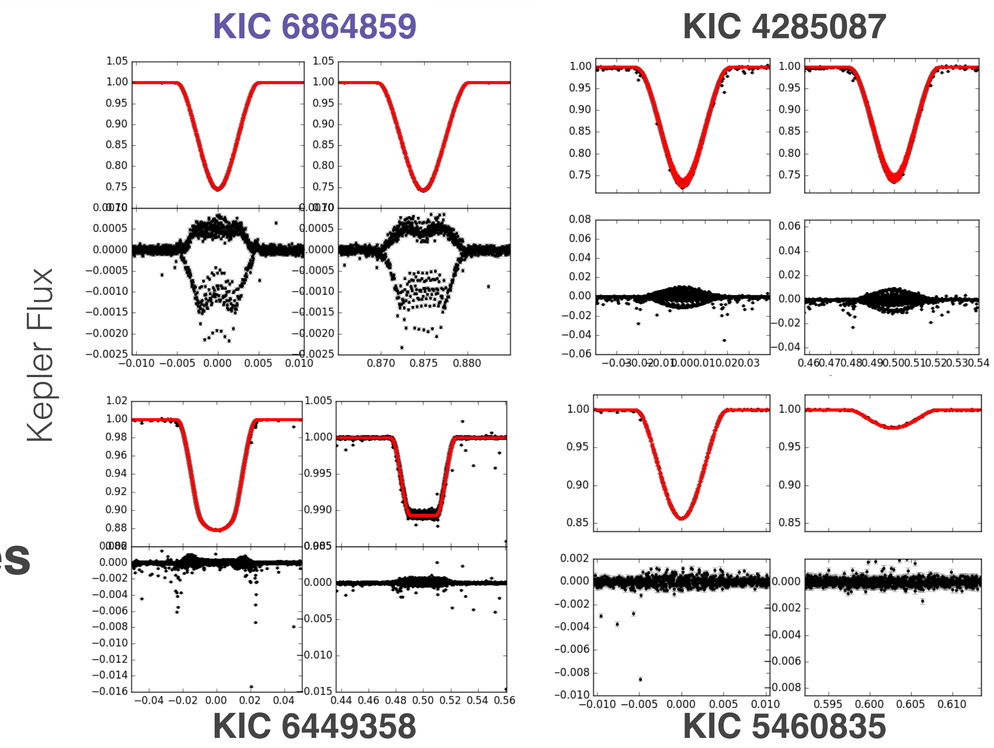
We select **uniquely accessible eclipsing binaries**

- Primary and secondary eclipse seen by *Kepler*
- Separated or semi-detached morphology
- *Kepler* magnitude brighter than 14
- Multiple APOGEE visits with no quality flags

→ About 50 targets meet these criteria

Light curves (LCs) + **newly extracted radial velocities** (RVs) allow us to model these binary systems and **measure fundamental stellar parameters**

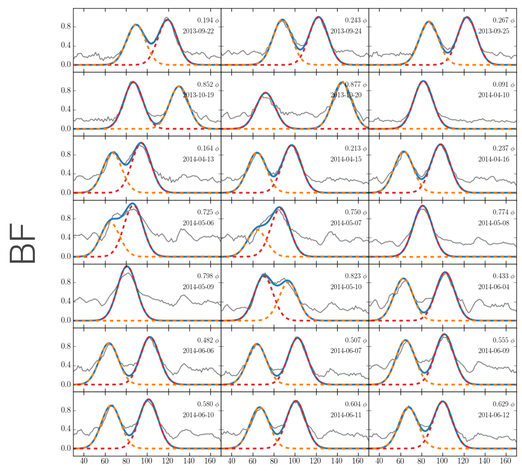
Our work is public and open: github.com/savvytruffle/cauldron



Preliminary light-curve-only KEBLAT models vs. phase

Extracting radial velocities from APOGEE visits

KIC 6864859 Period = 40.9 days



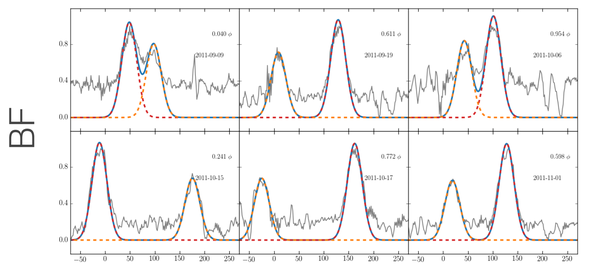
The broadening function (BF) **separates components of a spectroscopic binary** more clearly than the cross-correlation function (CCF) (Rucinski 1992; Rawls+ 2016)

- Normalize a high-res PHOENIX template spectrum similar to target (Husser 2013)
- Obtain, normalize, and de-spike a series of APOGEE visit spectra (Bovy 2016)
- Identify and fit BF peaks with Gaussians
- Result: **radial velocities for each star** that can be folded on the orbital period

The BF is run on a log λ grid from 15170–16935 Å with 1.5 km s^{-1} resolution

PHOENIX templates are interpolated to match APOGEE catalog $T_{\rm eff}$ and log g with solar metallicity

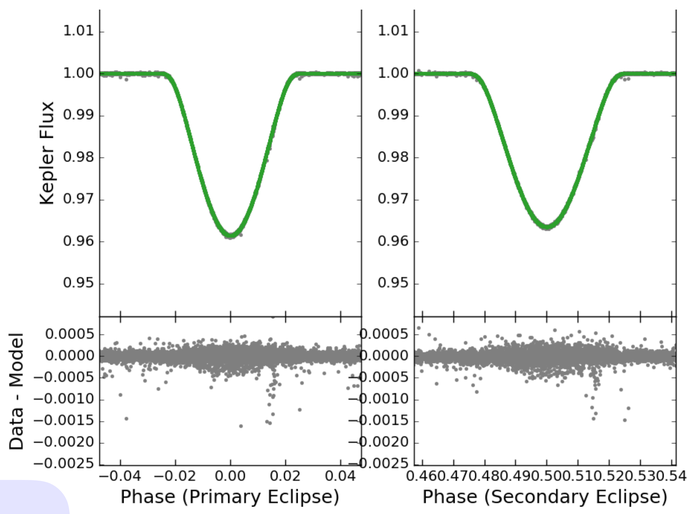
KIC 5285607 Period = 3.9 days

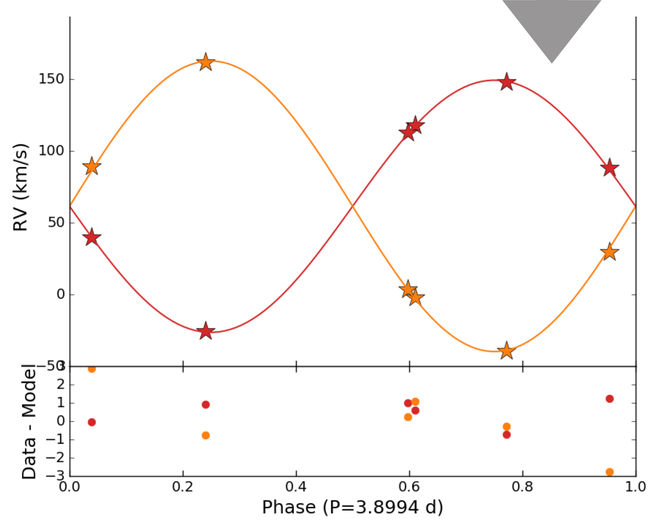


A new set of stars with accurate masses and radii

We use KEBLAT (Windemuth+ in prep) to model both LC and RV data

- **17 best-fit parameters** with `lmfit` (non-linear least squares)
- Posteriors sampled with `emcee` (Monte-Carlo Markov Chain)





First results – KIC 5285607

Star 1	Star 2
$M = 1.54 \pm 0.03\ M_\odot$	$M = 1.33 \pm 0.03\ M_\odot$
$R = 2.27 \pm 0.03\ R_\odot$	$R = 1.20 \pm 0.04\ R_\odot$

- Use quadratic limb darkening and correction for long-cadence temporal binning (Mandel & Agol 2002; Kipping 2010)
- Marginalize stellar variability with local second-order polynomial
- Seed initial radial velocity model from LC-only fit and RV amplitudes
- Iteratively fit eclipses and velocities individually before optimizing both simultaneously