Eclipsing Binaries in the LSST Era

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Motivations

The Large Synoptic Survey Telescope (LSST) will be able to survey an unprecedented number of eclipsing binary stars (EBs) during its ten year runtime (Prsa et al 2011). Our best way of studying EBs is through light curves, where dips correspond to eclipses, pictured below:

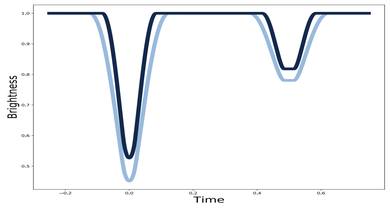

Fig 1. Light curves generated from *ellc (light blue)* software and LDCs from Claret (2011) (navy).

One necessity in studying EBs with telescope filters is the use of limb-darkening coefficients (LDCs). These account for the differences in brightness from the center to the limb of a star. We use LDCs, and other parameters, to generate light curves for simulation EBs.

Limb-Darkening in LSST Filters

In addition to the SDSS *ugriz* filters and the 2MASS *JHK* filters, there is a new LSST y-band filter (924-1048nm). Light curves are fit with the 4-paramter law from Claret (2011)

$$\frac{I(\mu)}{I(1)} = 1 - \sum_{k=1}^{4} a_k (1 - \mu^{\frac{k}{2}})$$

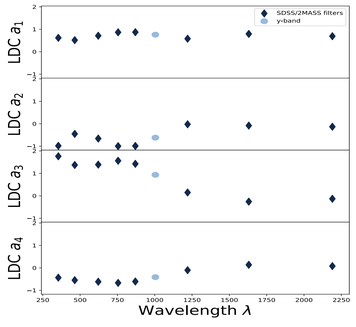

Fig 2 Linear interpolation for y-band (orange) for stellar conditions T_{eff} = 5000K, log(g) =2.5, and M_H = 0.

LSST Observation Strategy

We use OpSim, software that simulates field selection for LSST, for our simulation cadences.

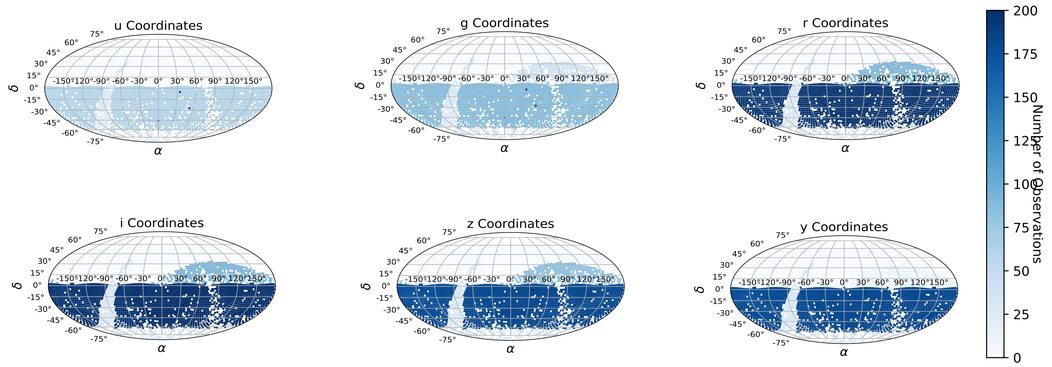

Fig.3 Number of LSST observations at different RA/Dec for each LSST filter.

Binary Population Statistics

Data from simulations shows that shorter periods are more easily recoverable. This is due to the fact that more eclipses will occur for systems with shorter periods.

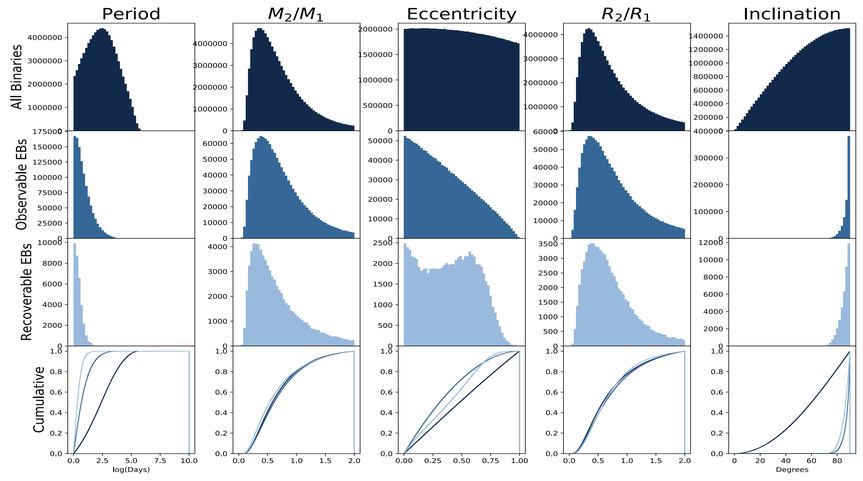

Fig 4 Different characteristics (log(Period), mass ratio, eccentricity, radius ratio, inclination) of 3 populations (All, Observable, Recoverable). Cumulative plots are shown on the right.

Eclipsing Binary Simulations

Population	% of All Binaries
All Binaries	~2.5 x 10^9 stars
Observable EBs	1.4%
Recoverable EBs	5.6% (of OEB)

- *All Binaries* : every binary in our simulated galaxy.
- *Observable EBs:* detached EBs within LSST's magnitude limits with periods less than the LSST observing window.
- *Recoverable EBs*: subset of Observable EBs for which the returned period is within 10% of the simulated input period.

This and future work will help to inform LSST's cadence to optimize the study of eclipsing binaries. These methods will help us to find characteristics of these stars more easily.

References/Acknowledgements

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