

Illuminating Hidden Binary Parameter Space with Roman Microlensing



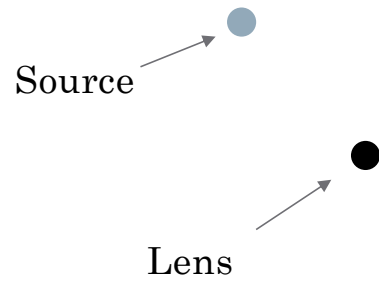
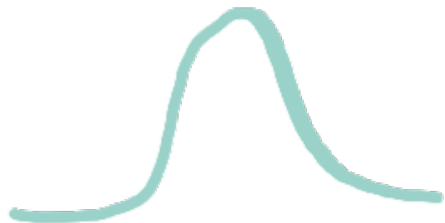
Packages used in
this work!

Natasha S. Abrams (UC Berkeley), Jessica Lu, Casey Lam, Sage Remulla, Michael Medford, Matthew Hosek, Sam Rose, Macy Huston, Sean Terry, Dex Bhadra, Andrew Scharf

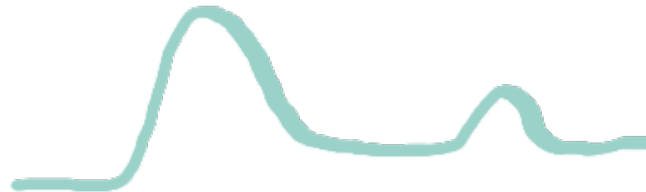
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Roman Shifting Landscapes 7-14-26

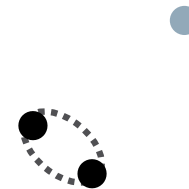
PSPL



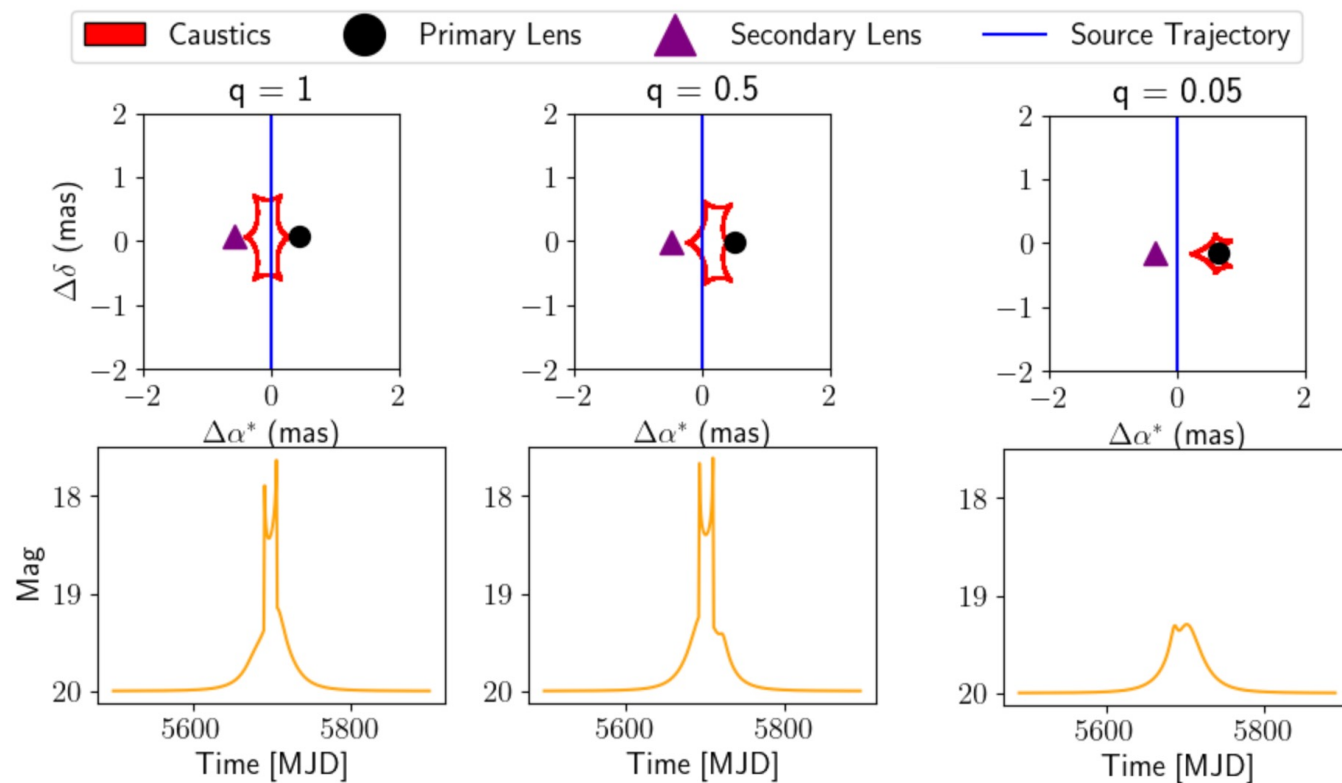
BSPL



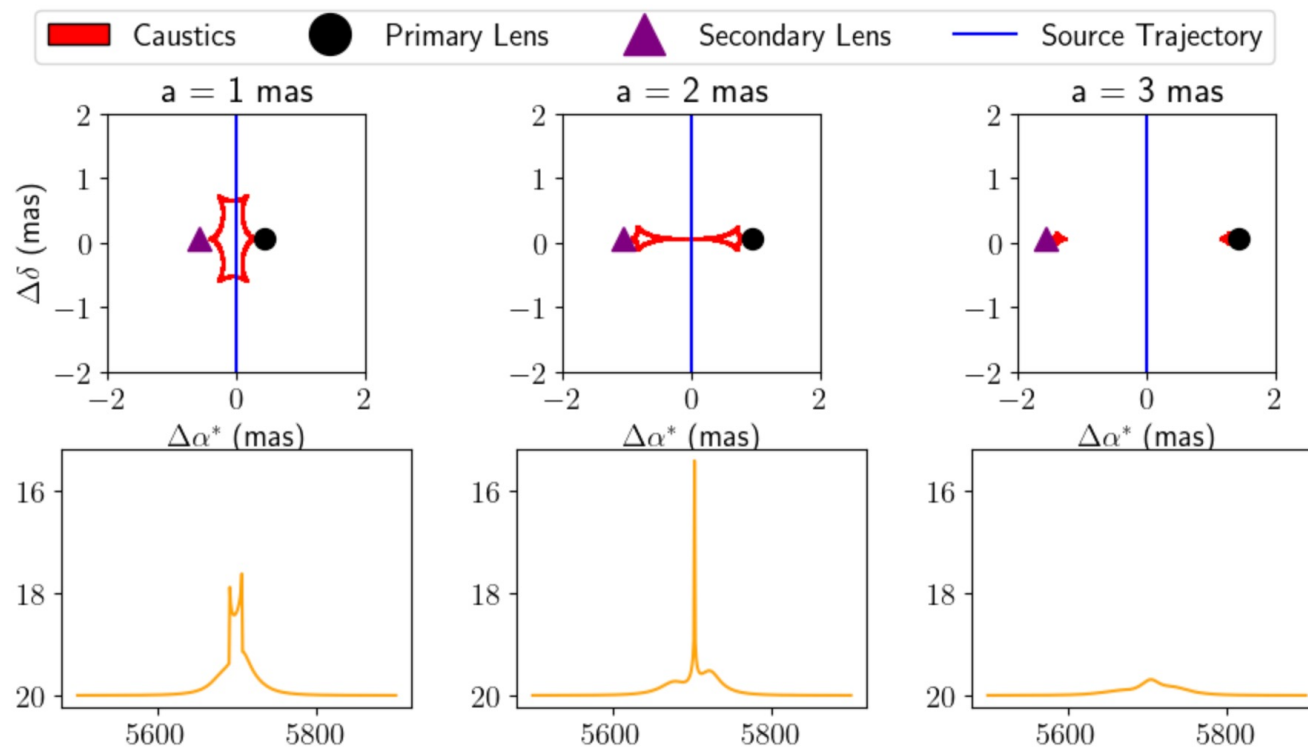
PSBL



Changing mass ratio of binary lens affects lightcurve

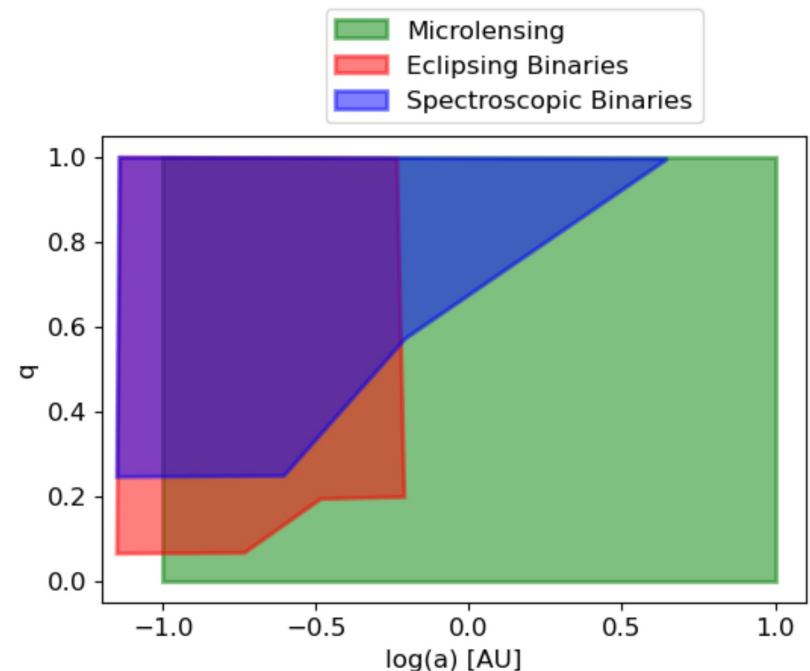


Changing separation of binary lens affects lightcurve



Microlensing probes a unique parameter space for binaries

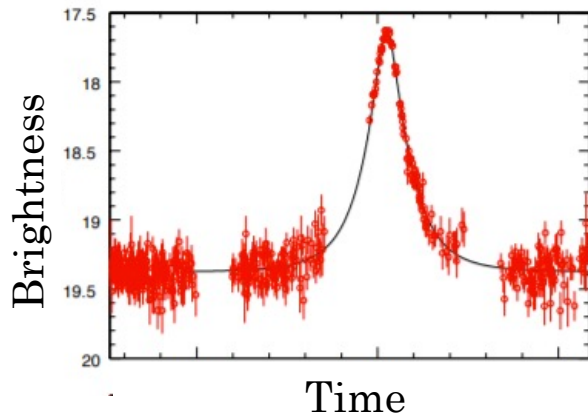
- Low mass ratio values (e.g. Bond+ 2017, Han+ 2025)
- Intermediate semimajor axes



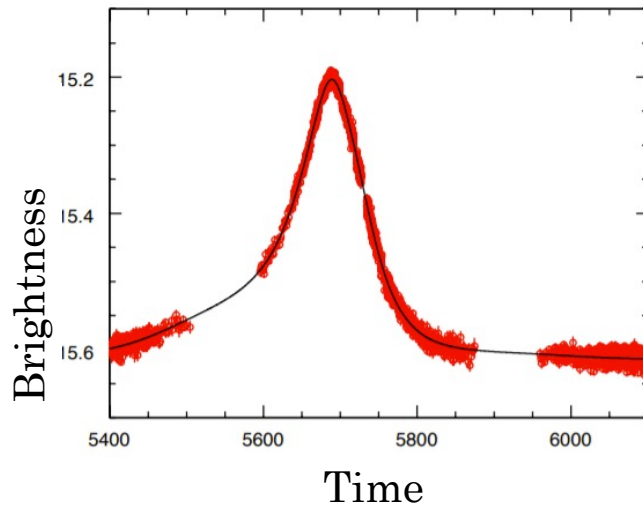
Moe & Di Stefano 2017

Abrams+ in prep

When do binaries make a measurable binary signal or when they masquerade as single lenses

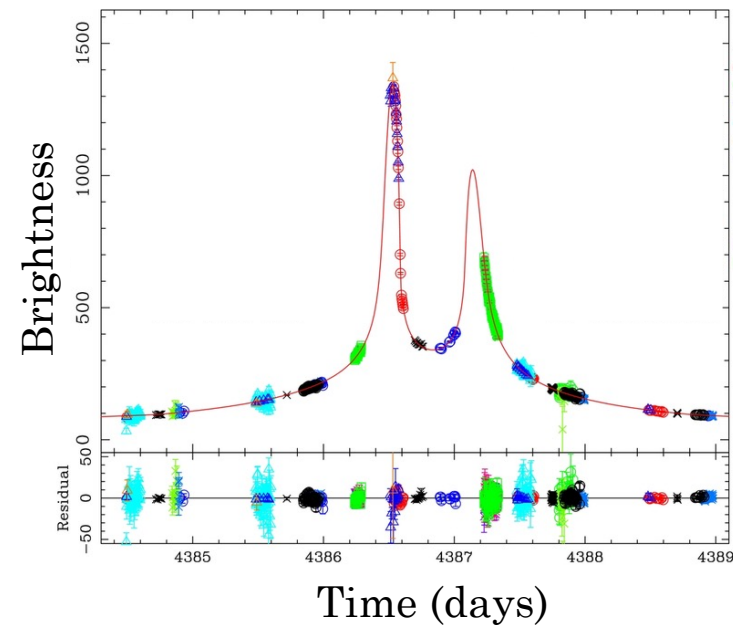


Single lens



Ambiguous Binary lens

Lu+ 2016



Miyake+ 2012

Predicting and Modeling Galactic Binary Populations with PopSyCLE Simulation



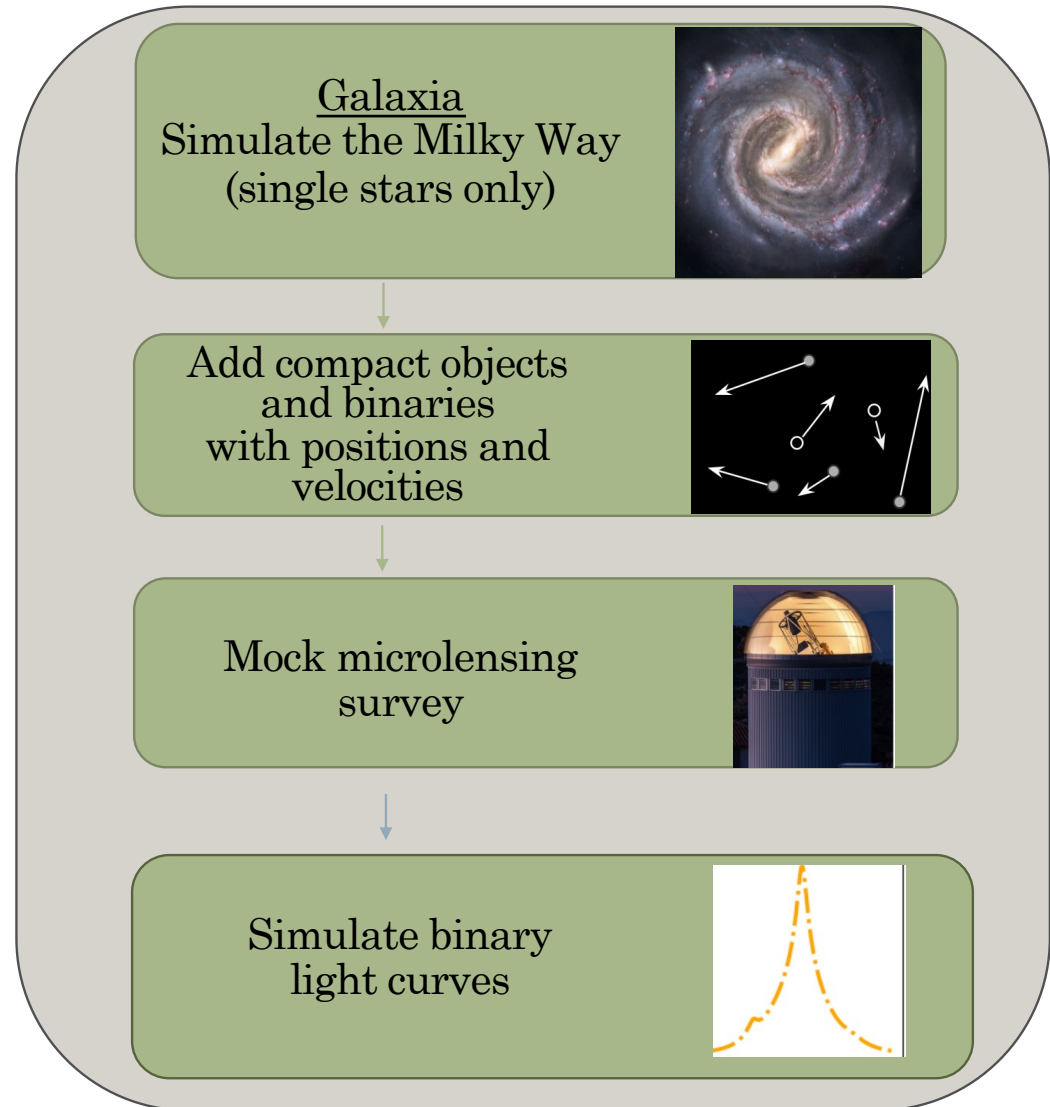
PopSyCLE

- Population Synthesis code
- Useful beyond microlensing!

Galaxia – Sharma et al. 2011;
SPISEA – Hosek et al. 2020;
PopSyCLE – Lam et al. 2020



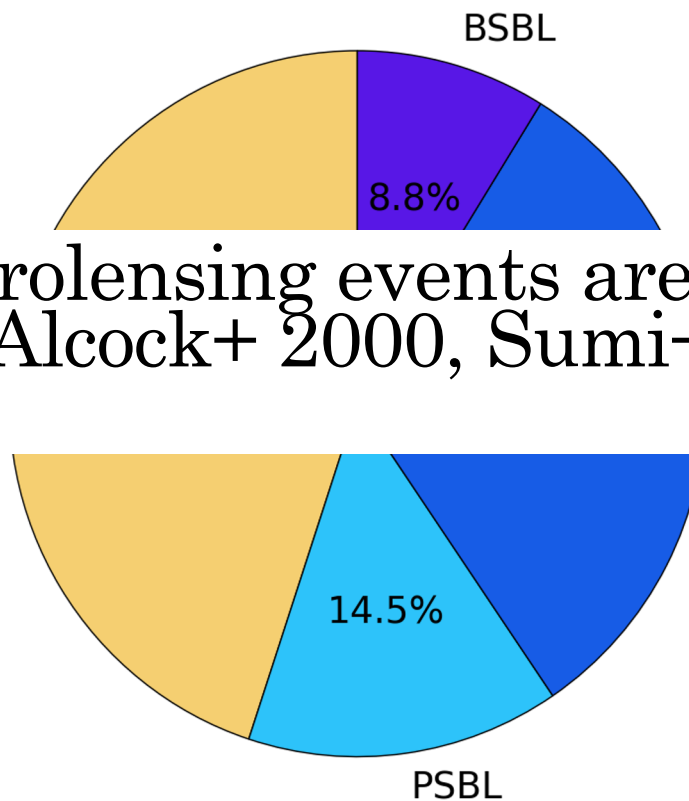
<https://github.com/jluastro/PopSyCLE>



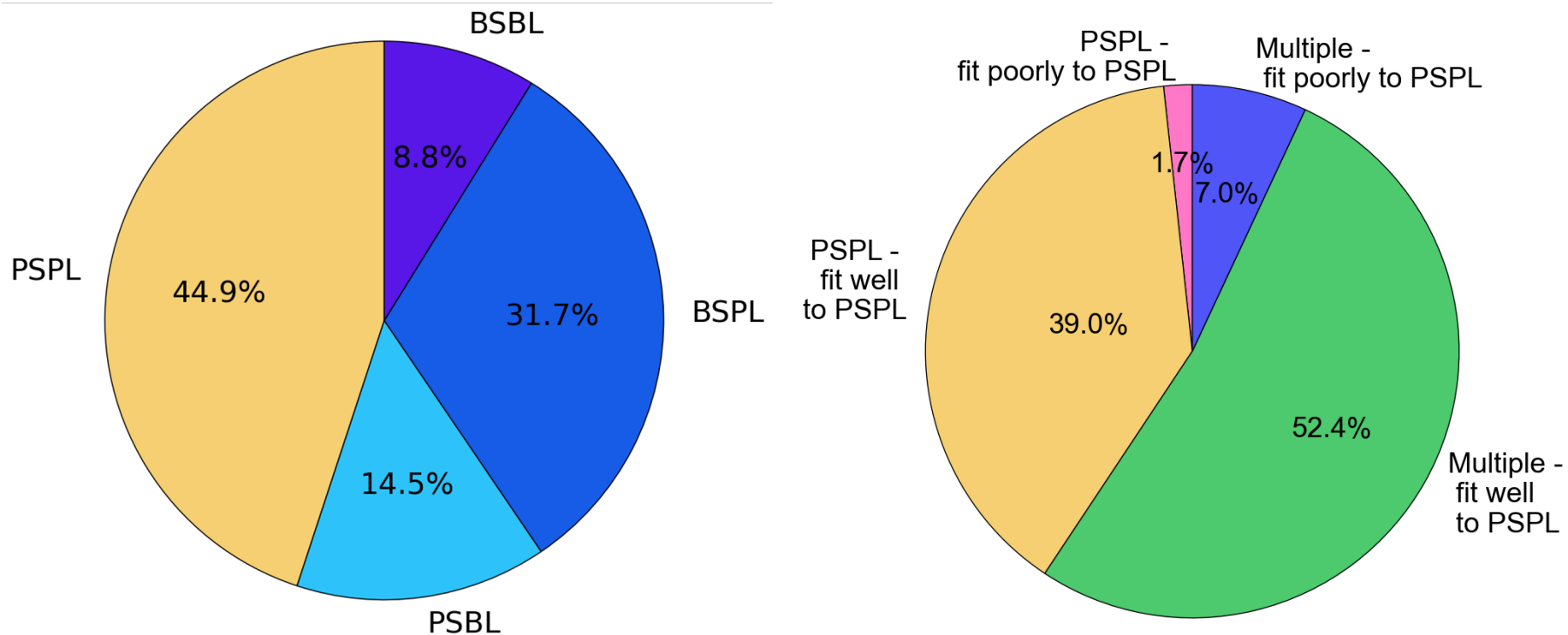
More than half of stellar and compact object microlensing events have at least one binary (ground based optical survey)



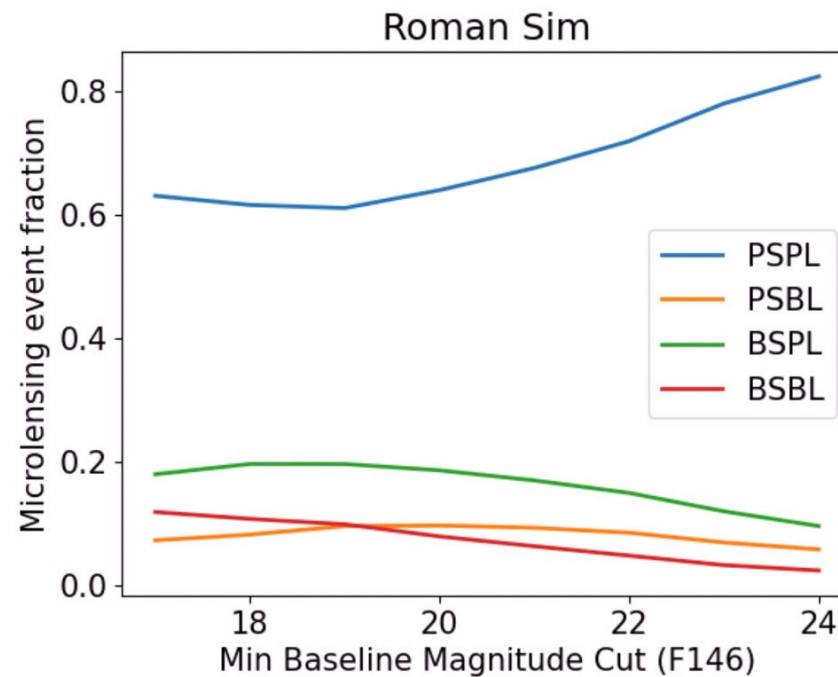
~10% of microlensing events are identified as binary (e.g. Alcock+ 2000, Sumi+ 2006, Mróz 2019)



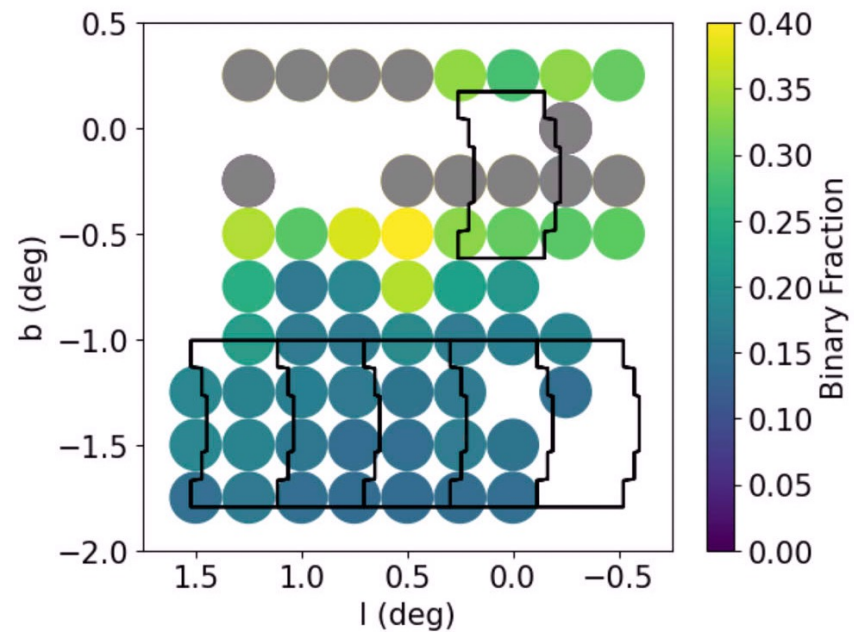
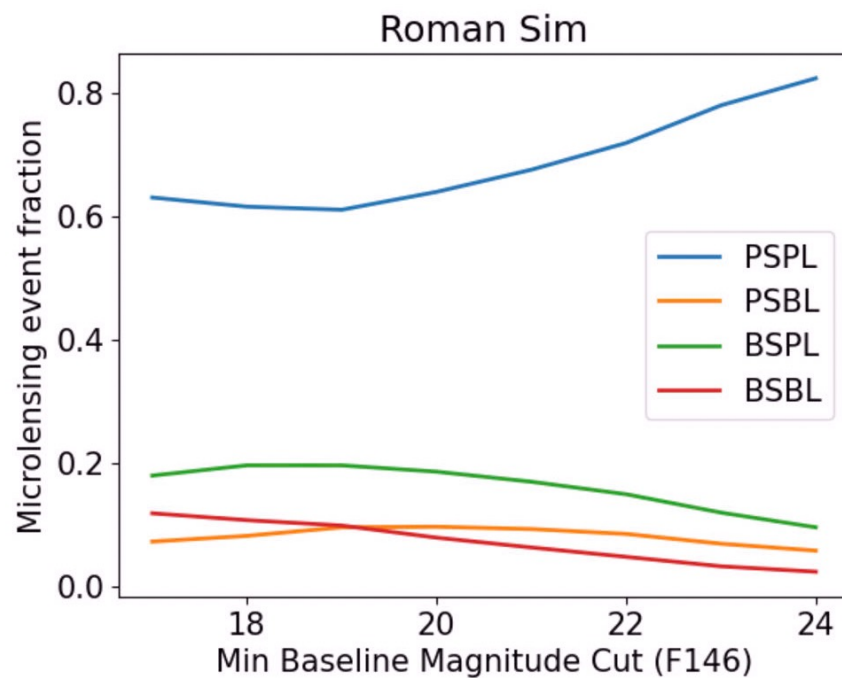
Majority of binary microlensing events were fit well by a PSPL model



Binary fraction is a function of magnitude sensitivity

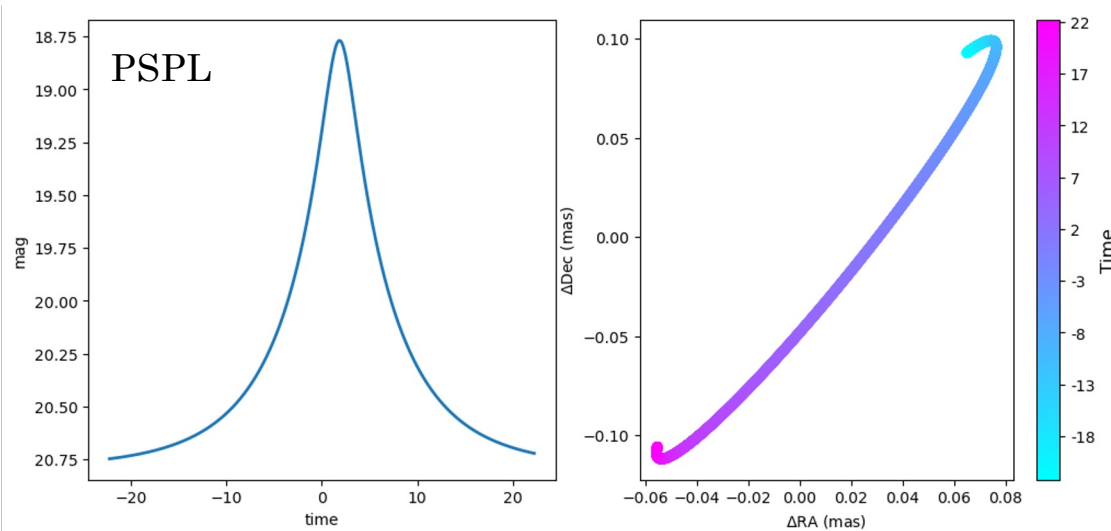
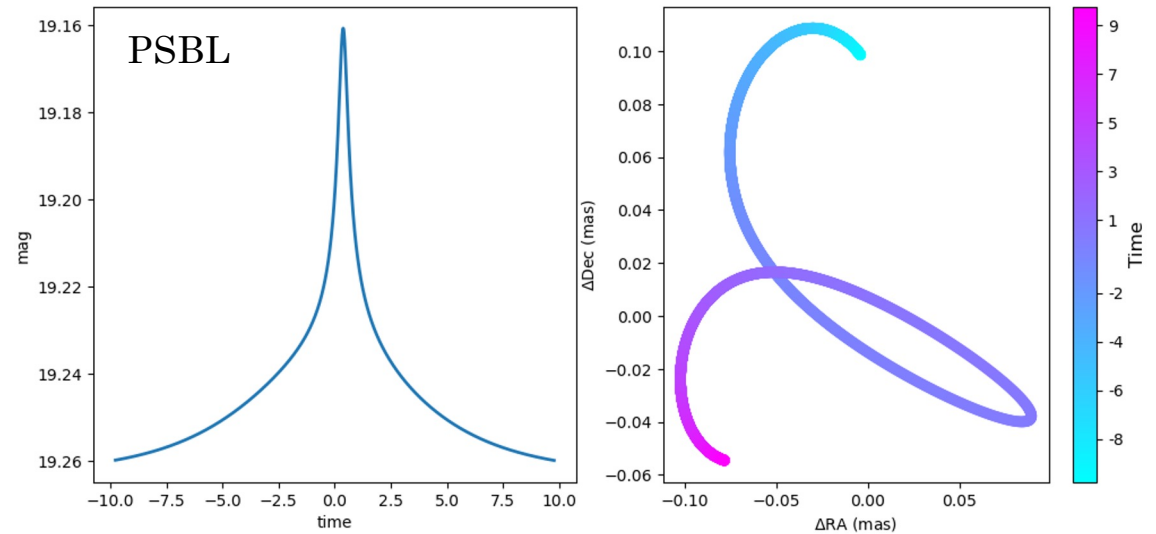


Binary fraction is a function of magnitude sensitivity and (therefore) Galactic location

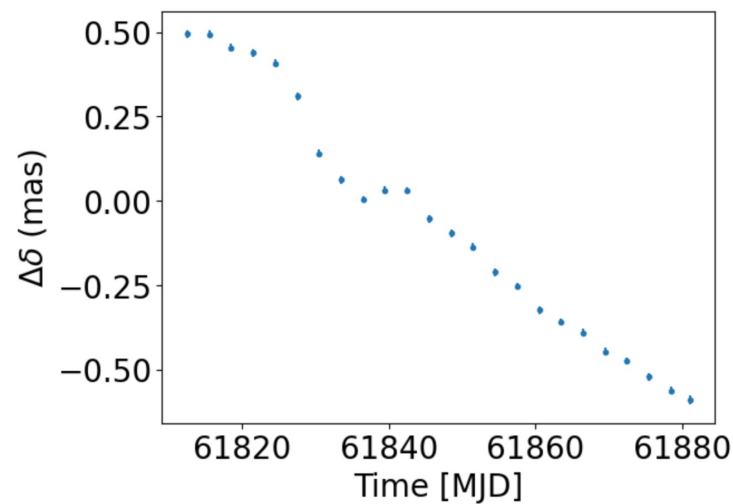
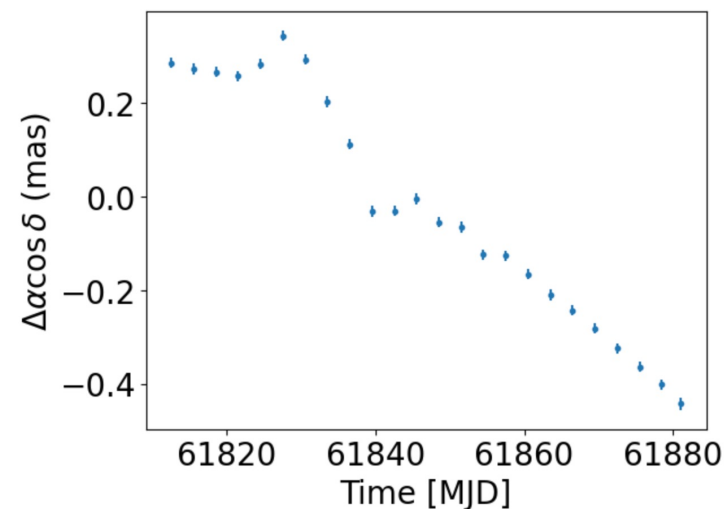
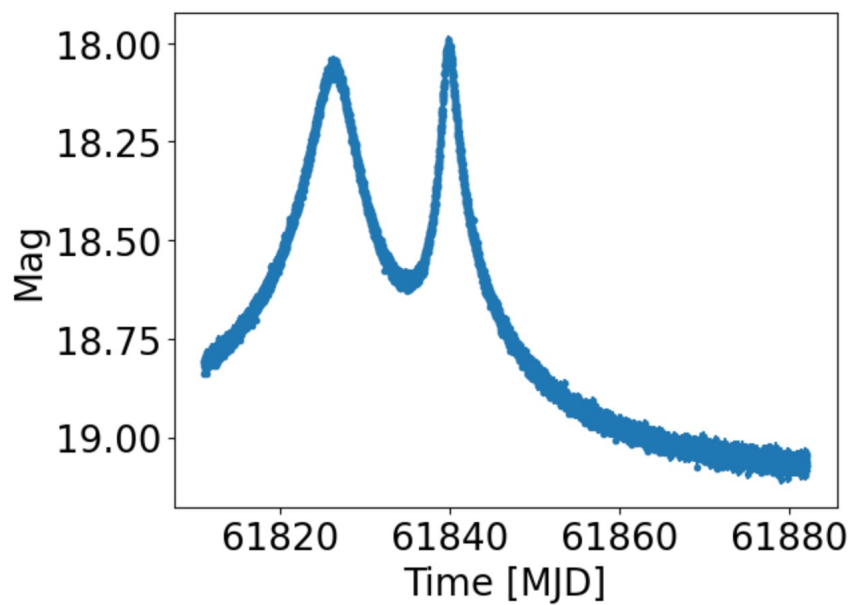


Fields with < 50 events grey

Binary lens
lightcurves with a
single peak may be
distinguishable in
their astrometric
microlensing signal

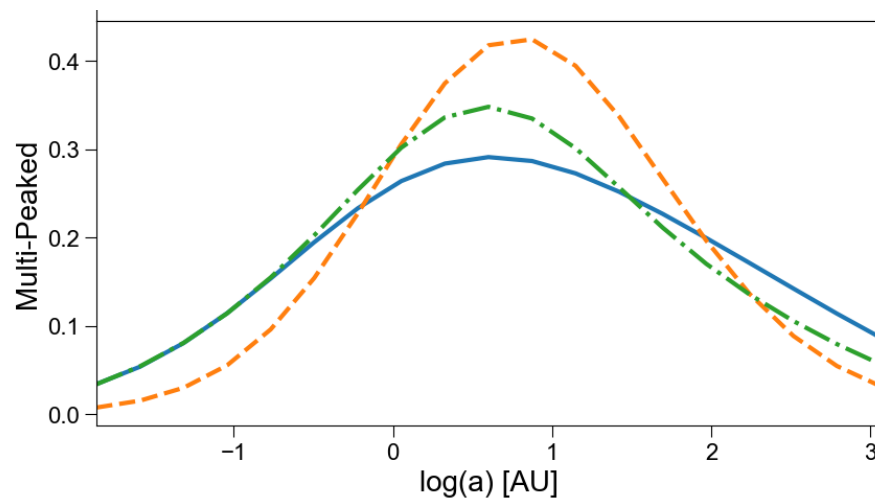


Mock Roman event

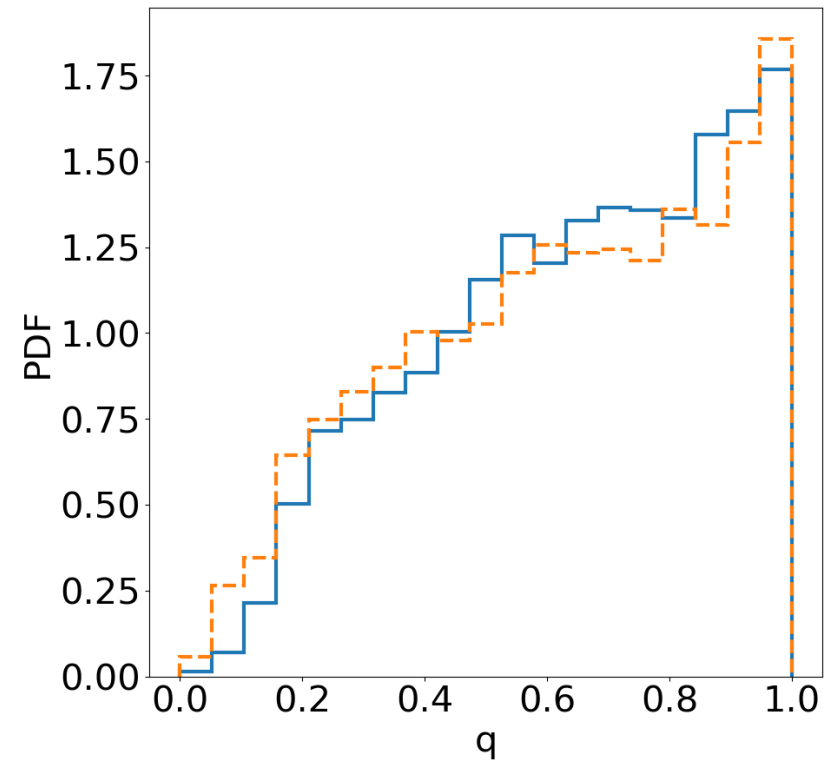


Astrometry 3-day bins

Simulated lightcurves enable completeness correction



- All binaries
- - Microlensing binary lenses
- · Microlensing binary sources



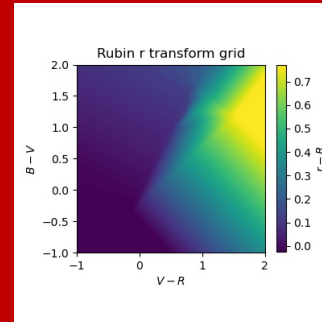
Recently completed and incoming upgrades to PopSyCLE

Incorporating binary evolution



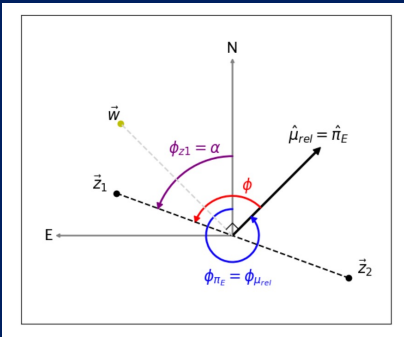
Breivik+ 2020

Rubin and Roman filters



Remulla, Abrams+ in prep

Binary orbital motion



Bhadra, Lu, Abrams+ 2026

Galactic model with objects moving through Galactic potential



Wagg+ 2025

Modular, flexible Galactic model



Klüter, Huston+ 2025

Summary

- We find that $> 50\%$ of our simulated events with PopSyCLE include a binary lens or source system for ground based surveys
- Critical for microlensing surveys to include binarity in predictions and modeling
- Joint photometric and astrometric measurements will enable better identification and measurement of binaries
- Roman microlensing will allow probe low mass ratio and intermediate semi-major axis binaries

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PopSyCLE
Binary
Microlensing:

