

Illuminating Hidden Binary Parameter Space with Roman Microlensing



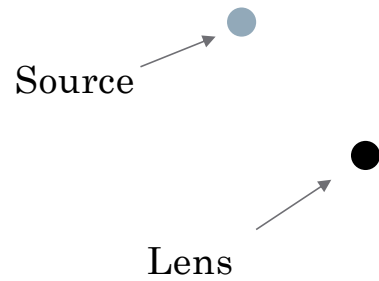
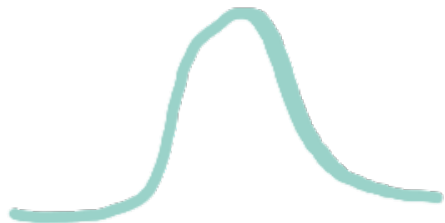
Packages used in
this work!

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Remulla, Michael Medford, Matthew Hosek, Sam Rose, Macy Huston,
Sean Terry, Dex Bhadra, Andrew Scharf

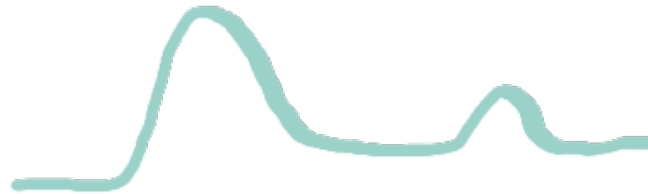
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Roman Shifting Landscapes 7-14-26

PSPL



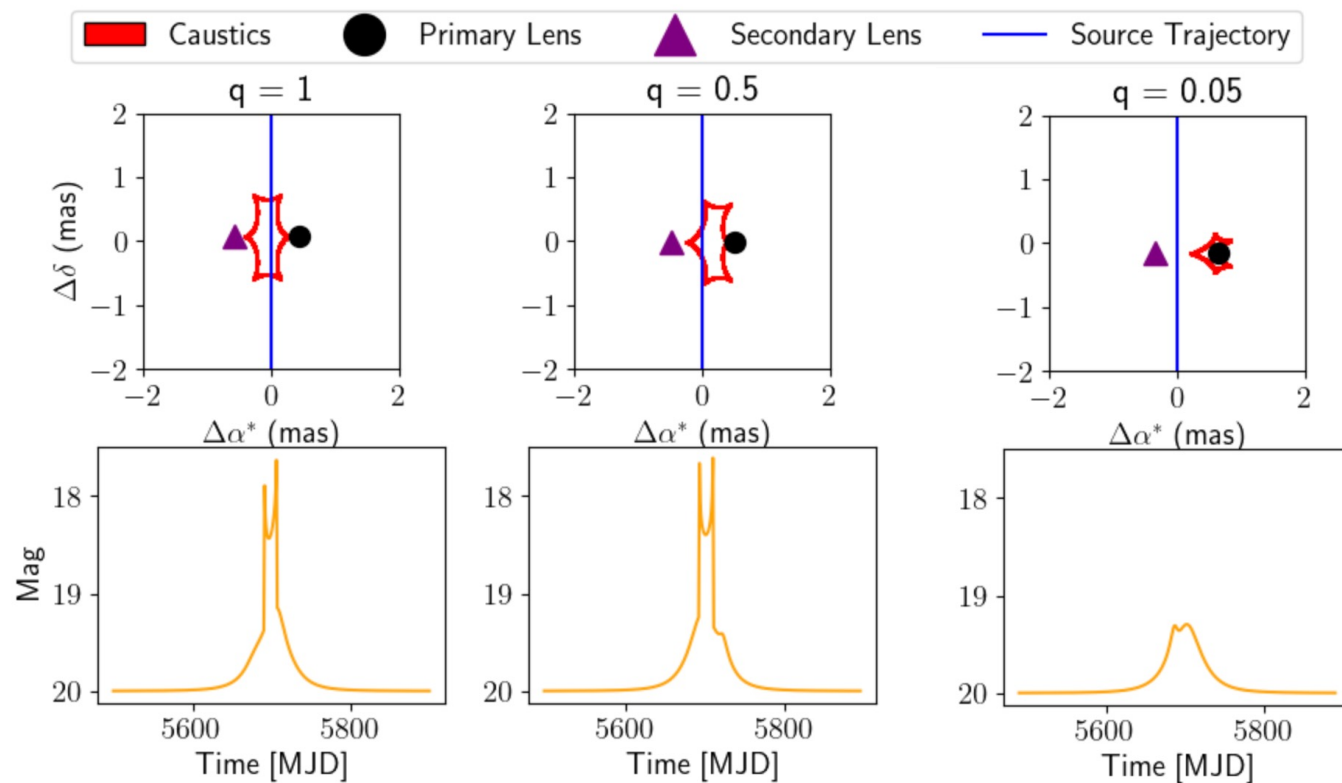
BSPL



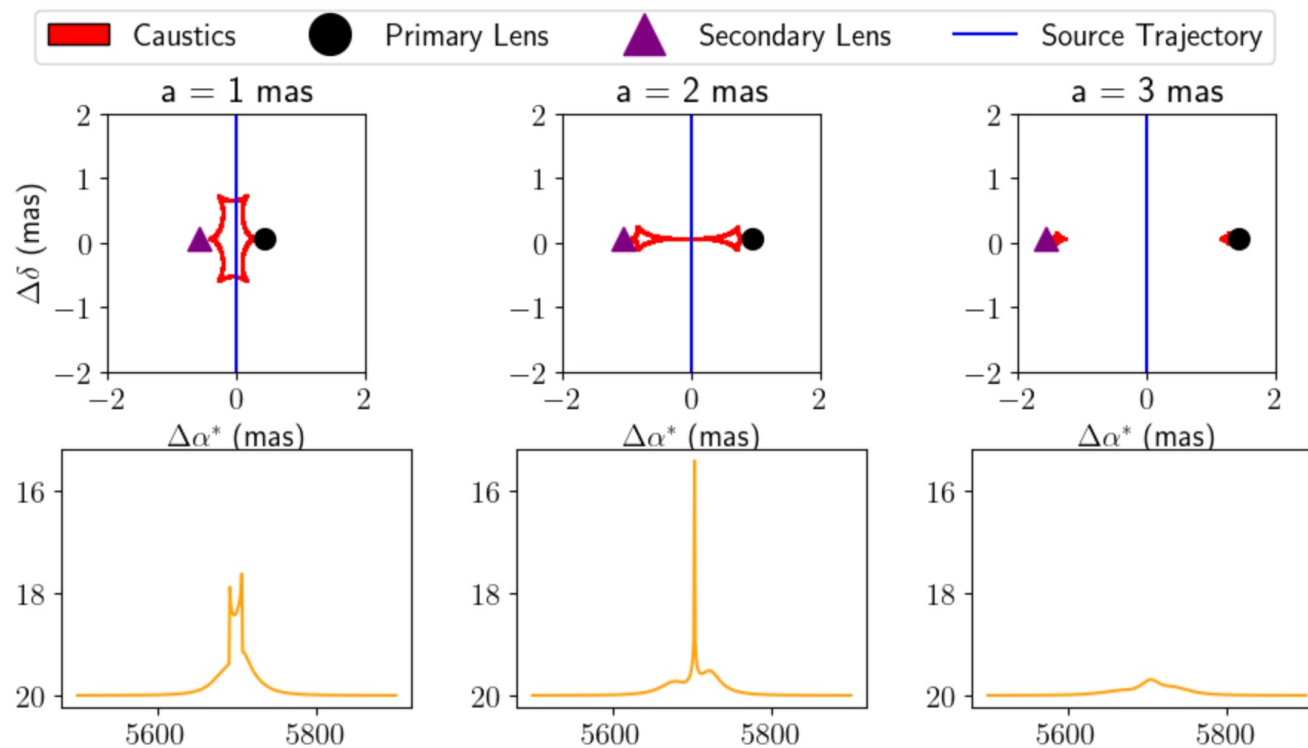
PSBL



Changing mass ratio of binary lens affects lightcurve

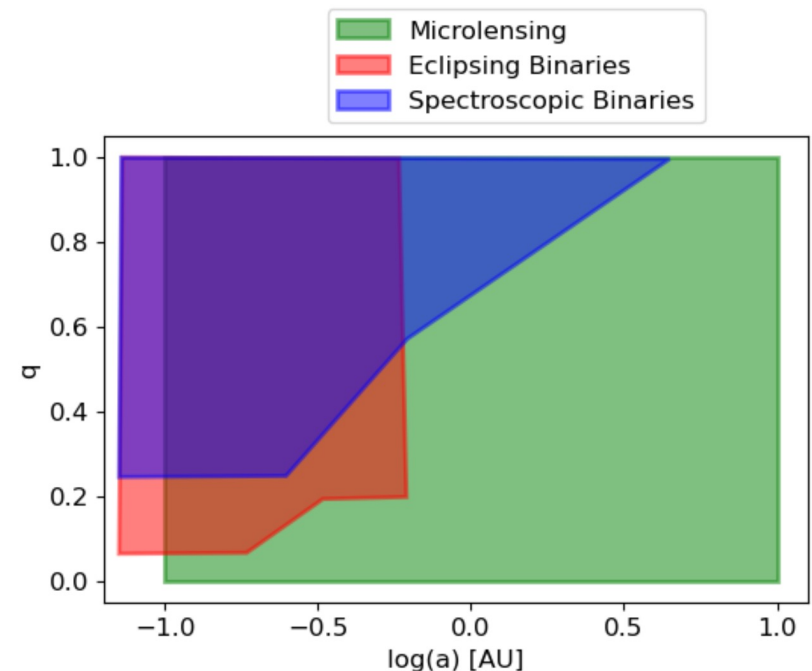


Changing separation of binary lens affects lightcurve



Microlensing probes a unique parameter space for binaries

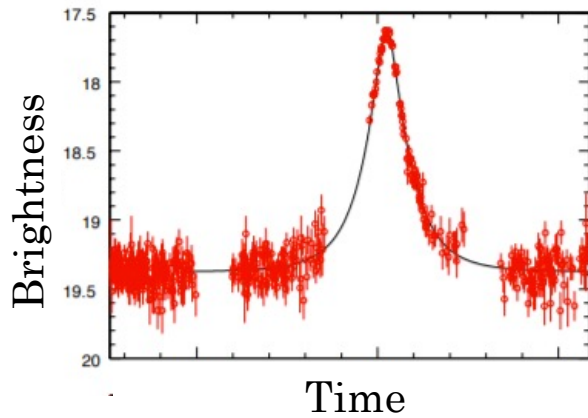
- Low mass ratio values (e.g. Bond+ 2017, Han+ 2025)
- Intermediate semimajor axes



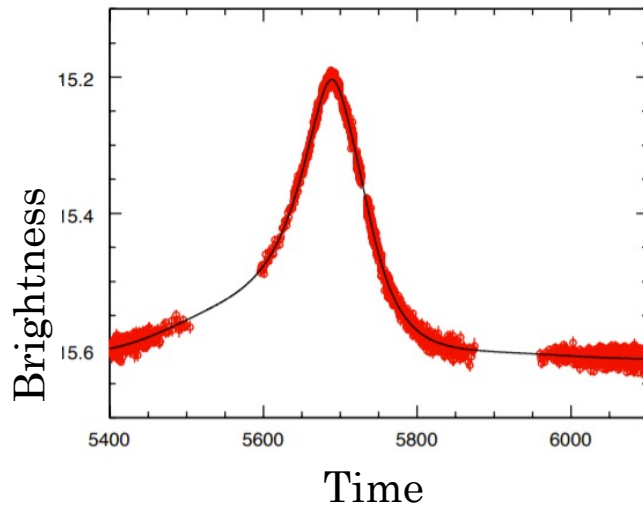
Moe & Di Stefano 2017

Abrams+ in prep

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



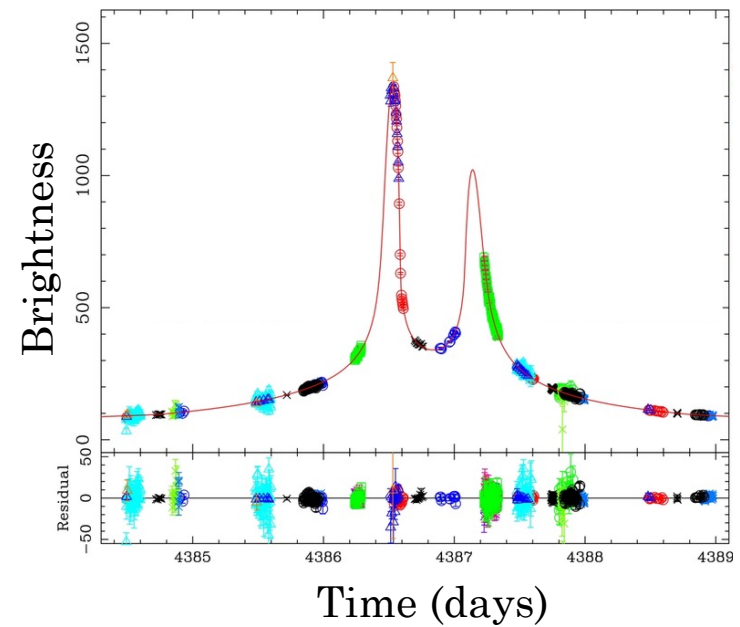
Single lens



Ambiguous Binary lens

Lu+ 2016

Obvious binary



Miyake+ 2012

Predicting and Modeling Galactic Binary Populations with PopSyCLE Simulation



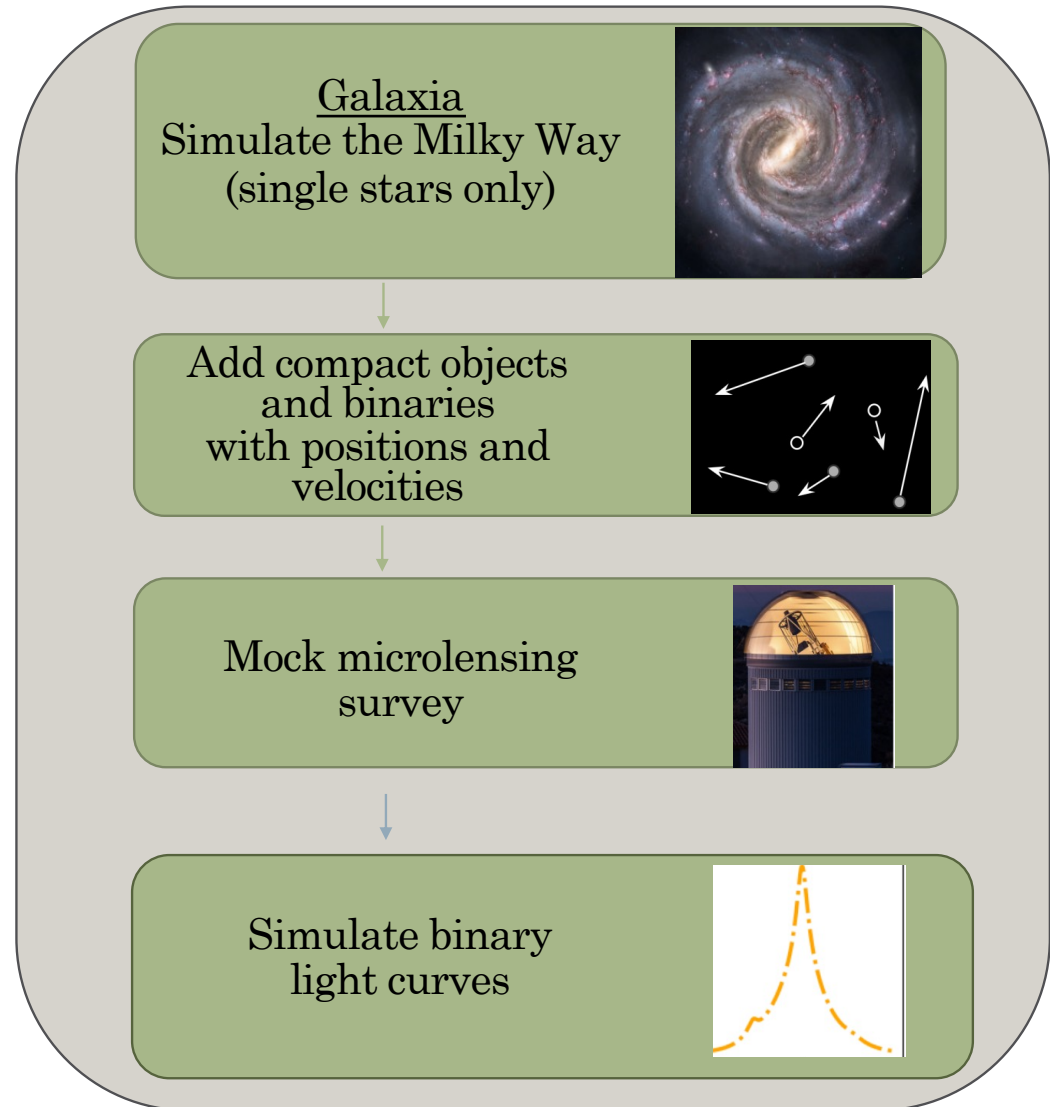
PopSyCLE

- Population Synthesis code
- Useful beyond microlensing!

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



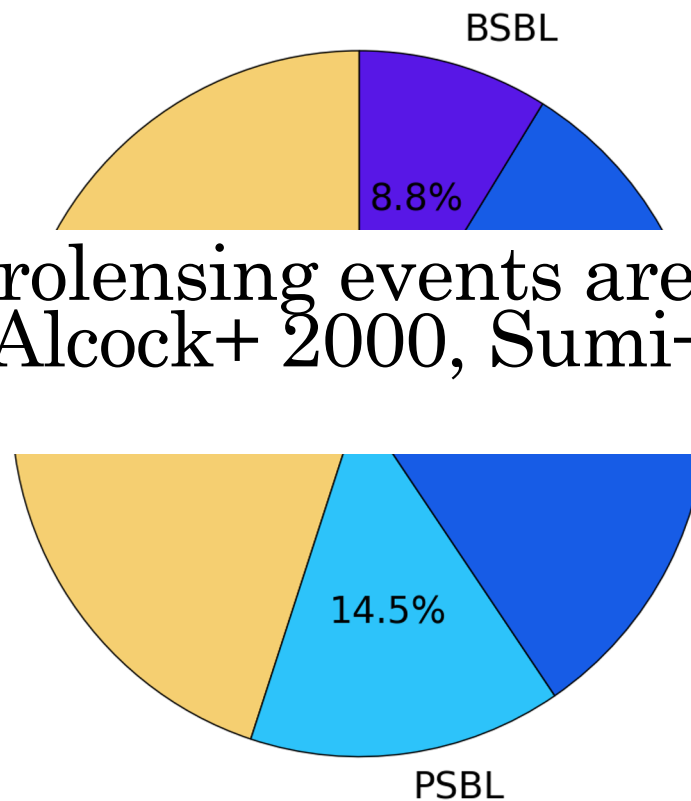
<https://github.com/jluastro/PopSyCLE>



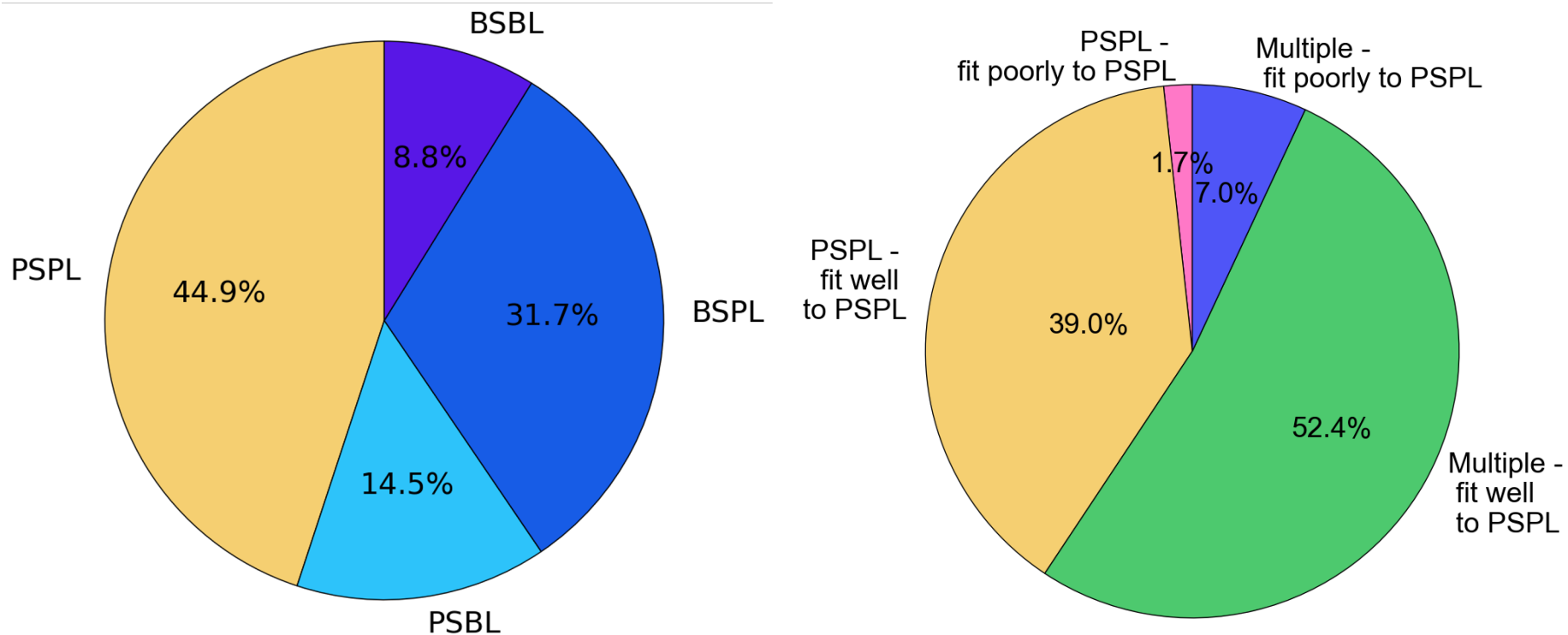
More than half of stellar and compact object microlensing events have at least one binary (ground based optical survey)



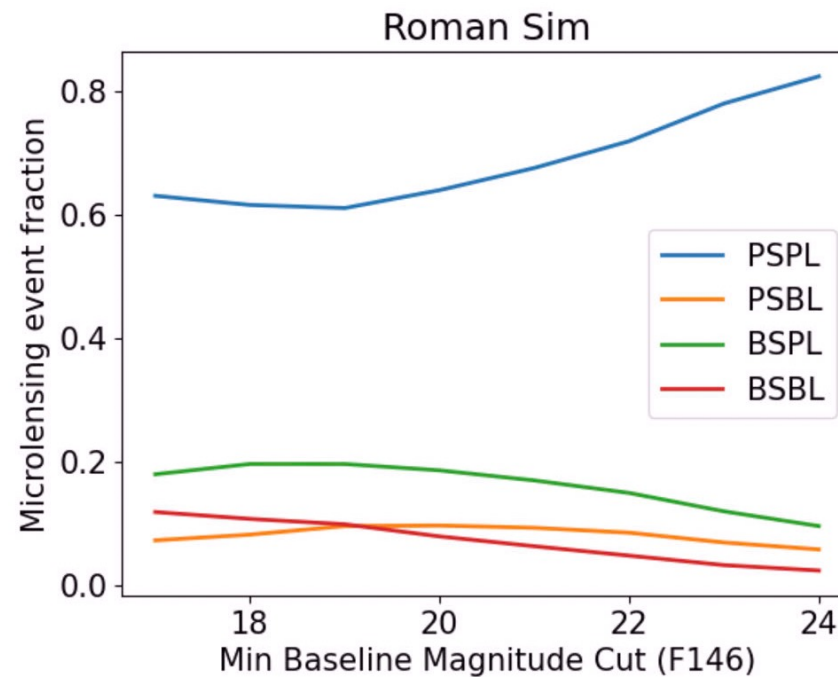
~10% of microlensing events are identified as binary (e.g. Alcock+ 2000, Sumi+ 2006, Mróz 2019)



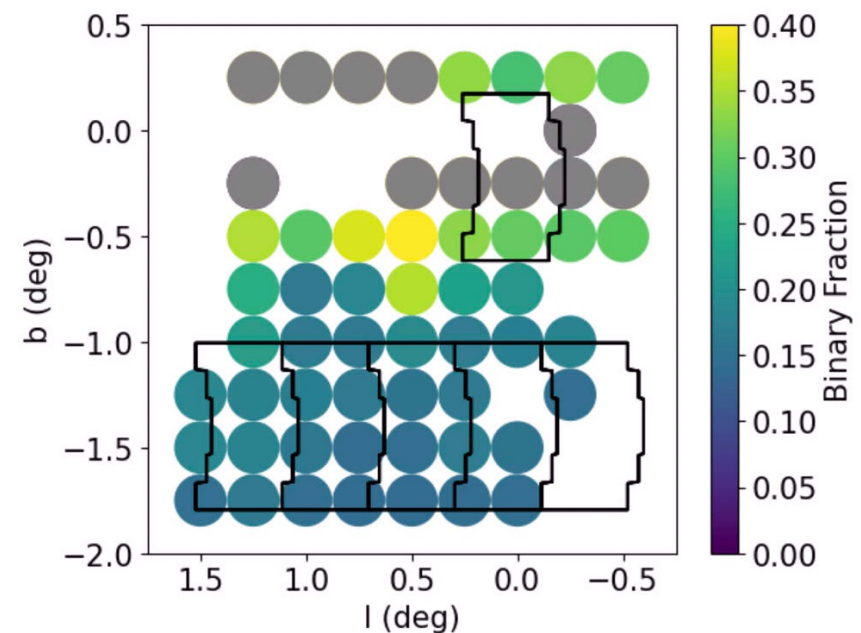
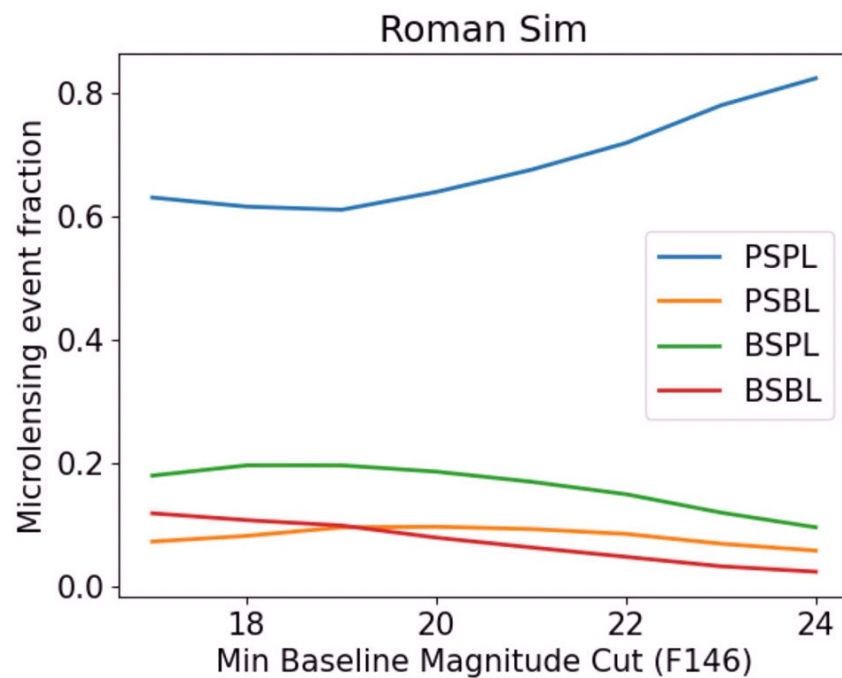
Majority of binary microlensing events were fit well by a PSPL model



Binary fraction is a function of magnitude sensitivity



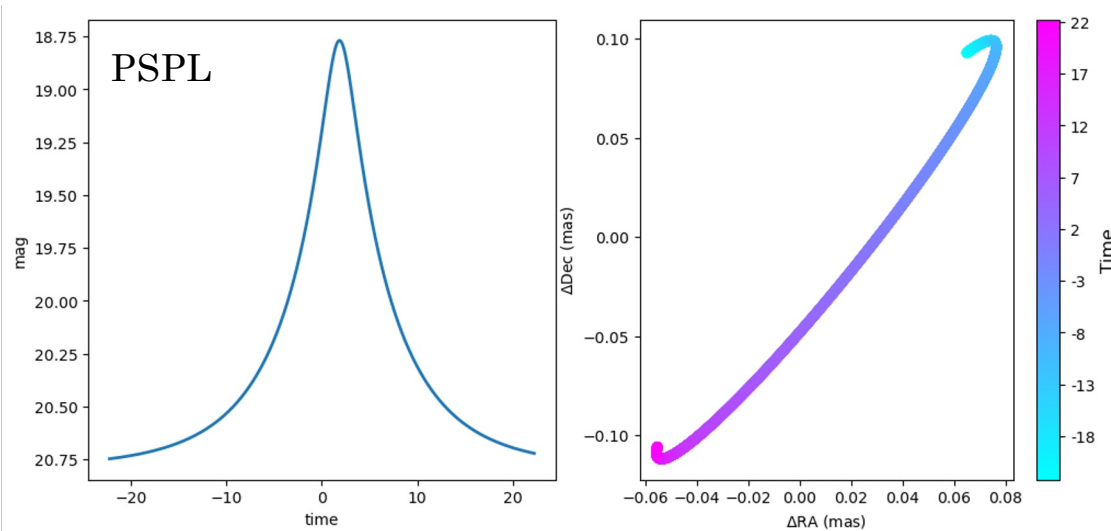
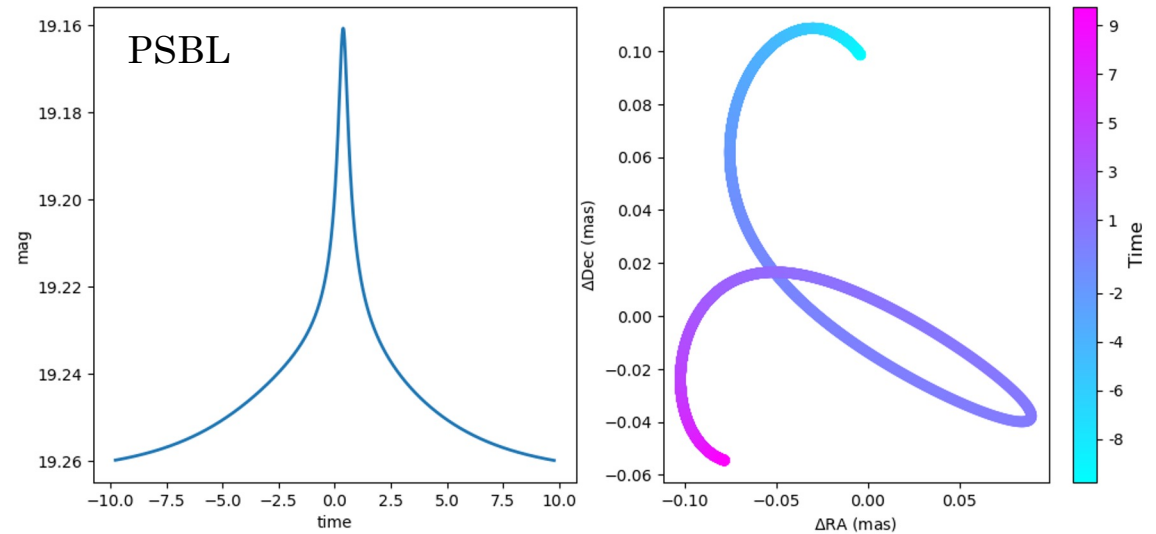
Binary fraction is a function of magnitude sensitivity and (therefore) Galactic location



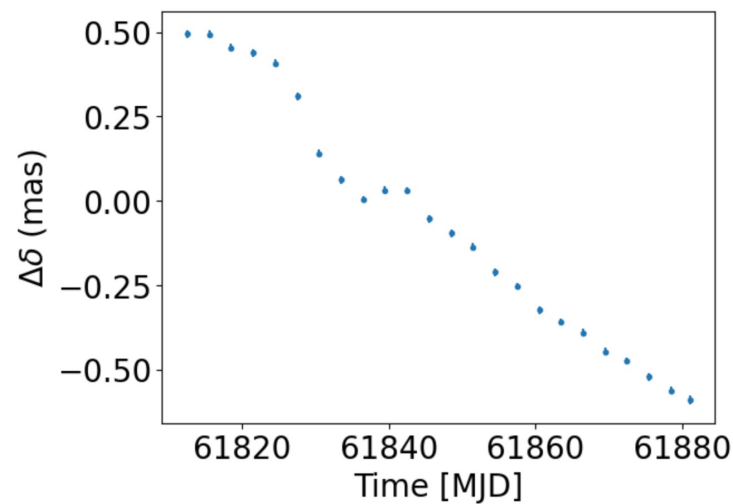
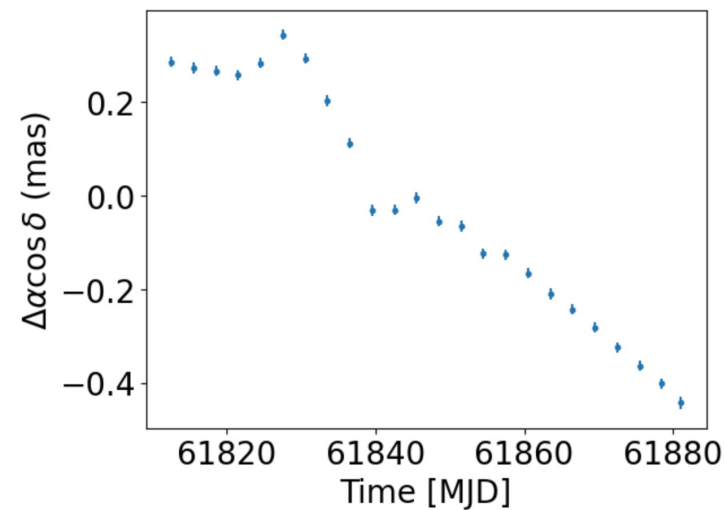
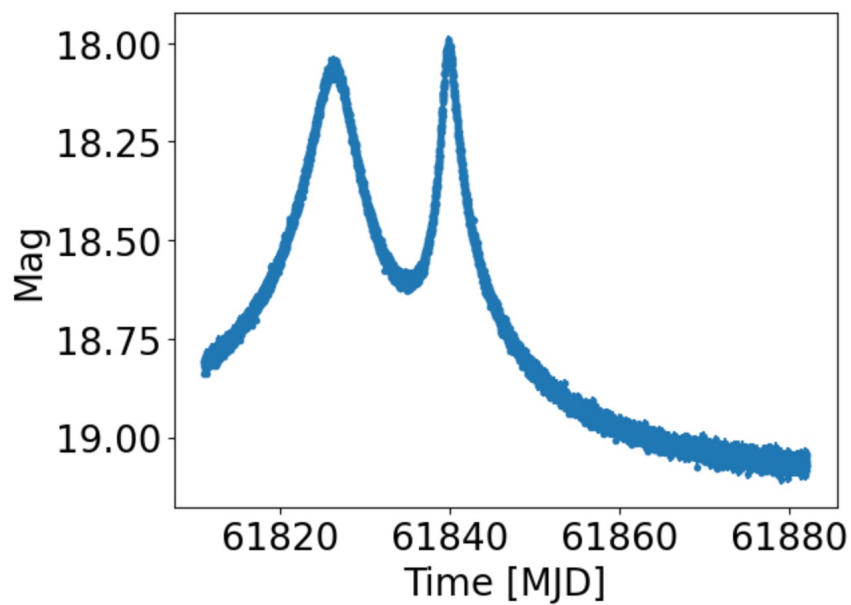
Note!! Does not include Nuclear Stellar Disk and Nuclear Stellar Cluster, so we underpredict events in the Galactic center here

Fields with < 50 events grey

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

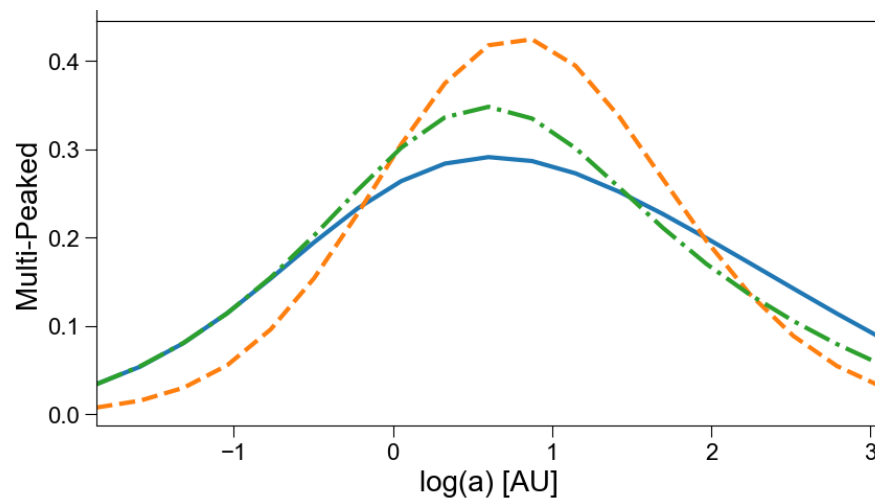


Mock Roman event

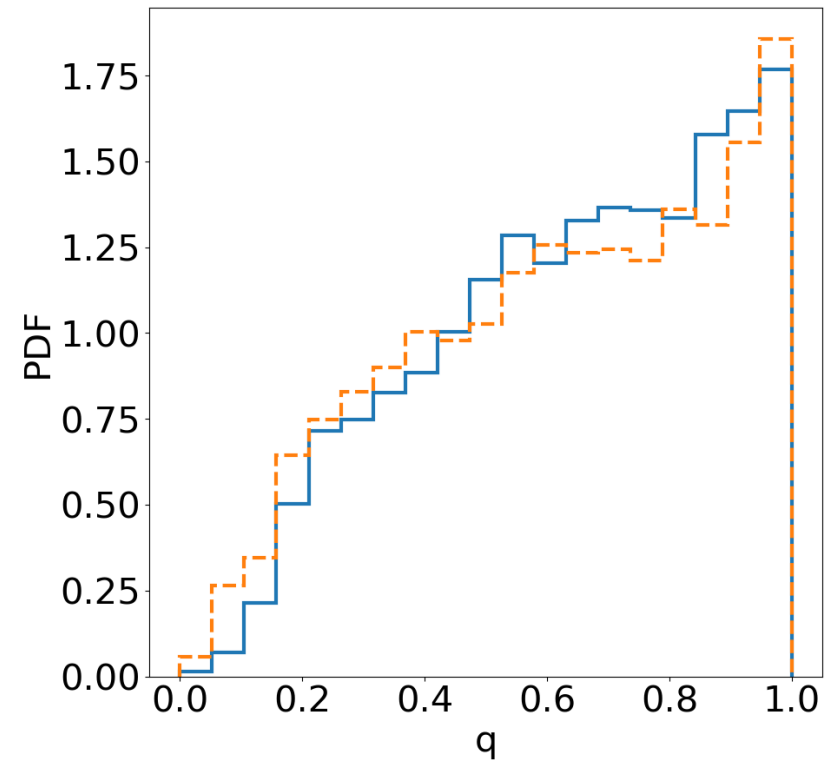


Astrometry 3-day bins

Simulated lightcurves enable completeness correction



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



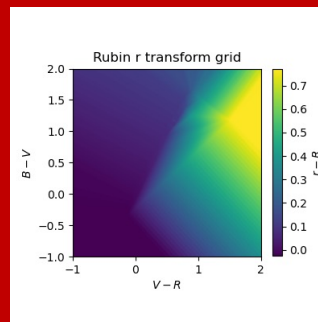
Recently completed and incoming upgrades to PopSyCLE

Incorporating binary evolution



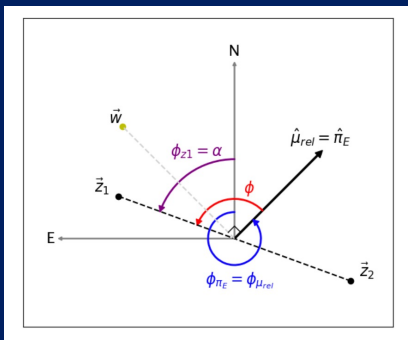
Breivik+ 2020

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:

