

WFIRST Microlensing Pipeline

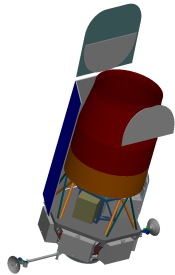
As part of MICROSIT

NASA Goddard

University of Maryland College Park

June 18, 2019

WFIRST Exoplanet Microlensing Survey

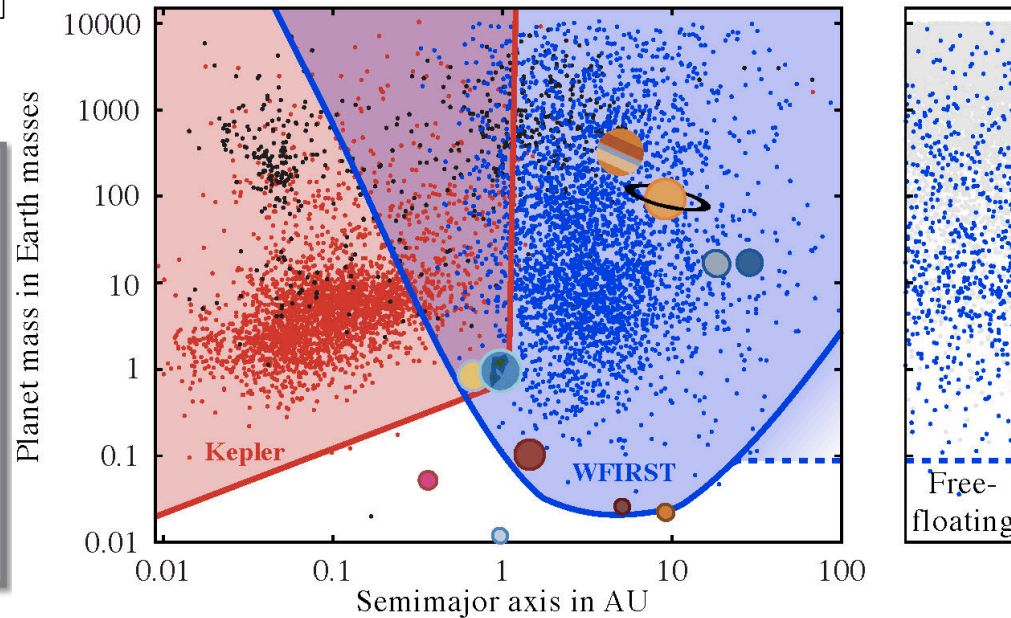


Selected as top priority project in 2010 Decadal Survey

Together, Kepler and WFIRST complete the statistical census of planetary systems in the Galaxy.

WFIRST will

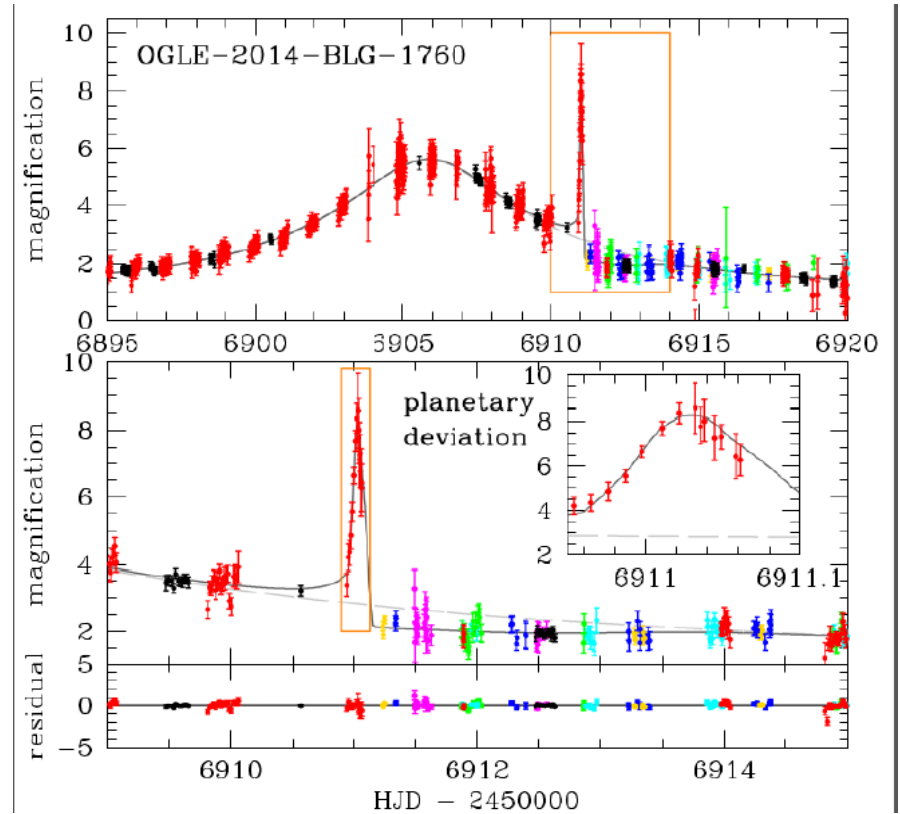
- 1) detect and
- 2) measure mass
- 3) build mass function of planets



Science Needs

- *Light curves to detect the planetary signal*
- Mass Measurement using host star detection or parallax measurement
- Detection Efficiency Calculation and yielding Mass Function

Requires: Time series Photometry + Detection and analysis of time varying Modeling, star catalog of proper motions

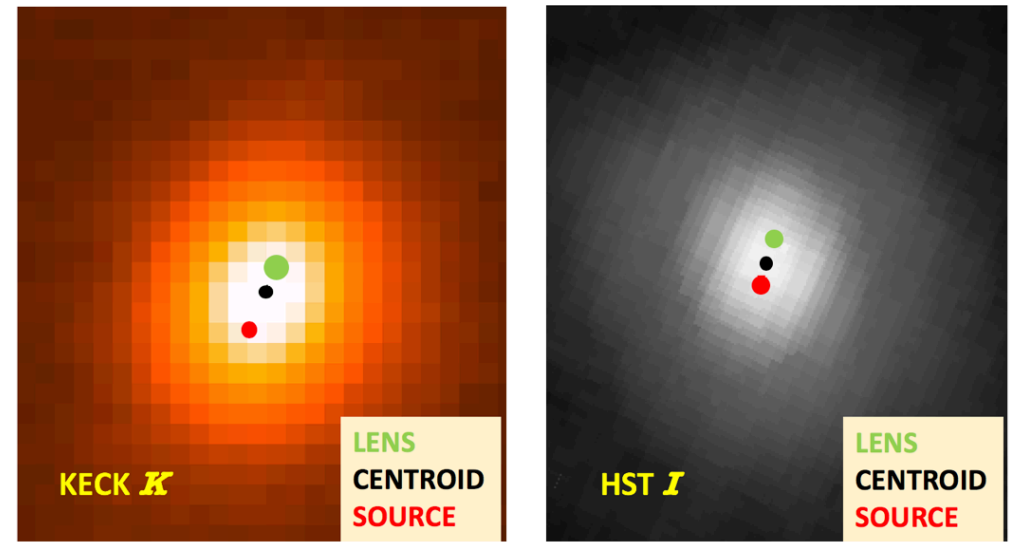


Bhattacharya+ 2016

Science Needs

- Light curves to detect the planetary signal
- *Mass Measurement using host star detection or parallax measurement*
- Detection Efficiency Calculation and yielding Mass Function

Requires: High Precision Astrometry specially in crowded fields, Track of neighbors and contaminations from binaries, Uncertainties as a function of positions, brightness and color, aims to measure centroid shift of 3 mas shift at 3 sigma, data handling of >6000 images

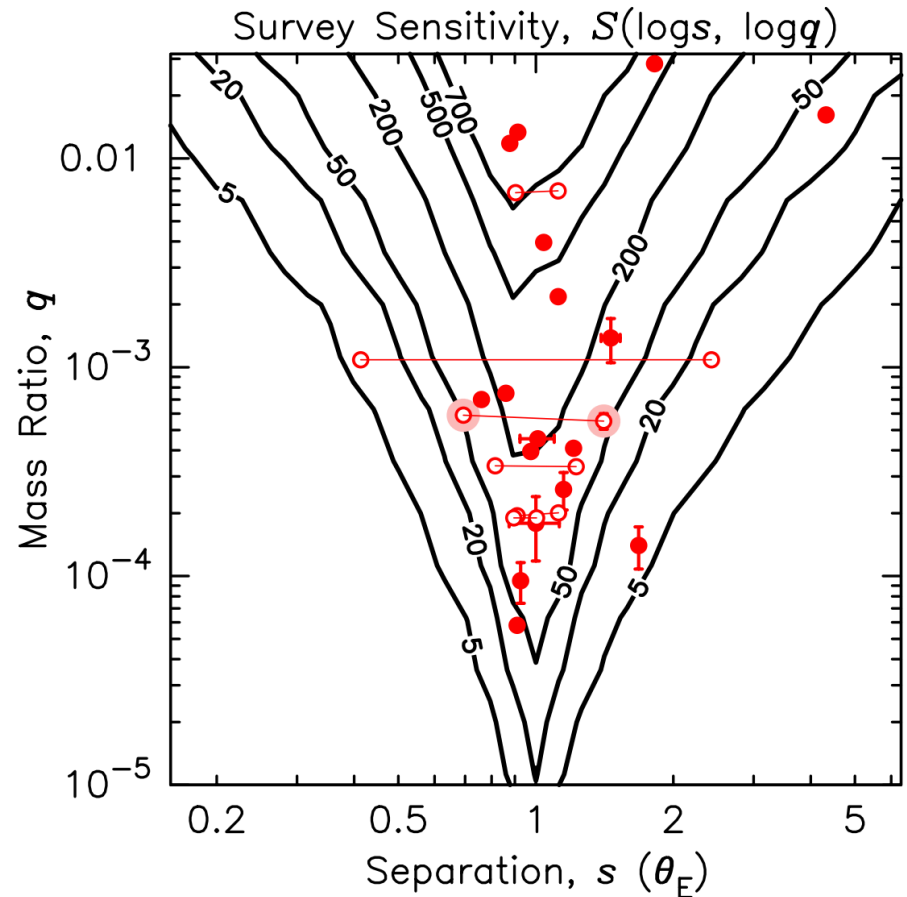


HST -> 7 images, Keck -> 40 images

Science Needs

- Light curves to detect the planetary signal
- Mass Measurement using host star detection or parallax measurement
- *Detection Efficiency Calculation and yielding Mass Function*

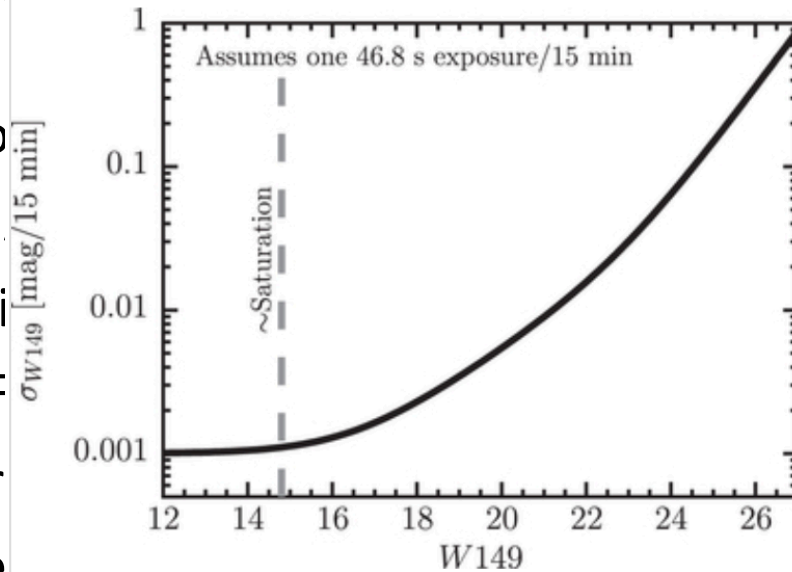
Requires: Injection of planet anomalies in the light curves, Injection of stars with different brightness at image level, reliability of the software



Suzuki+ 2016

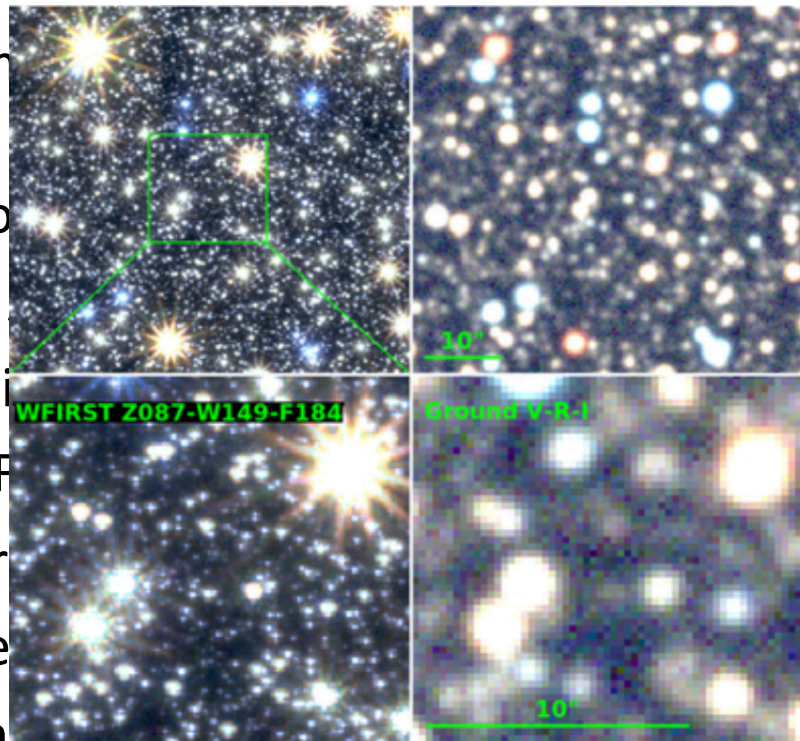
Parts of Microlensing pipeline interesting to other science

- Build Reference image and keep track of star catalog: mag, color, err, positions, proper motion)
- Time series photos
- Difference Image
- Detection of moving sources
- Crowded field PSF model for wings
- Following a hybrid model for wings
- --Empirical model
- PSF model varying with space and color



Parts of Microlensing pipeline interesting to other science

- Build Reference in positions, proper
- Time series photo
- Difference Image
- Detection of movi
- Crowded field PSF
Following a hybr
--Empirical mode
- PSF model varying with space and color



g: mag, color, err,

el for wings

Parts of Microlensing pipeline interesting to other science (continued)

- Microlensing modeling of light curves (including non-planetary)
- Injections of stars of different magnitudes at image level
- Completeness calculation and reliability of software
- Calibration using PRIME telescope – IR microlensing survey -science data of 5 yrs before launch
- Photometry and astrometry will be in several batches:
 - Daily photometry
 - End each season photometry
 - End of all season photometry

Additional Advantage

- ~40000 images over 6 seasons (W149), ~1000 images in other passbands, ~6000 images every season
- Total microlensing field area $\sim 2 \text{ deg}^2$, 100 millions of stars.
- High precision photometry + astrometry + time series variation
- The pipeline prototype will be built and tested for efficient algorithms and bugs -- Before and during the mission, i.e. till 2031 (season in the beginning and in the end)
- Updated catalog daily, each season and end of season

Huge insight into data – please take advantage of it!!

Open to better algorithms or testing algorithm ideas from other SIT

Thank you!!