

Summary report of Microlensing break out session

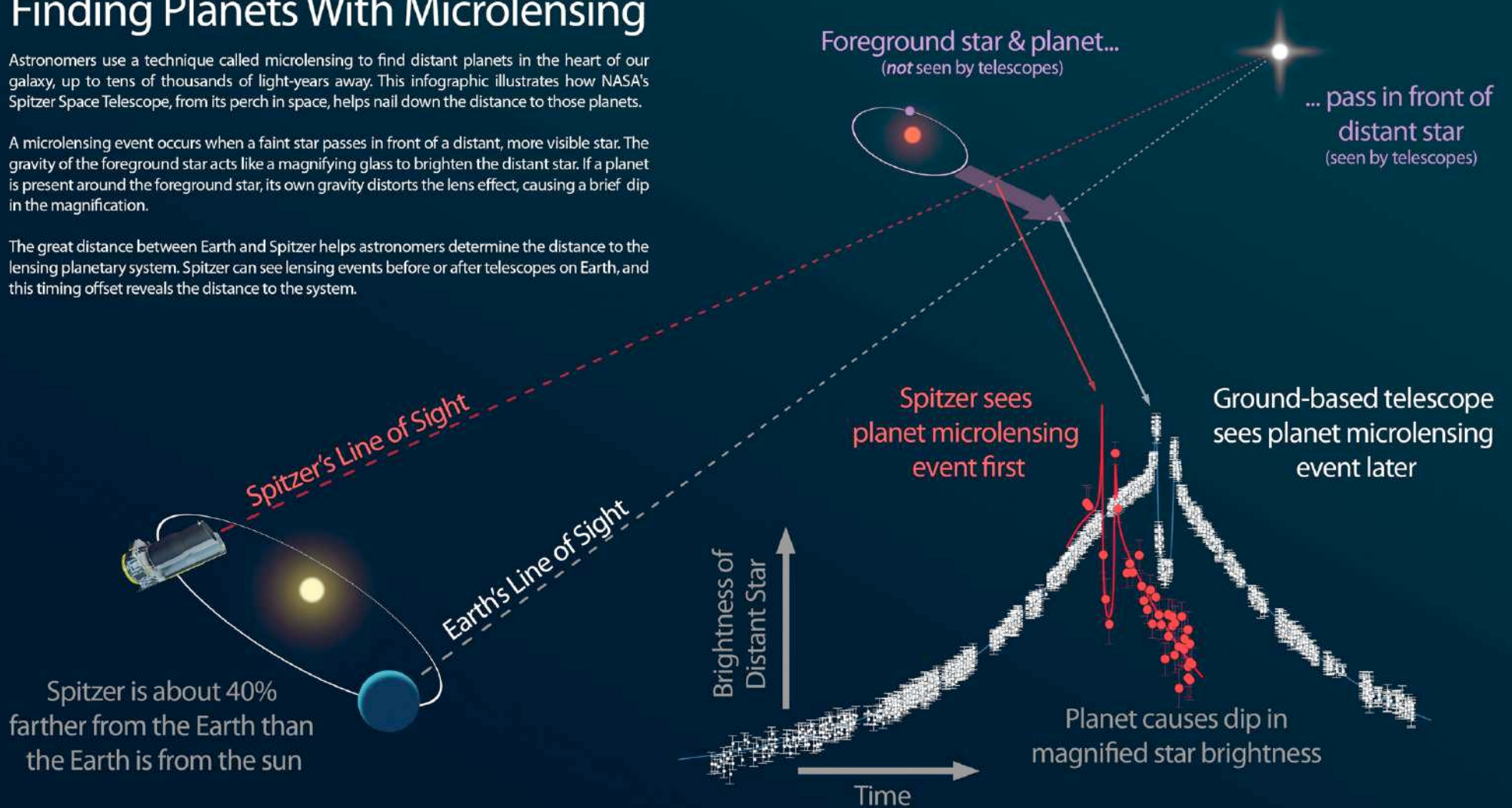
Toward Precise Mass

Finding Planets With Microlensing

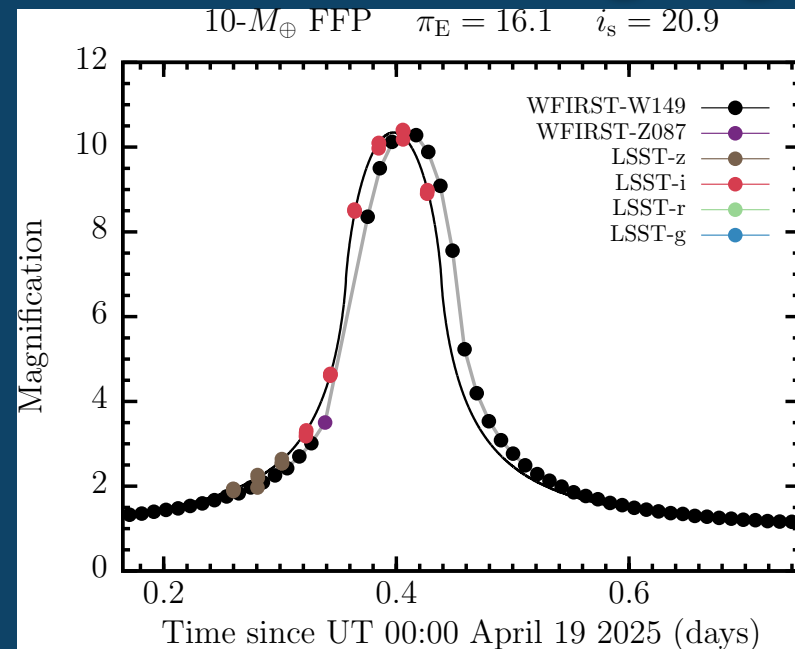
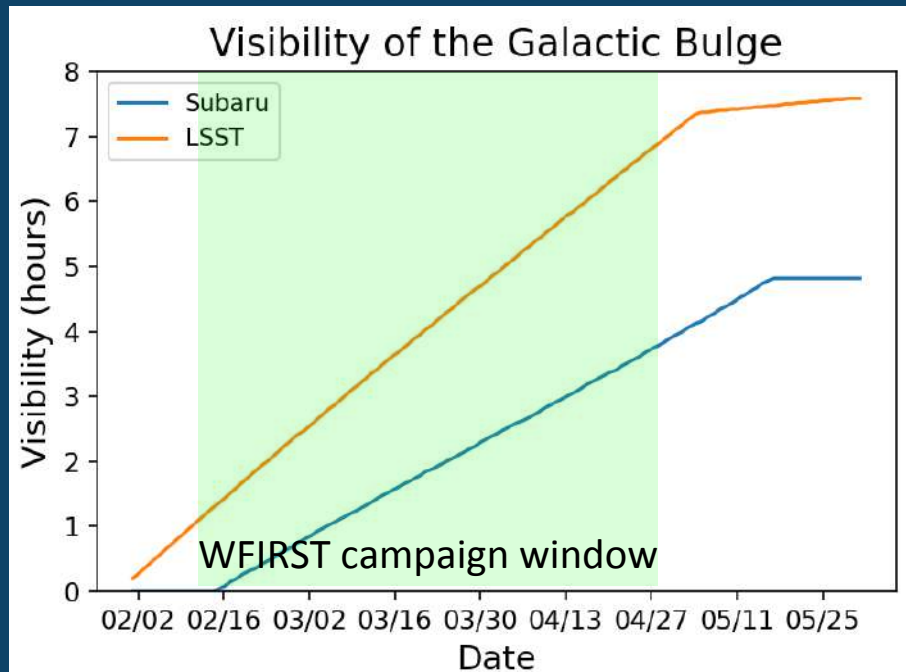
Astronomers use a technique called microlensing to find distant planets in the heart of our galaxy, up to tens of thousands of light-years away. This infographic illustrates how NASA's Spitzer Space Telescope, from its perch in space, helps nail down the distance to those planets.

A microlensing event occurs when a faint star passes in front of a distant, more visible star. The gravity of the foreground star acts like a magnifying glass to brighten the distant star. If a planet is present around the foreground star, its own gravity distorts the lens effect, causing a brief dip in the magnification.

The great distance between Earth and Spitzer helps astronomers determine the distance to the lensing planetary system. Spitzer can see lensing events before or after telescopes on Earth, and this timing offset reveals the distance to the system.



Simultaneous HSC & WFIRST Imaging

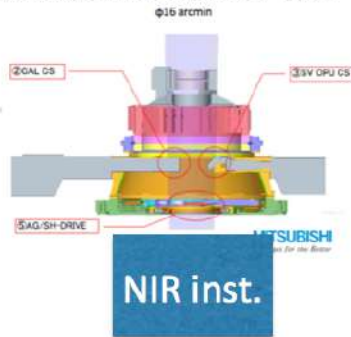


- We propose simultaneous imaging with both LSST & Subaru HSC
- 15-30 minute cadence
- WFIRST – LSST & Subaru microlensing parallax is only way to measure mass of free-floating planets
- WFIRST observing seasons are optimal for parallax signal, but not ground-based observations
- Only a small fraction of free-floating planets can be observed from the ground, but even weak detections will be useful.
- The only way to provide alerts – WFIRST will not have rapid alerts

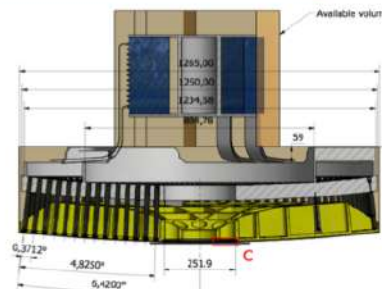
Concurrent Observations using ULTIMATE-Subaru

(3) Wavefront Sensors

4x LGS
> 8x8 Shack-Hartmann for each
3x Tip/Tilt NGS
2x2 Shack-Hartmann for each



(1) Adaptive Secondary Mirror



Preliminary Subaru ASM designed by Microgate with ~1000 actuators

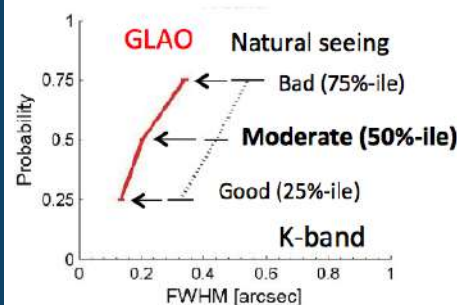
(4) Wide-field NIR instruments

- Imager
- Multi-Object Slit spec.
- Multi-Object IFU spec.

FoV~16arcmin max.
at Cs. focus

(2) Laser Guide Star system

TOPICA 20W CW fiber laser(589nm) x 2
Generate 4 laser guide stars



Band	Natural Seeing (")			GLAO(")		
	Good	Moderate	Bad	Good	Moderate	Bad
J	0.38	0.50	0.71	0.17	0.26	0.44
H	0.38	0.46	0.60	0.15	0.23	0.39
K	0.33	0.44	0.54	0.14	0.20	0.34

- FWHM ~ 0.2-0.3'' for $\phi 15'$ @K-band

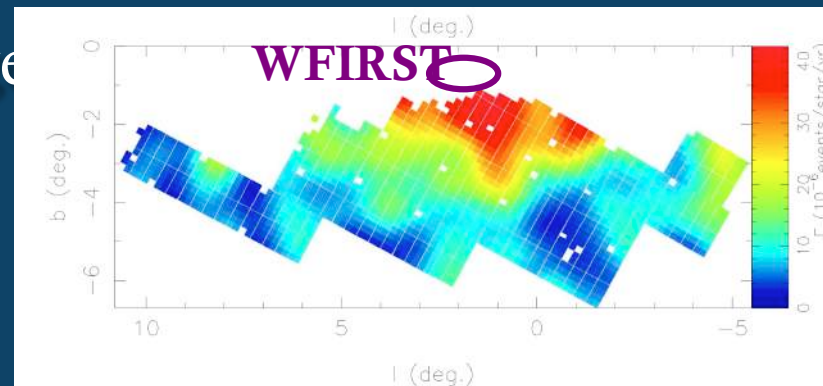
- Completion will be ~2025

Concurrent Observations using ULTIMATE-Subaru

Advantages

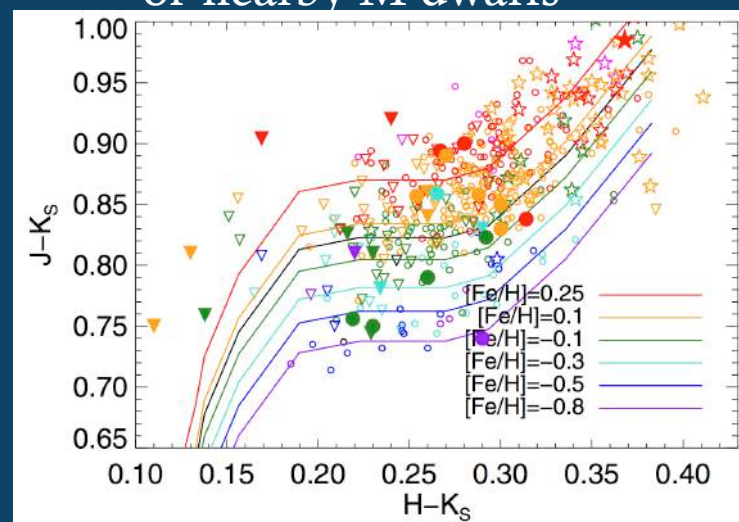
- NIR -> can go closer to central bulge
 - Higher event rate
 - Complement to LSST/HSC
- High resolution -> less blending
 - Fainter events
 - Lens flux
- K band capability -> lens' colors
 - Complement to WFIRST (< H band)
 - (Z087 – K) and (W149 – K) colors
 - Metallicity of M-dwarf host stars can be estimated

Event rate toward the galactic bulge



Sumi & Penny 2016

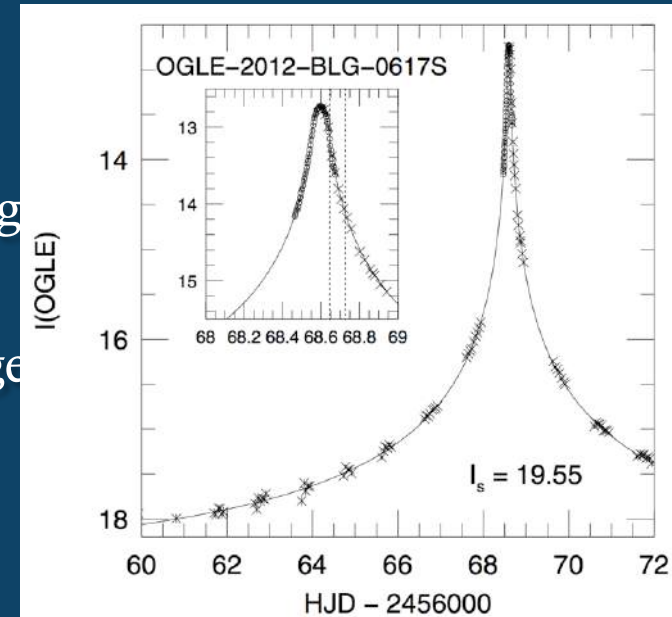
NIR color-color diagram of nearby M dwarfs



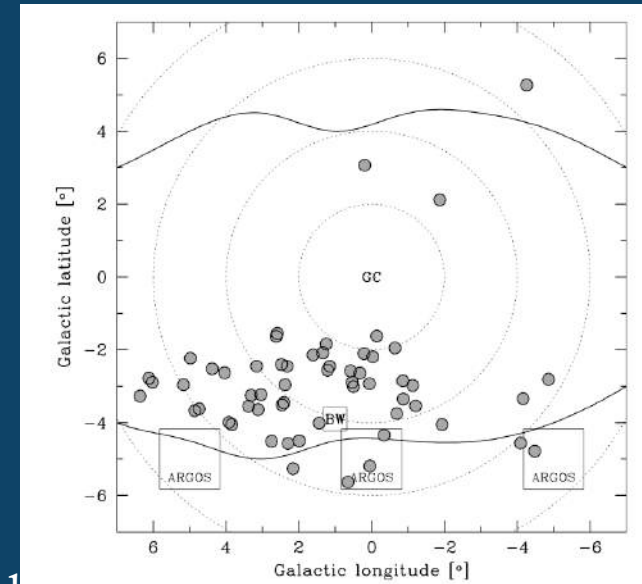
Newton et al. 2014

NIR Spec. of Bulge Dwarfs through High-mag μ lens

- Environment study of the central bulge
 - WFIRST can examine the dependency of planet abundance on the stellar properties (e.g. stellar age, metallicity, and kinematics)
 - Recent studies support the presence of younger ($\sim$ a few Gyr) populations



- High-mag ($A_{\text{max}} > 50$) μ lensing events will allow IR spectroscopy of bulge dwarfs
 - $A_{\text{max}} > 50$: $H=19 \Rightarrow H < 14.8$, mid R w/ IRCS (or PFS)
 - $A_{\text{max}} > 500$: $H=19 \Rightarrow H < 12.3$, high R w/ IRCS or IRD



(This idea is also proposed by N. Matsunaga @Univ. of Tokyo)

Bensby et al. 2013

a) List possible Scientific programs.

b) Possible feasible scenario

1, HSC concurrent observation, 30min cadence, ~2 hours/night, Feb-May, 30sec expusre+30sec readout+throw time, (2filed ~ 7 WFIRST field)
5min/2 fields, x 4 /night x72 = 24 hours/8hr=3nights/season= 18 nights/6season
(3/4)=13.5nights/6season (bright night)

2, Ultimate, concurrent survey (WFIRST observe 7 fields.)
0.5min.+0.5min. 32 fileds (32filed = 6.4 WFIRST field) x2 / night
1hr /night x 72/8 = 9 nights / 1season. 54nights/6 season.
(x3/4)=40.5night/ 6season (bright night)

3, IRD, follow-up for high mag, measure extinction, metallicity of source.
Precursor observation during bright time. S/N=50, 30min exp+ 30min overhead.
J<12mag, 1.5hrs per target.
1.5 x 15 alerrts / yr =22.5 hrs/ yr. /8hr = 2.8night /yr. 11.2night / 4yrs. (60events)

c) Procedure to decide the observational programs.

WFIRST ML science team including Japanese representative decide