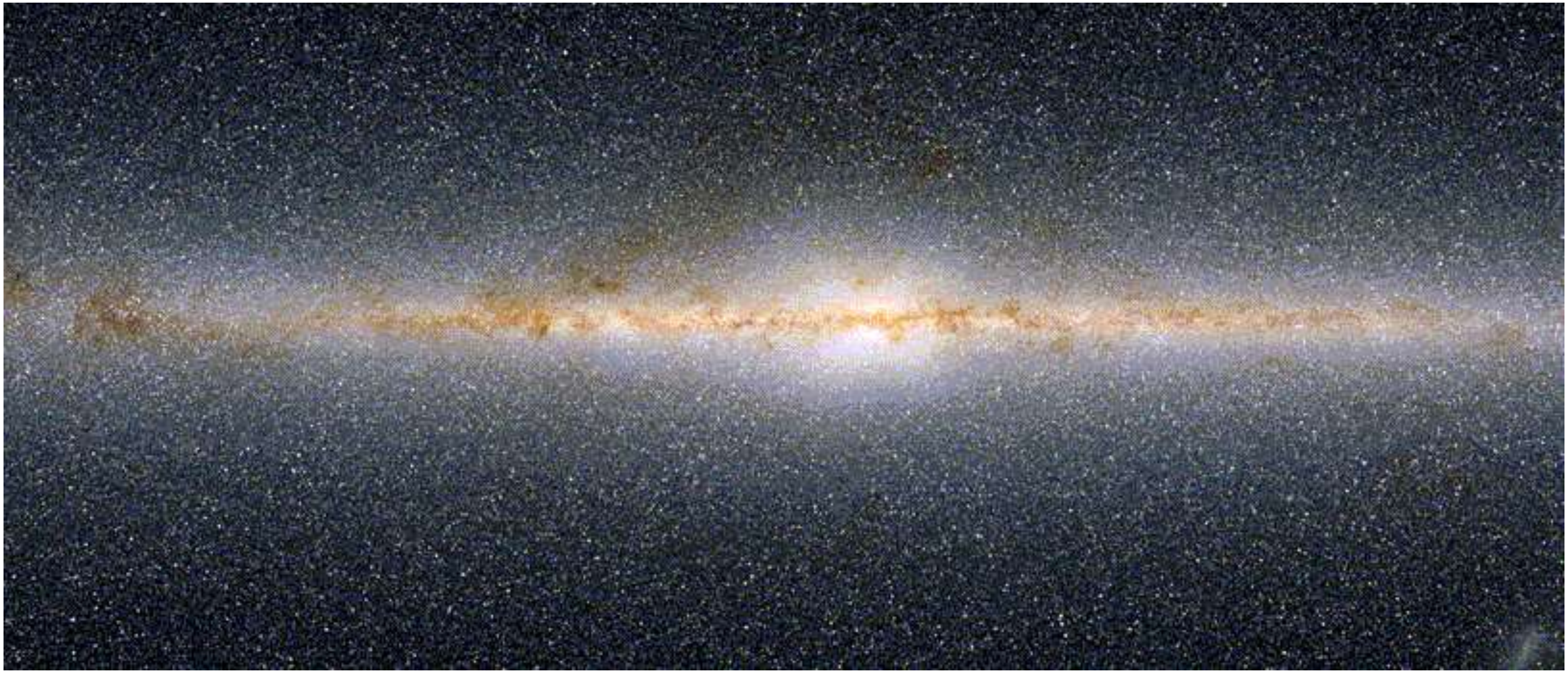
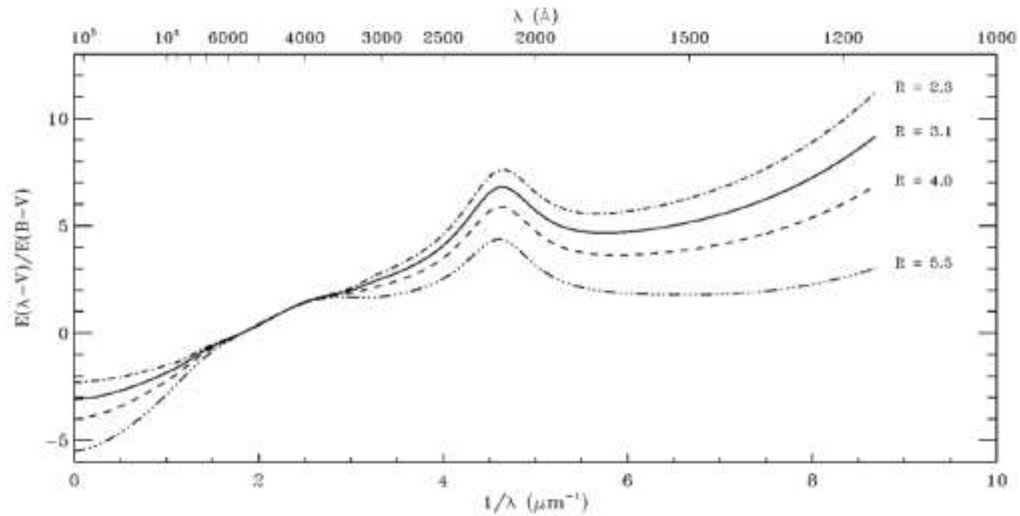
SkyMapper Photometry of the Galactic Bulge: A Probe of Dark Energy and Exoplanets



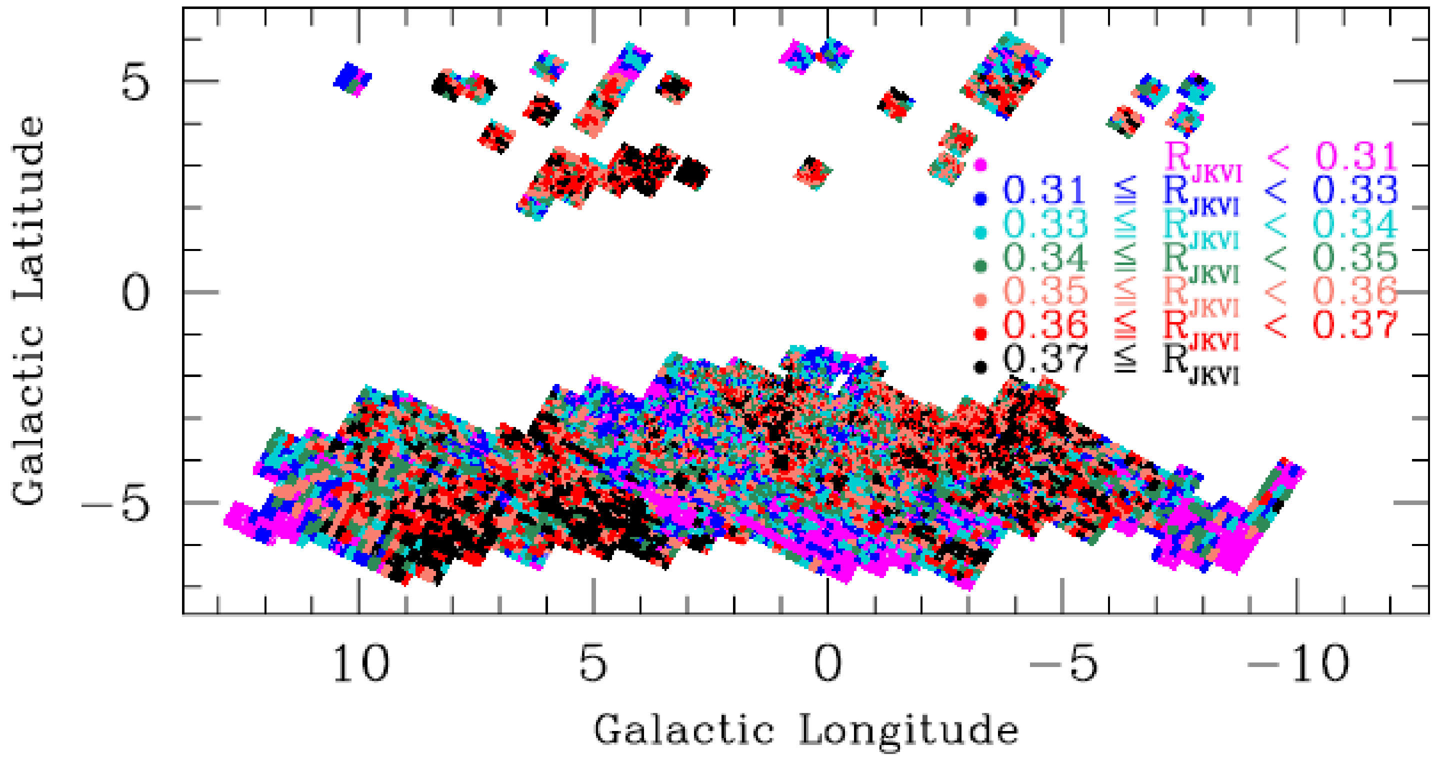
Part I: SkyMapper photometry of the Bulge and Constraints on Dark Energy

- Analysis of ugriBVYJH for 32 Type Ia SNe yields a mean R_V=2.1 with a maximum of R_V=2.7, compared to R_V=3.1 as the "standard Milky Way extinction curve" (M. M. Phillips *et al.* 2013 *ApJ* **779).**
- Unfortunately, the shape of the interstellar extinction curve for R_V <= 2.6 is nearly unconstrained, it is based on an extrapolation of a 7th degree polynomial.



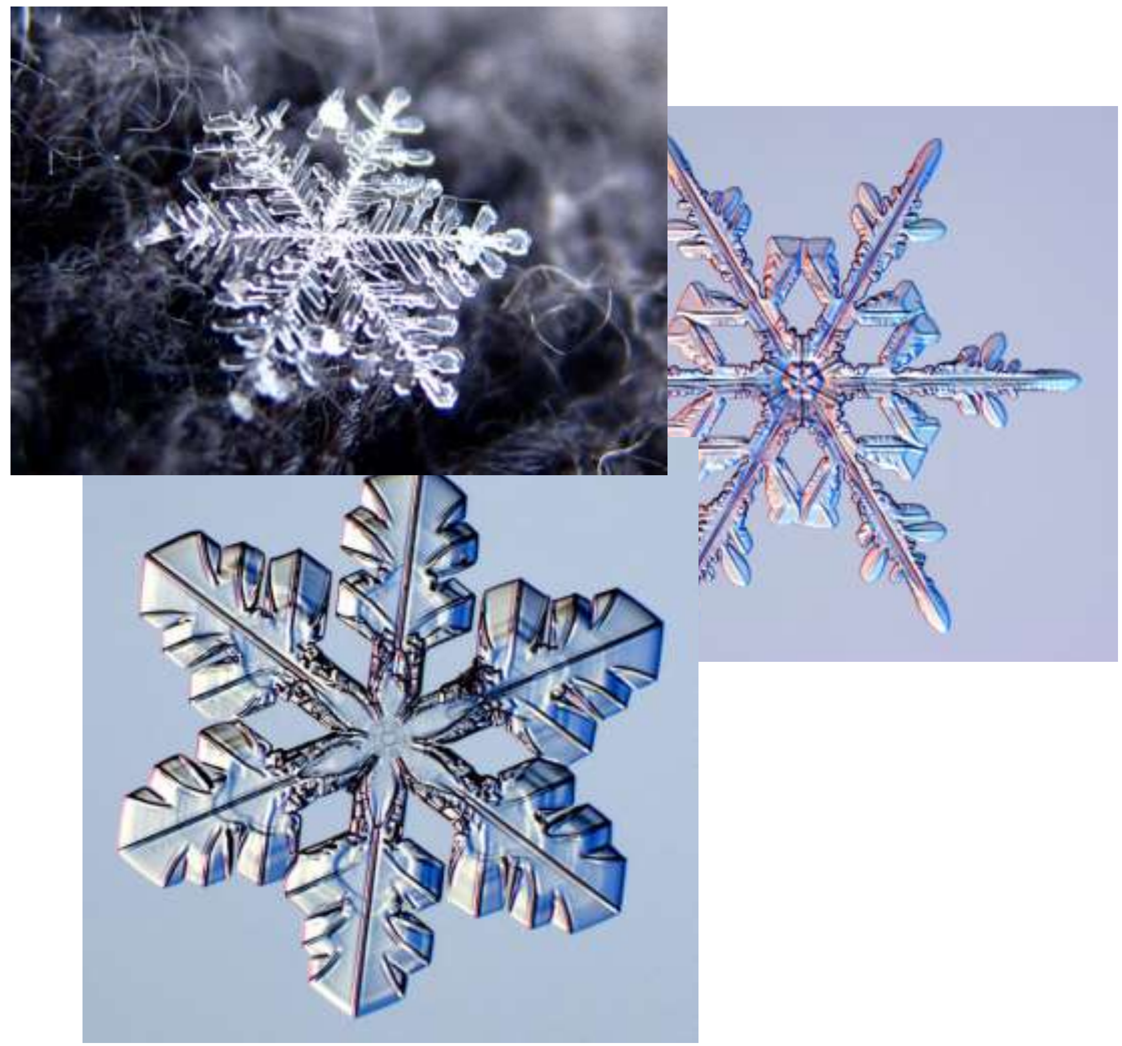
Part I: SkyMapper photometry of the Bulge and Constraints on Dark Energy

- The dust toward the inner Milky Way is composed of smaller dust grains, leading to interstellar extinction curves with 2.0 <≈ R_V <≈ 2.9 (David M. Nataf *et al.* 2013 *ApJ* **769** 88).



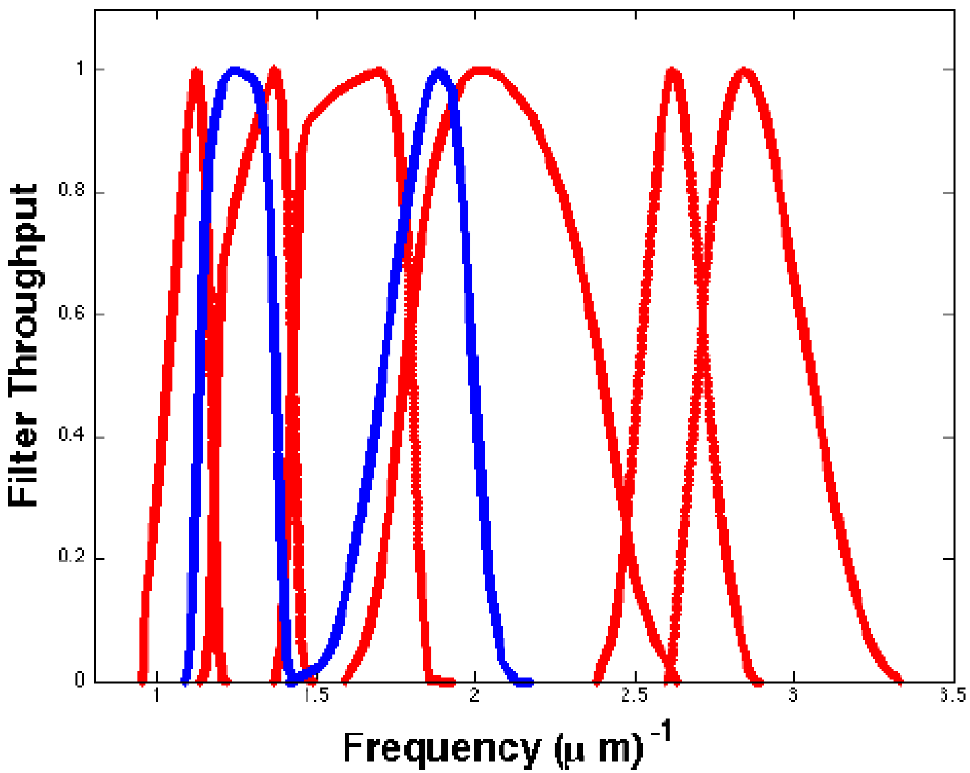
Part I: SkyMapper photometry of the Bulge and Constraints on Dark Energy

- For the study of interstellar extinction, every filter is its own special snowflake, and skymapper can provide six such snowflakes.



Part I: SkyMapper photometry of the Bulge and Constraints on Dark Energy

- SkyMapper transmission curves (zirgvu, shown in red) shown as a function of inverse wavelength – they are distinct from the Landolt IV filters (shown in blue).
- Data will automatically come out of the deep survey.

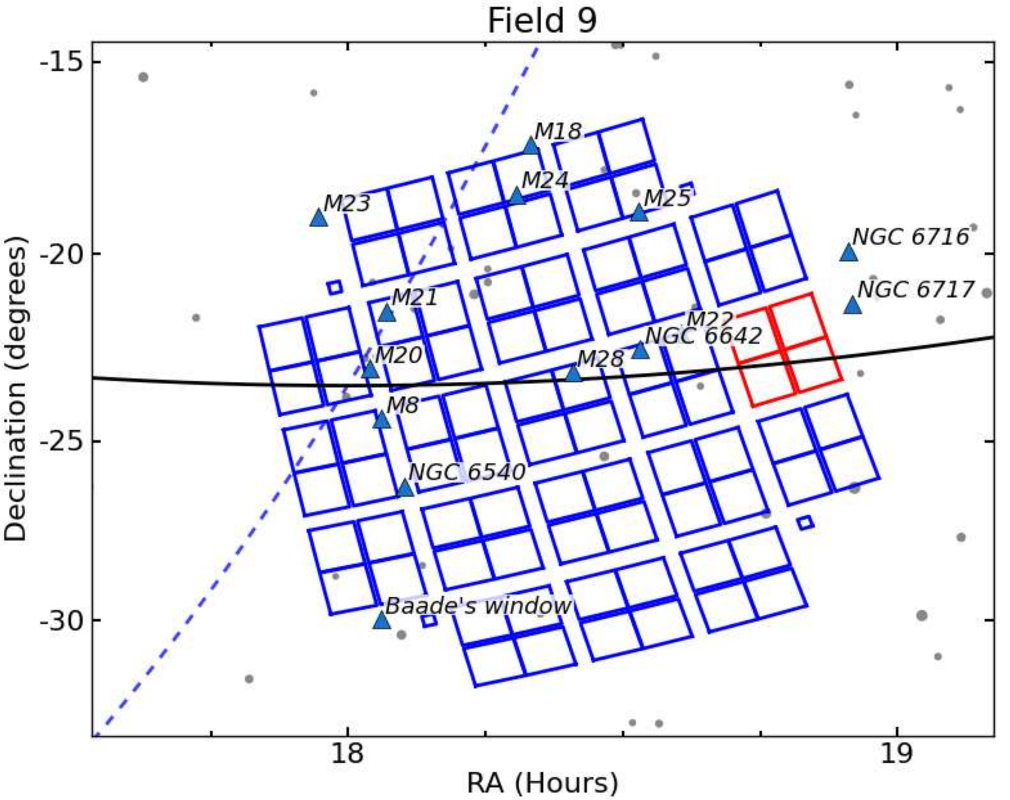


Part I Conclusion: SkyMapper photometry of the Bulge and Constraints on Dark Energy

- Supernovae cosmology is hampered by a significant systematic: there are no empirical constraints on the interstellar extinction curve for $R_V \leq 2.6$.
- SkyMapper photometry of the Galactic bulge can robustly deliver those constraints.

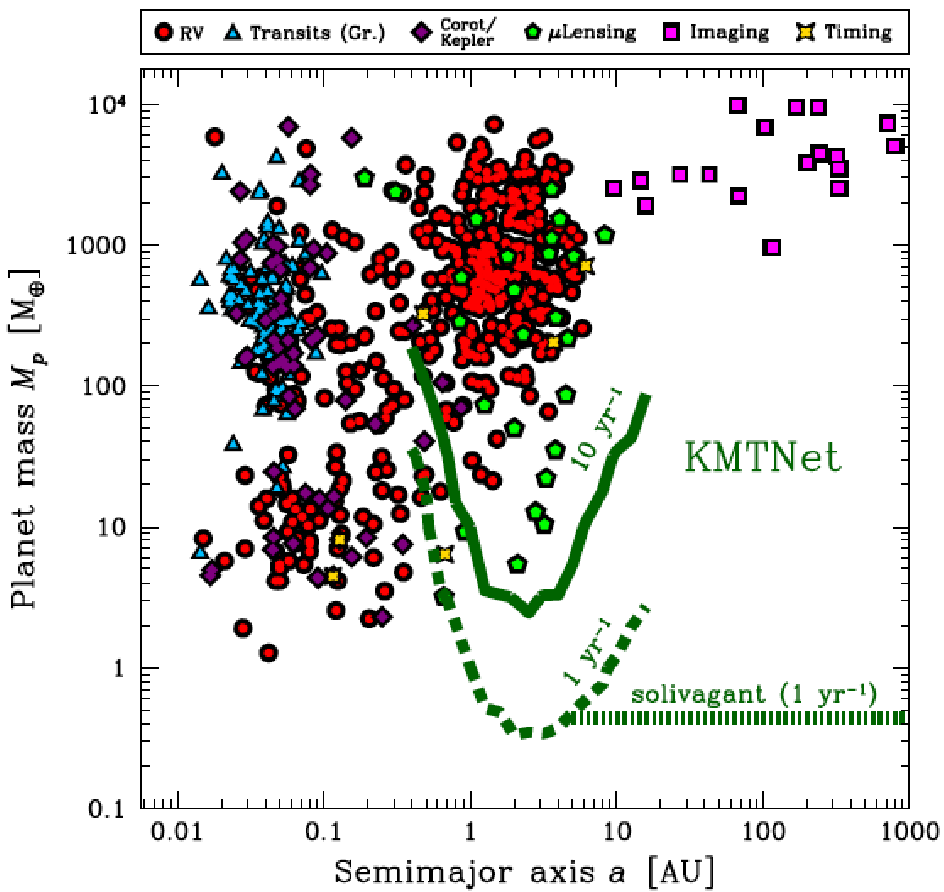
Part II: SkyMapper Photometry of the Galactic Bulge as a Probe of Exoplanets

- Kepler may observe the Galactic bulge around May 2016.
- Microlensing community is planning to request 100% of the pixels within a single patch ~5-6 deg^2 in size.



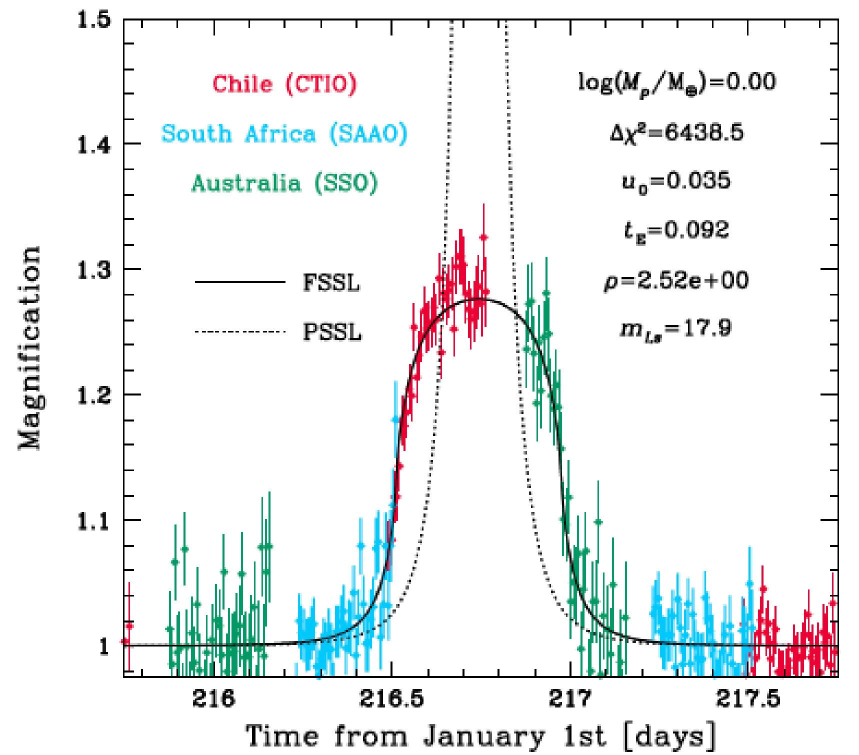
Part II: SkyMapper Photometry of the Galactic Bulge as a Probe of Exoplanets

- The benefit of microlensing is that it can identify low-mass planets at intermediate separations from their host stars, as well as free-floating (solivagant) planets down to the mass of Mars.
- **<u>Right</u>**: sensitivity to planet detection from Henderson et al. (2014, in prep).



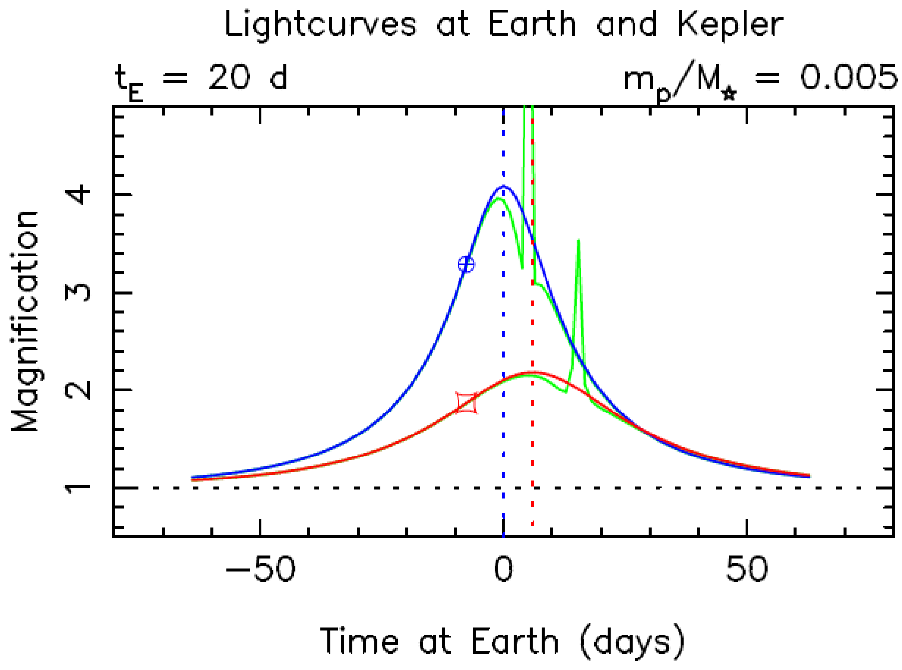
Part II: SkyMapper Photometry of the Galactic Bulge as a Probe of Exoplanets

- With high-cadence, Earth-Mass solivagant planets are straightforward to detect. Next-generation microlensing experiments will find one per year if they exist at the level of one per star.
- **Right**: from Henderson et al. (2014, in prep), an Earth-Mass free-floating planet yielding a 0.30 magnitude amplification for ~12 hours.



Part II: SkyMapper Photometry of the Galactic Bulge as a Probe of Exoplanets

- SkyMapper, based on Earth, will see a different gravitational lensing signal than Kepler, due to “microlens parallax”.



The difference between the two lightcurves can break some degeneracies, and thus yield a direct and precise measure of the lens mass and position within the Galaxy.

Left: From Gould and Horne (2014). Kepler sees red lightcurve, Earth sees blue lightcurve.

Conclusions, SkyMapper Photometry of the Galactic Bulge as a Probe of Dark Energy and Exoplanets

- SkyMapper deep-survey can constrain the interstellar extinction curve in the domain of small dust grains, $R_V < 2.6$, important to supernovae cosmology and for which there are nearly no constraints at this time.
- SkyMapper high-cadence photometry in April-June 2016 could yield better sampling of microlensing lightcurves, and thus direct mass estimates of Earth-like planets at the snowline and beyond.