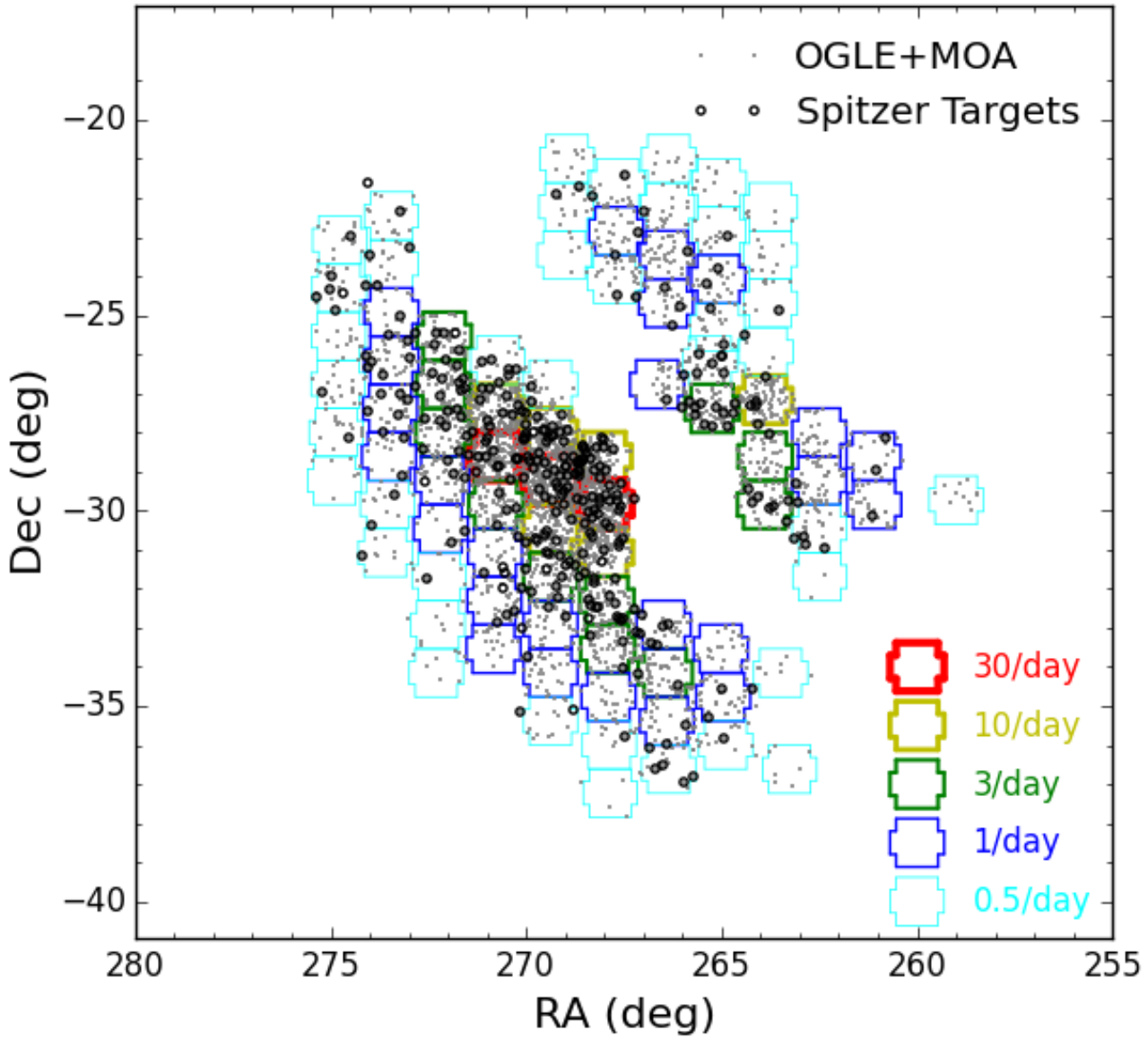
Results From The 2015 High-Cadence Spitzer Microlensing Sample

Wei Zhu
(OGLE, KMTNet, Spitzer Team)
2017 Feb 3, Pasadena

arXiv: 1701.05191

Spitzer Microlensing (so far)



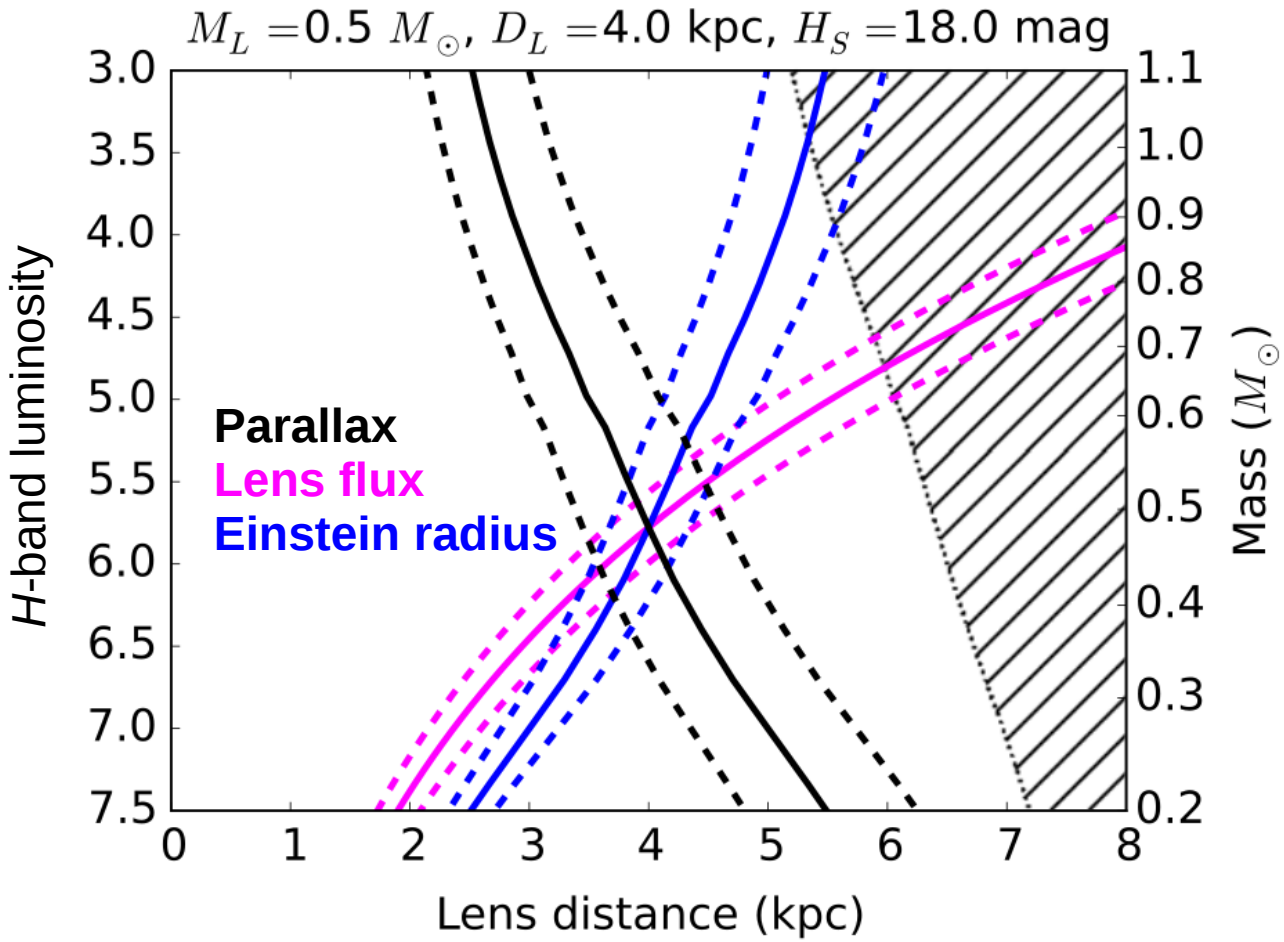
Spitzer hrs (2014+15+16)	**~1000**
Total Events	**~360**
Planet	**6(+1?)**
Binary	**~40?**

Primary Science Goal

- Relative abundance of planets in the bulge vs. in the disk
  - Different stellar populations: mass, metallicity, multiplicity
  - Different stellar environments: irradiation

Mass & Distance Determinations

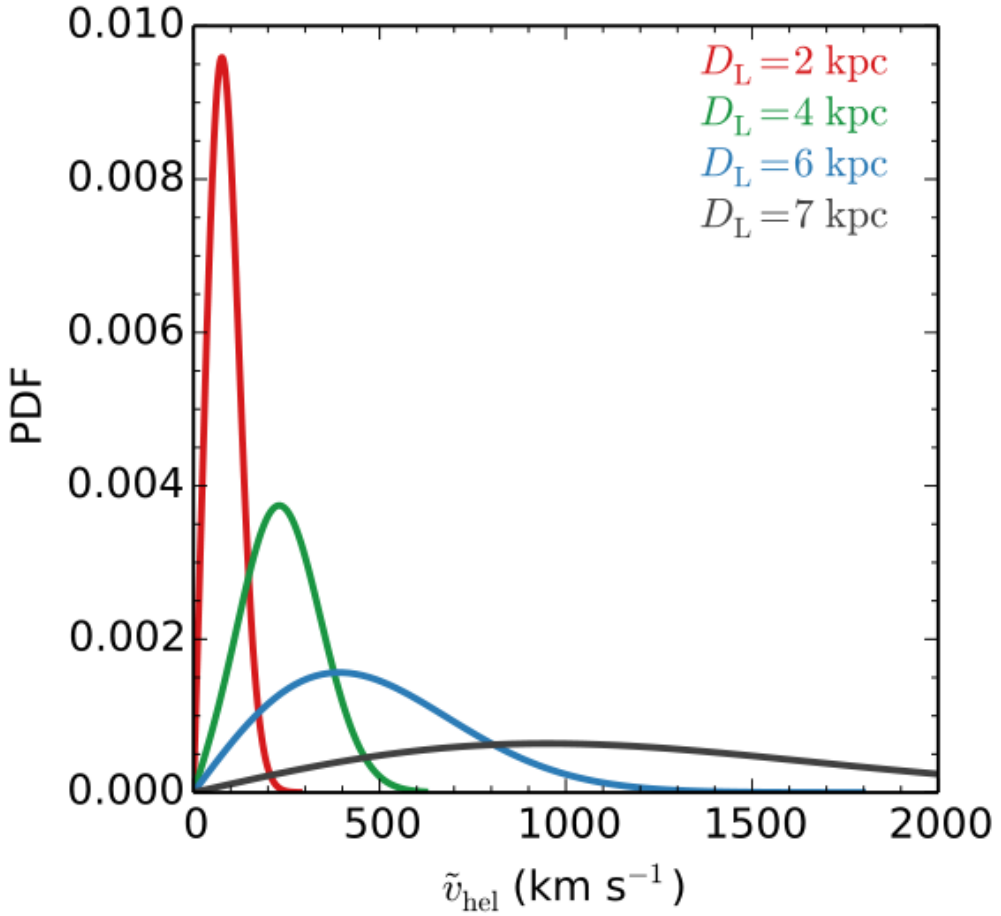
- Direct measurement

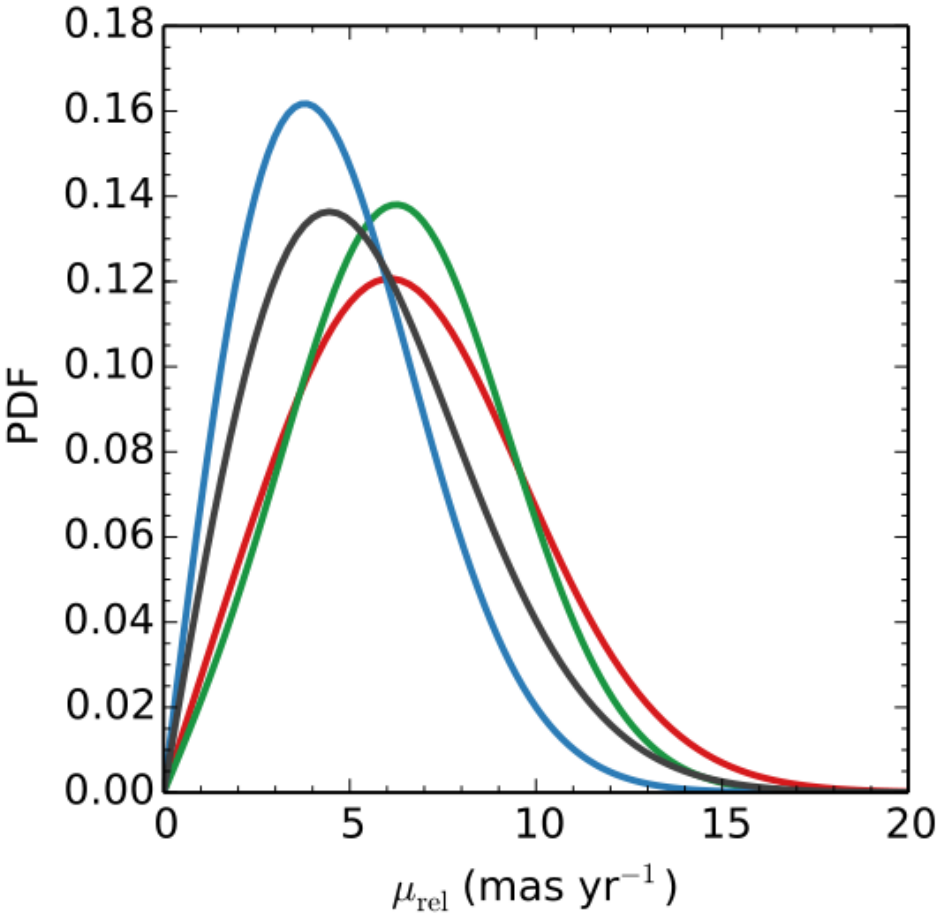


Yee, 2015, ApJL, 814, 11

Mass & Distance Determinations

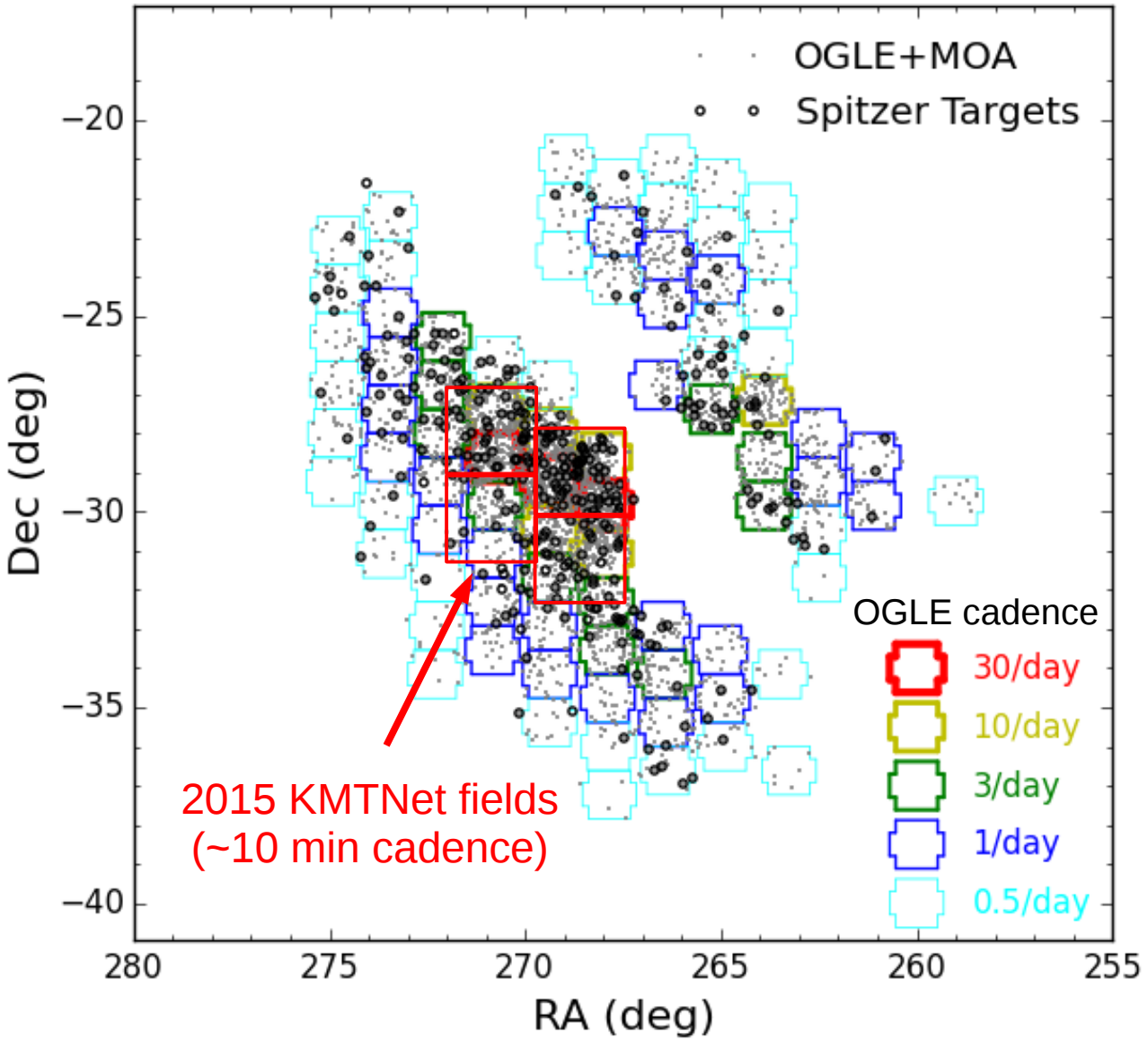
- Statistical inference



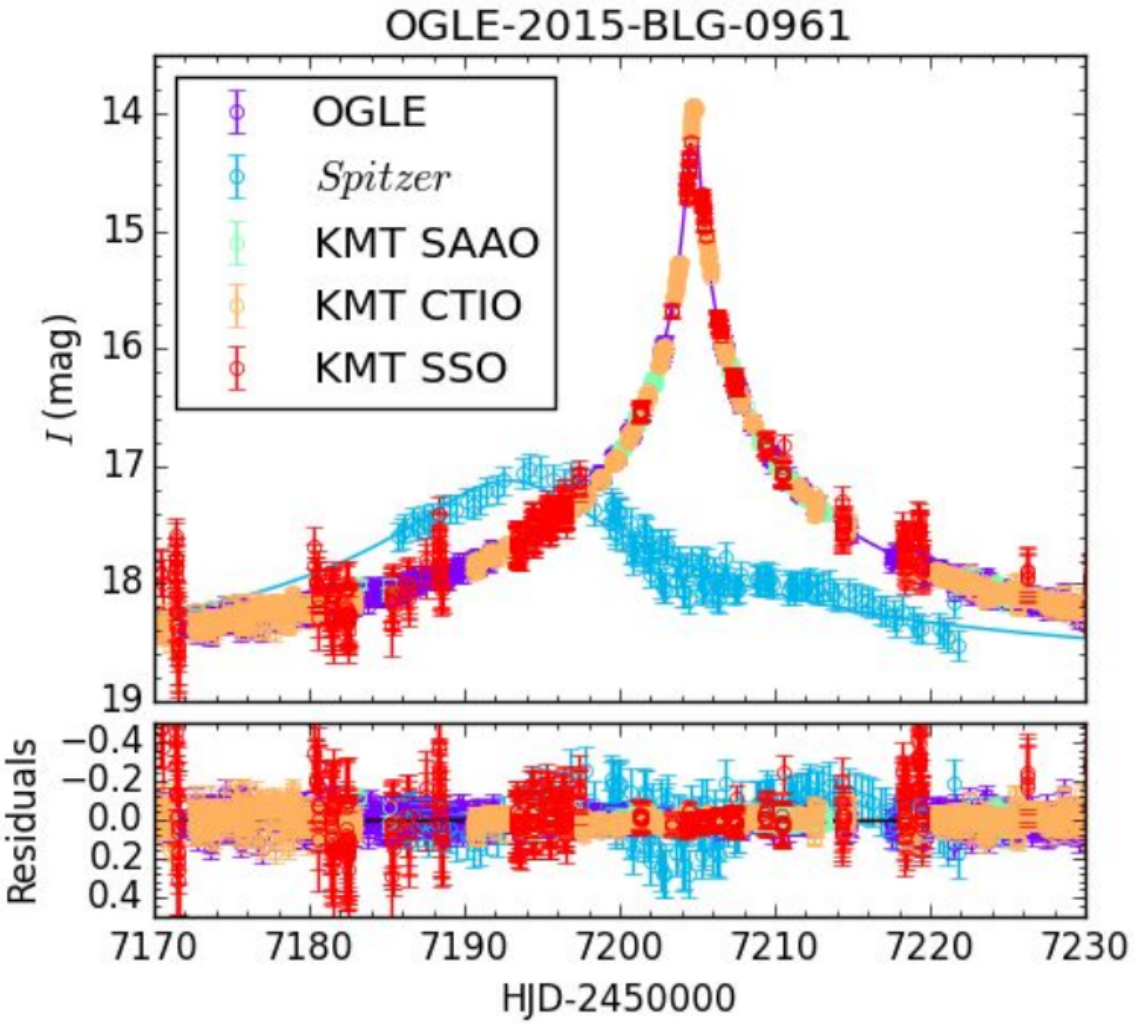


Zhu et al., arXiv: 1701.05191

2015 Spitzer High-Cadence Sample: 50 Events



OB150961 As An Example



- Dense coverage from the ground
- Long-term trend in Spitzer:
  - Impossible due to binary lens
  - Unlikely due to binary source
  - Systematics

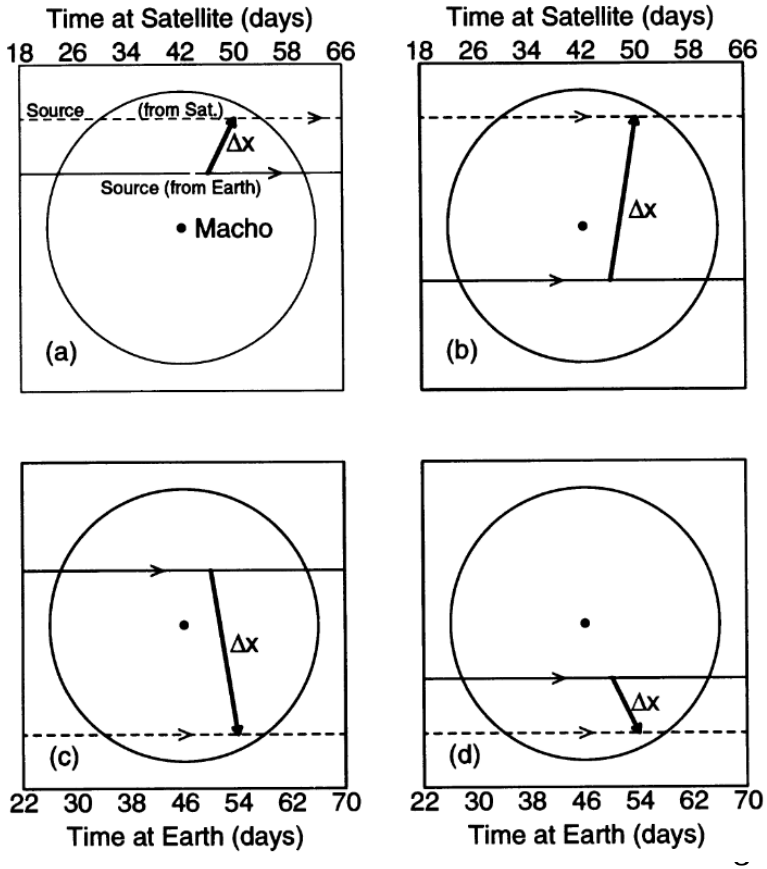
Zhu et al., arXiv: 1701.05191

Derive Lens Distribution

- For each solution: Prior of lensing probability & Posterior of microlensing parallax

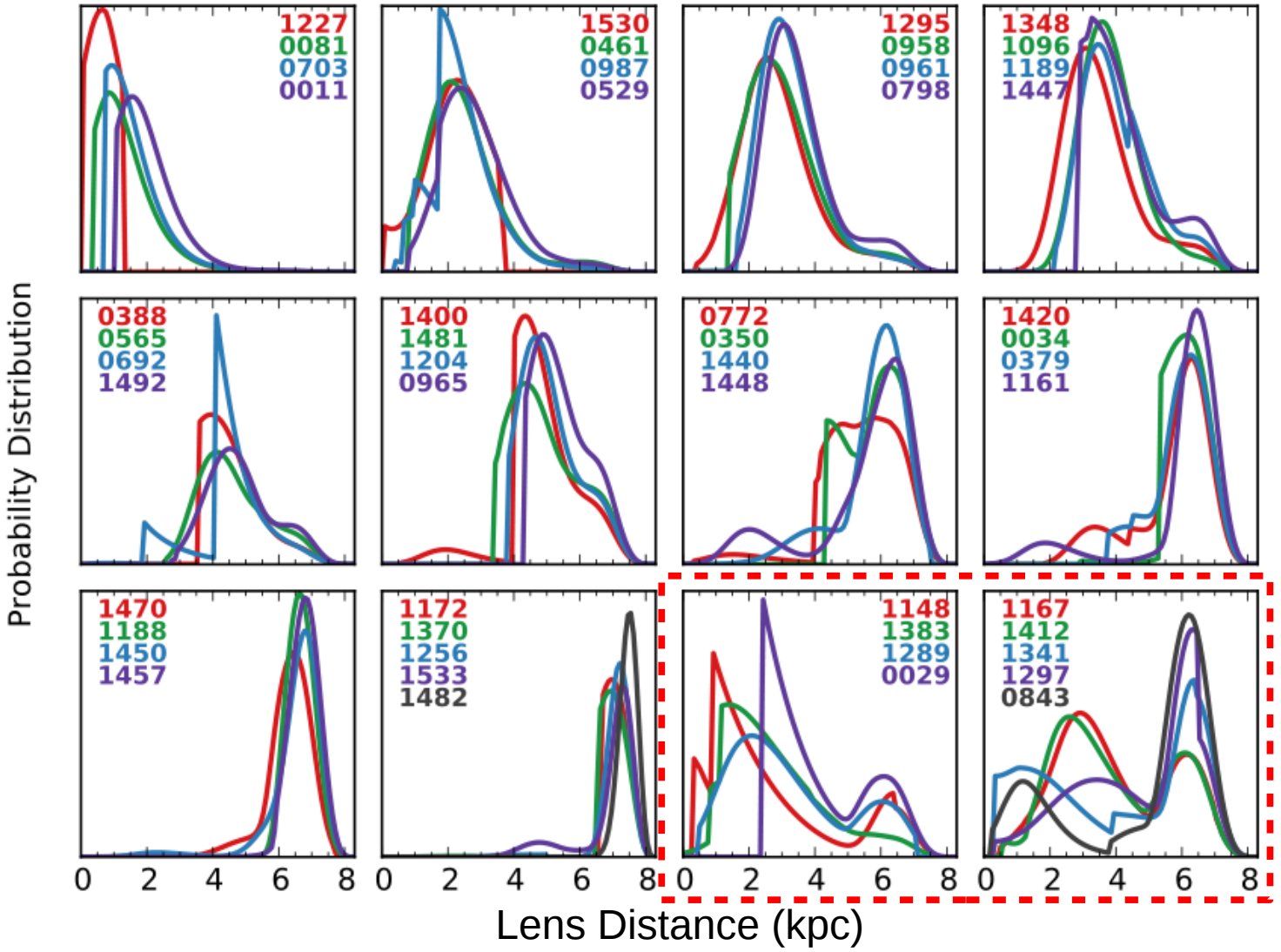
- Weight different solutions:

  Rich argument $w = \pi_E^{-2}$



Gould, 1994, ApJ, 421, 75

Lens Distance Distributions

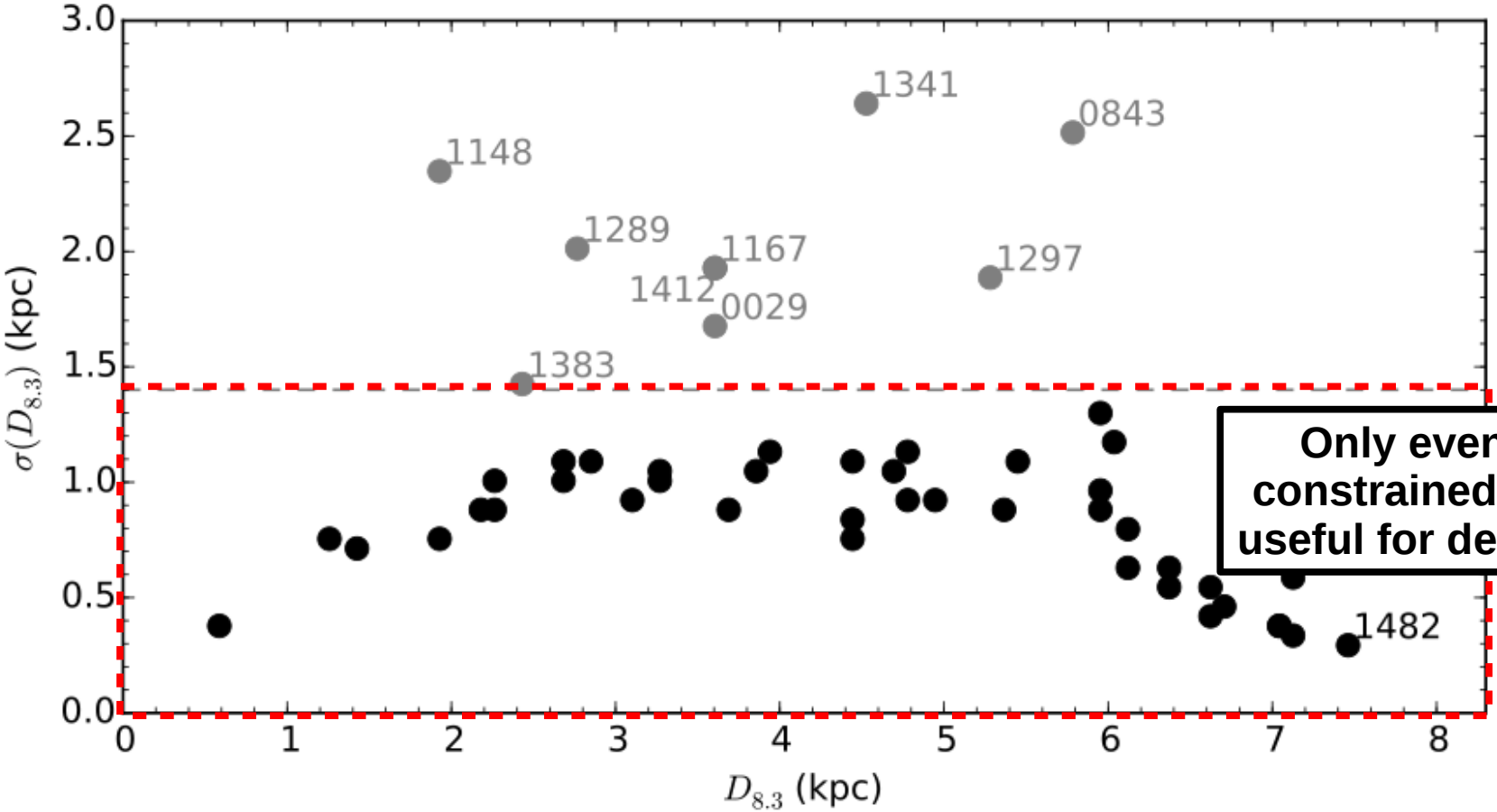


Atypical parallaxes lead to broad distributions

Zhu et al., arXiv: 1701.05191

Select Events for Statistics of GDP

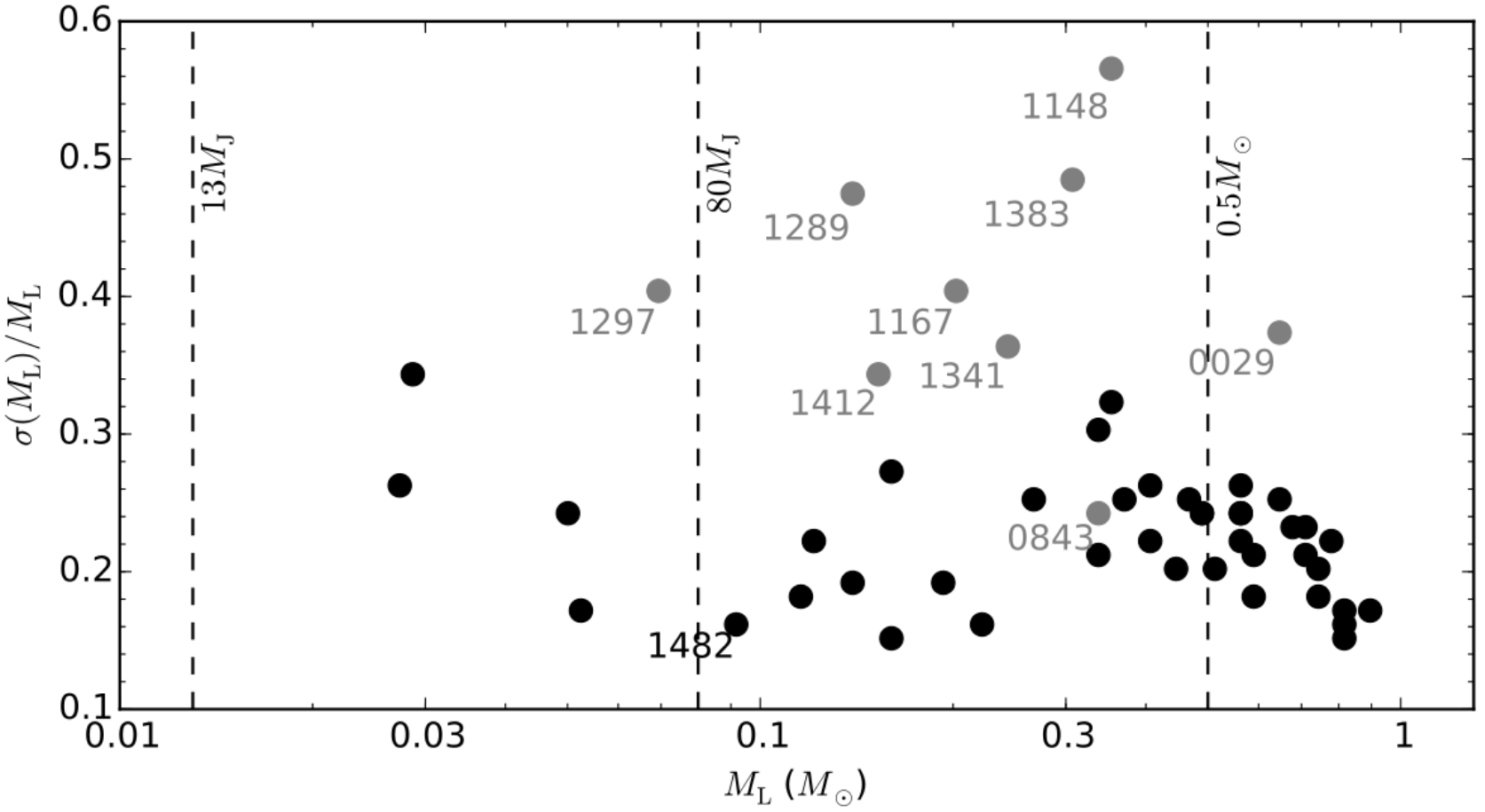
- Not all events have well measured parallax



Zhu et al., arXiv: 1701.05191

Lens Mass Distributions

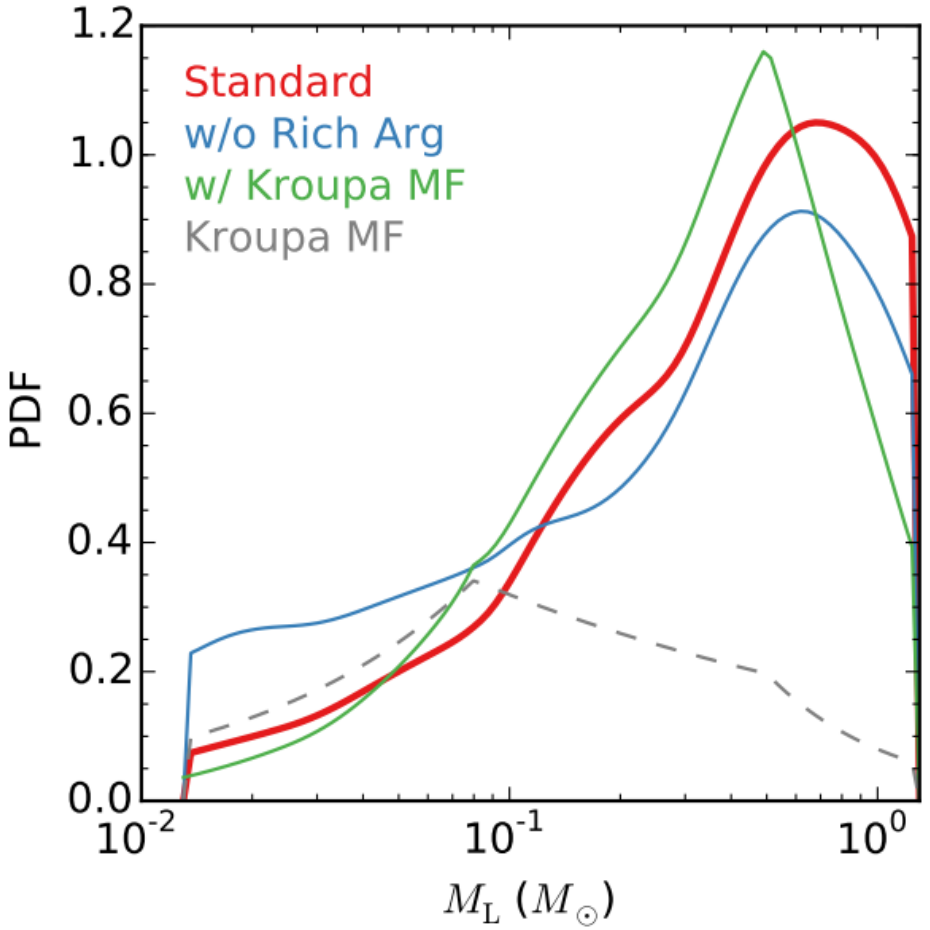
- Lens mass and distance uncertainty: ~25%



Zhu et al., arXiv: 1701.05191

Lens Mass Distributions

- Lens MF peaks at 0.5 M_sun, regardless of what prior MF is assumed.



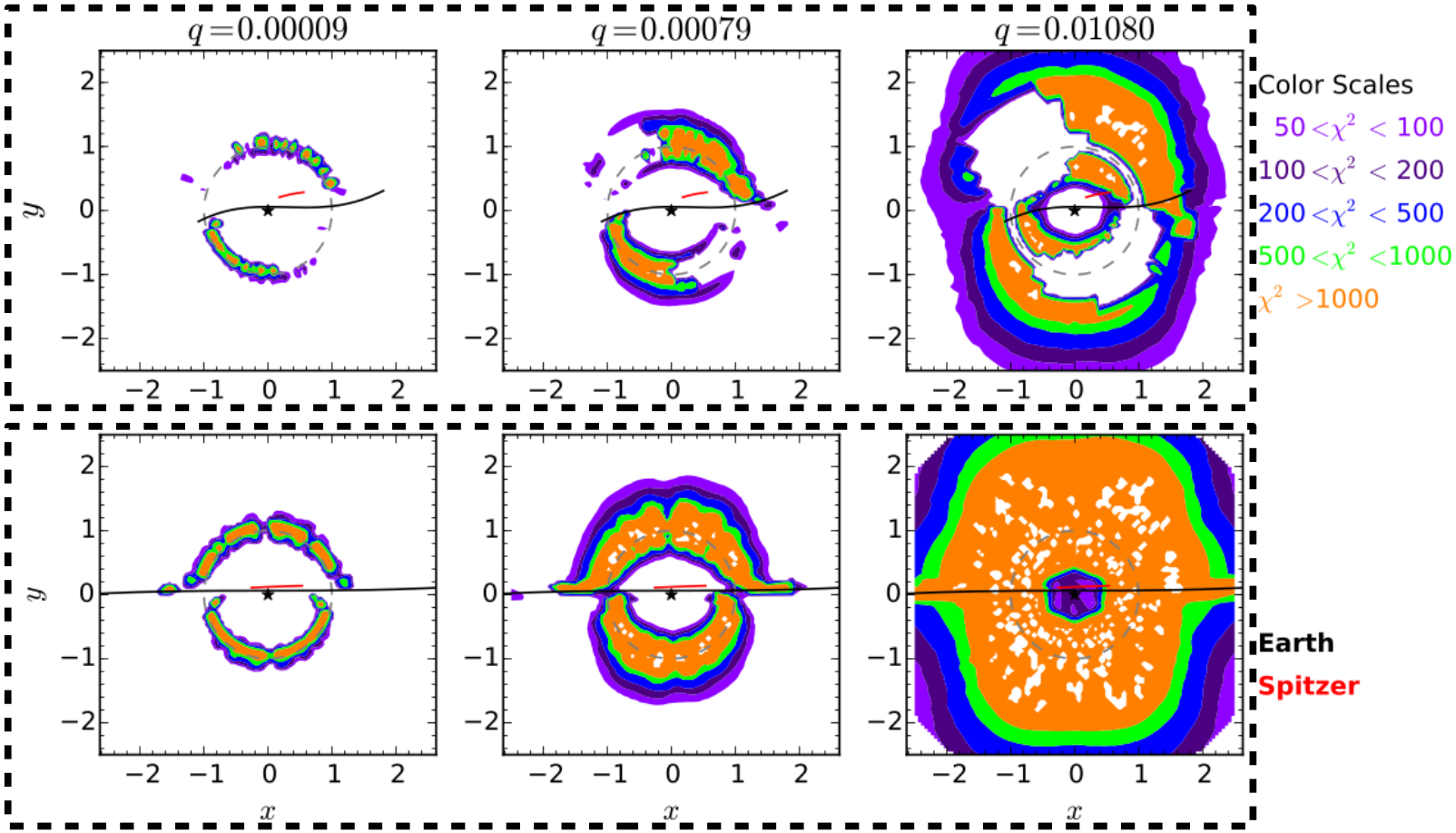
Zhu et al., arXiv: 1701.05191

Planet Sensitivities

- Effect of selection procedure

Subjectively Selected Event

Objectively Selected Event

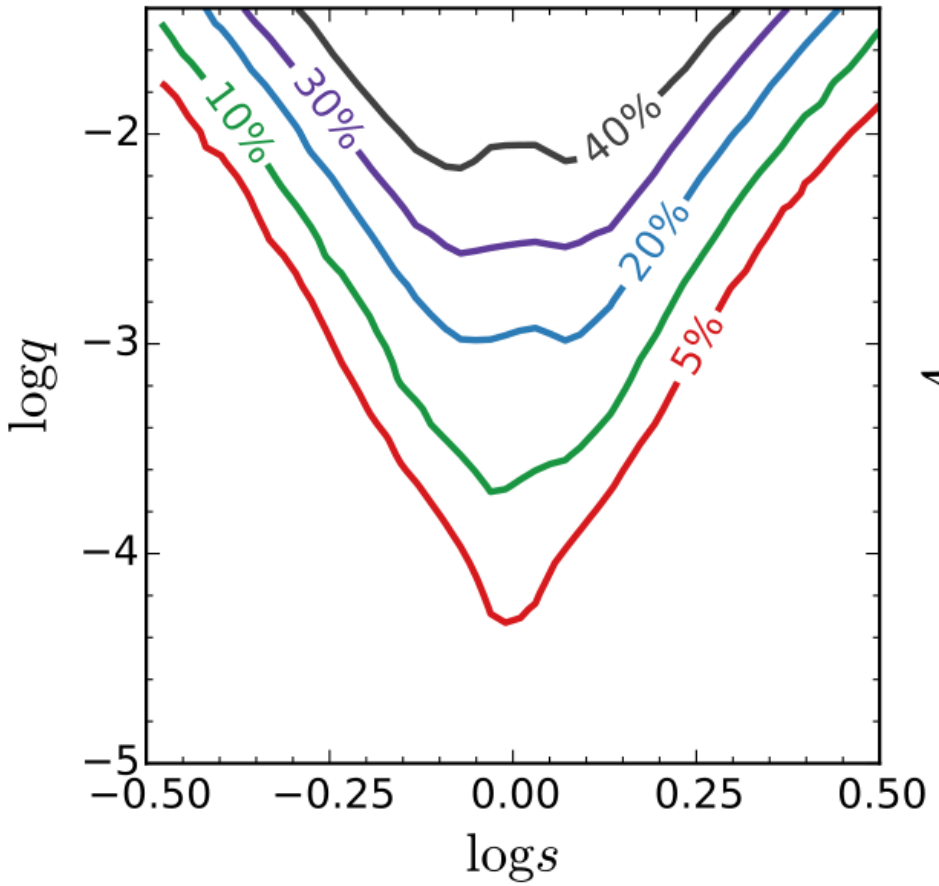


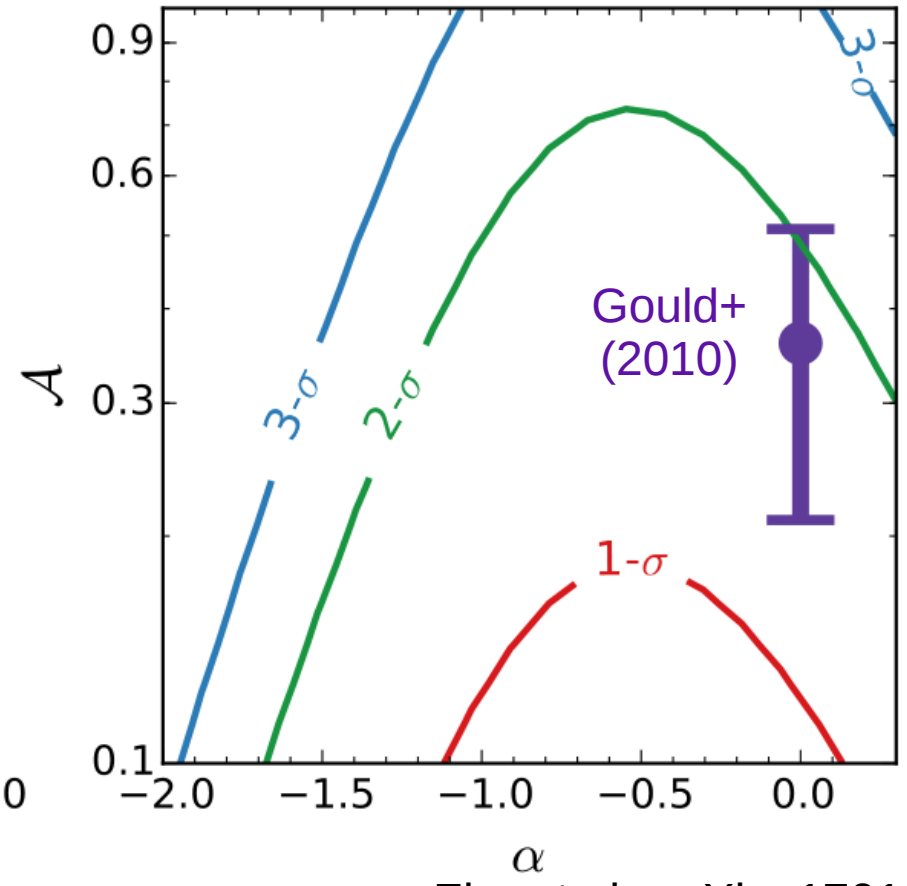
Zhu et al., arXiv: 1701.05191

Planet Sensitivities

- Constrain the planet distribution function:

$$\frac{\mathrm{d}N}{\mathrm{d}\log q} = \mathcal{A}\left(\frac{q}{q_{\mathrm{ref}}}\right)^{\alpha}$$

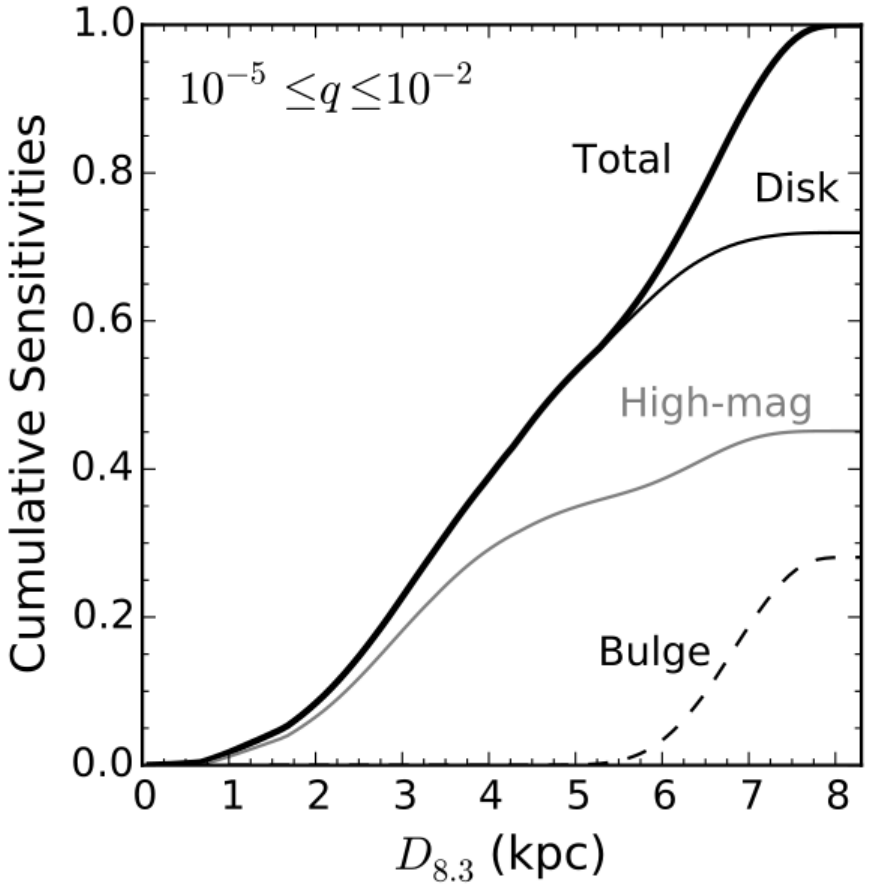


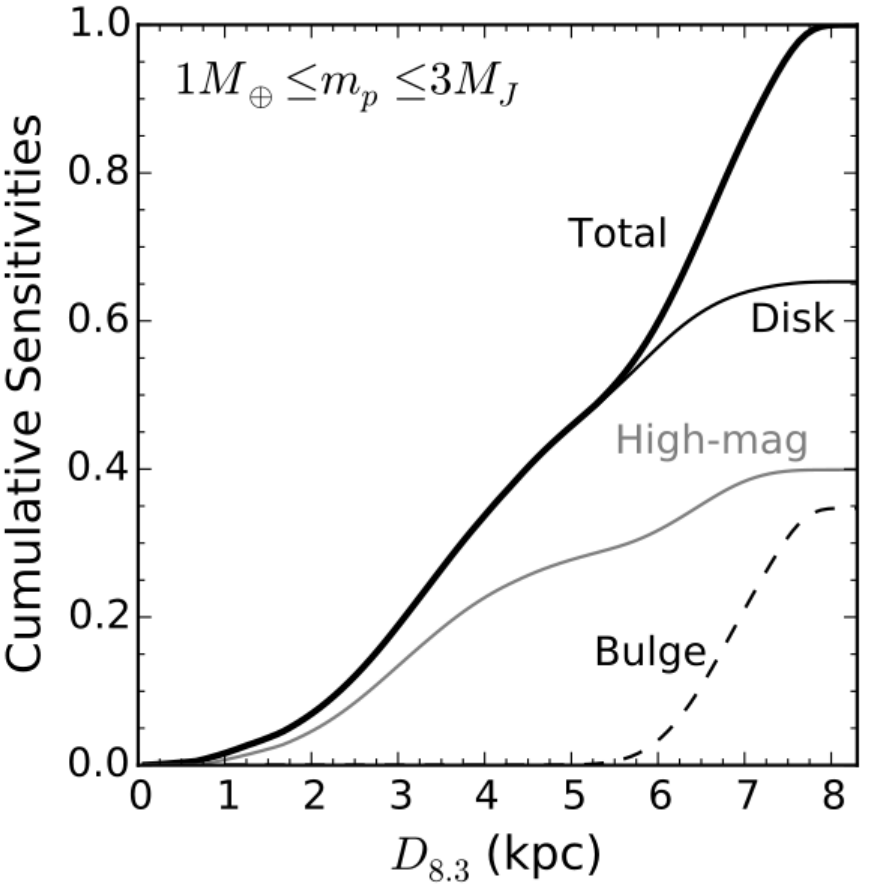


Zhu et al., arXiv: 1701.05191

Prediction for GDP

- If planet distributions are the same in the bulge as in the disk, ~1/3 of planet detections will be from bulge events.





Zhu et al., arXiv: 1701.05191

Summary & Future Work

- 2015 high-cadence Spitzer sample
- Criterion for including events for statistical analysis: distance uncertainty < 1.4 kpc
- Parallax alone leads to lens mass and distance determinations (~25% uncertainty)
- 1/3 of planet detections from bulge events
- Future work:
  - Spitzer events (high-mag, high-cadence)
  - K2C9 events