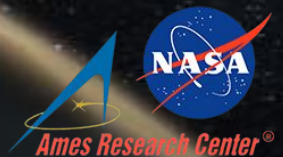
Detecting Extrasolar Planets Using Eclipsing Binaries as Natural Starshades

Stefano Bellotti, PhD student, IRAP, Toulouse
Ann Zabludoff, University of Arizona
Olivier Guyon, University of Arizona, NAOJ
Ruslan Belikov, NASA Ames
Maxwell Moe, University of Arizona
Chirag Rathi, University of Arizona

Lunar and Planetary Laboratory Conference 2020

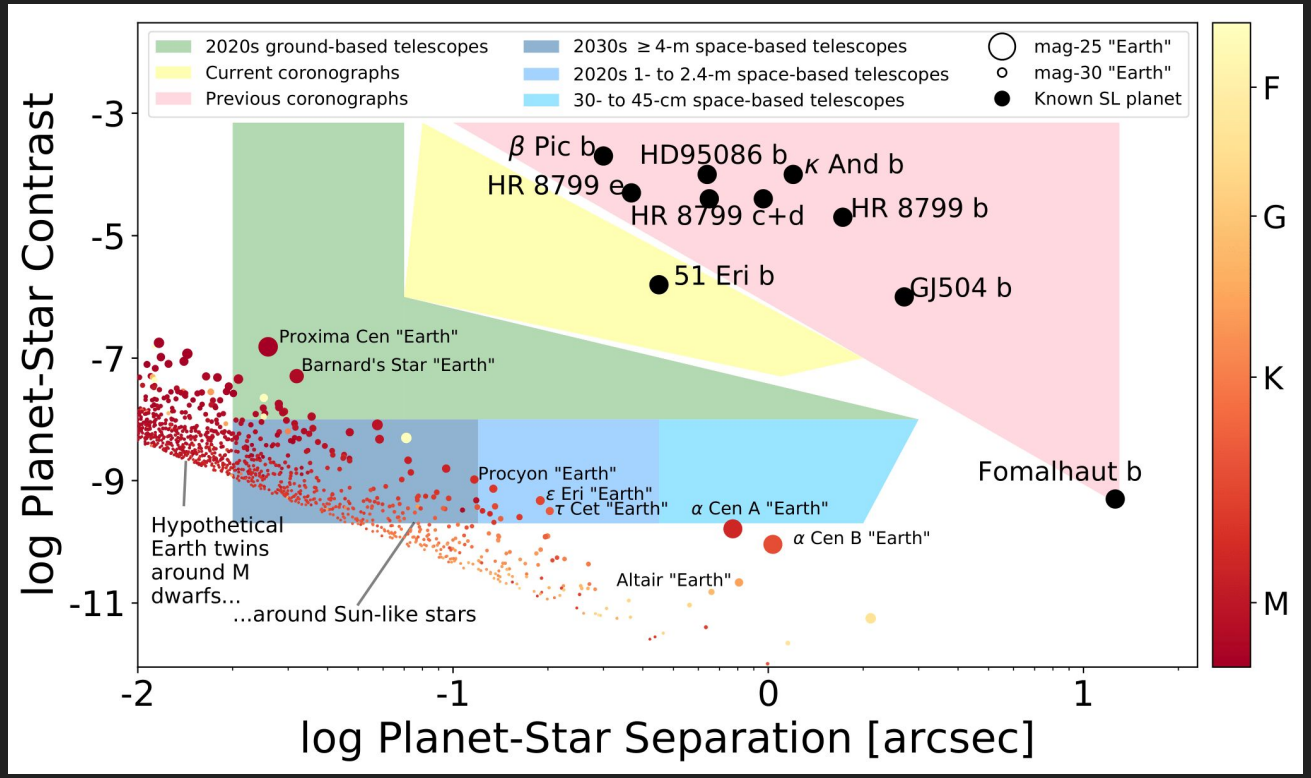


Motivation

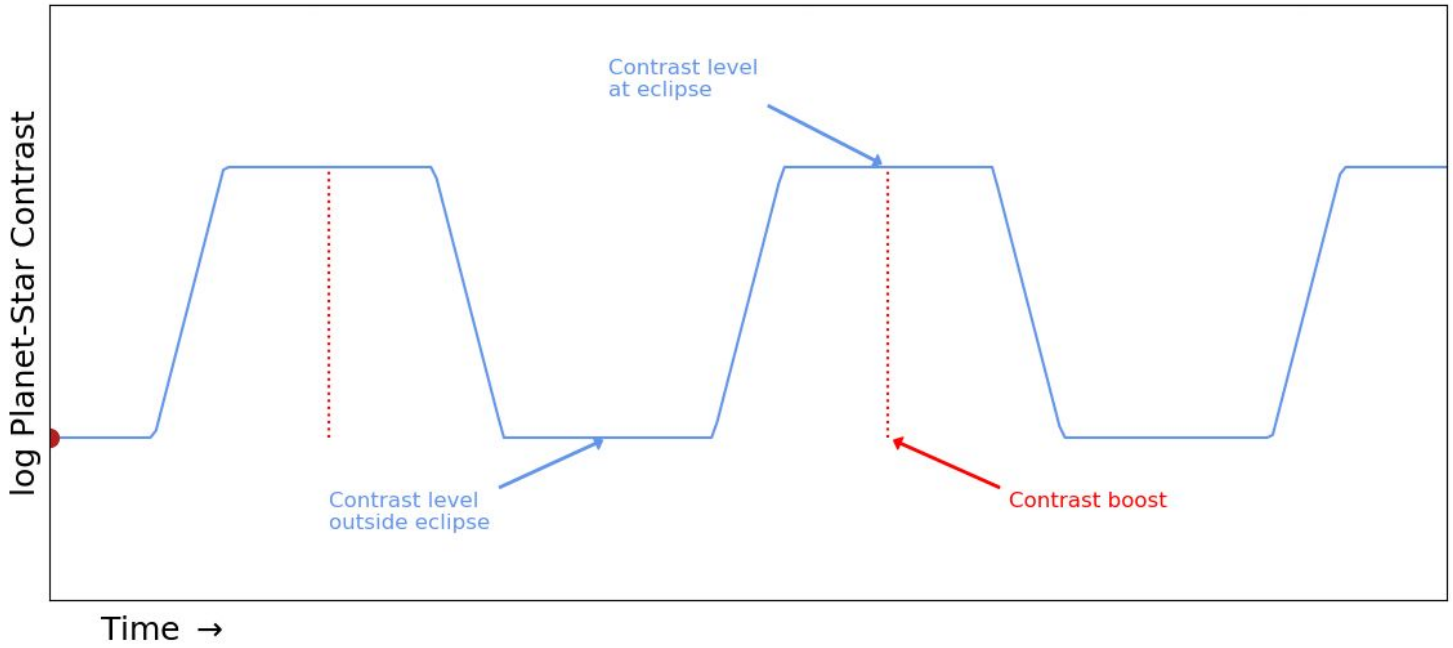
Directly imaging habitable Earth-like planets is challenging:

1) Contrast too low
2) Separation too low

Can we improve this?



Idea: eclipsing binaries



Eclipsing binary sample

- Catalog of Algol Type Binary Stars (Budding et al. 2004)
- Catalog of Eclipsing Variables. Version 2 (Avvakumova et al. 2013)

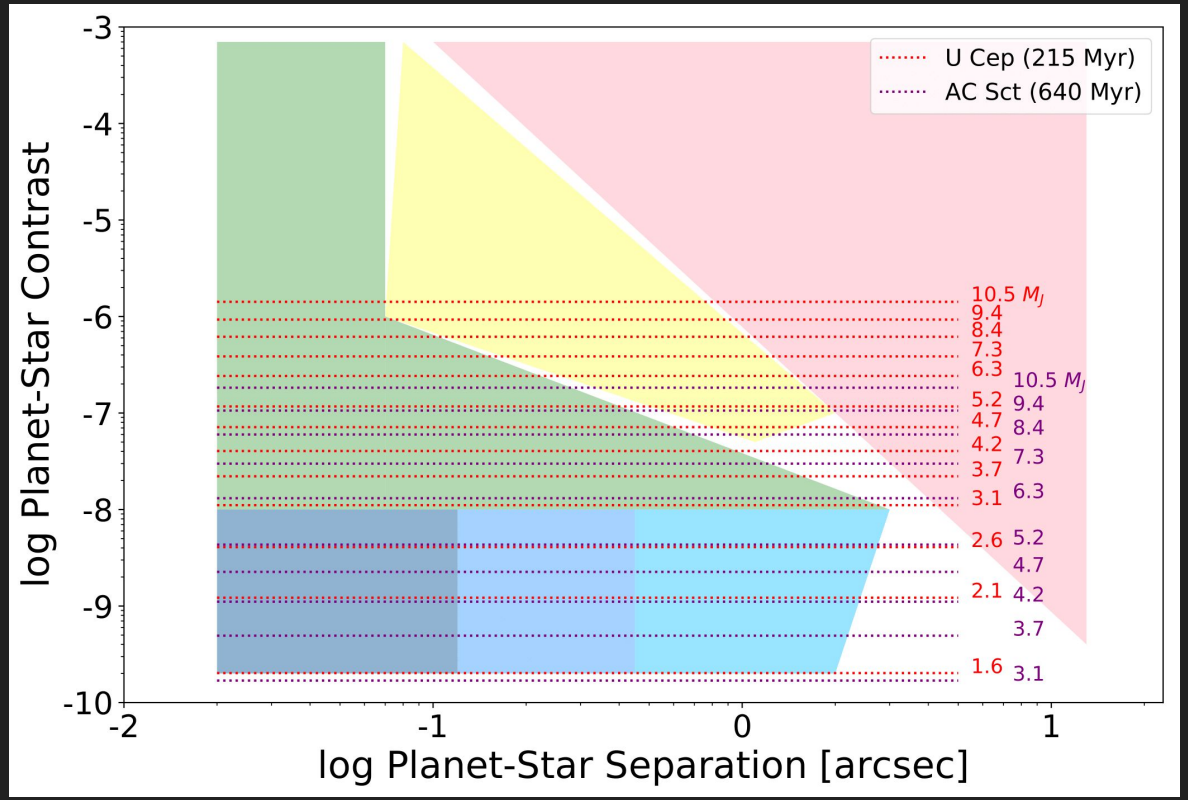
Main selection criterion: primary eclipse depth ≥ 2.5 mag.

self-luminous planet

reflected light planet

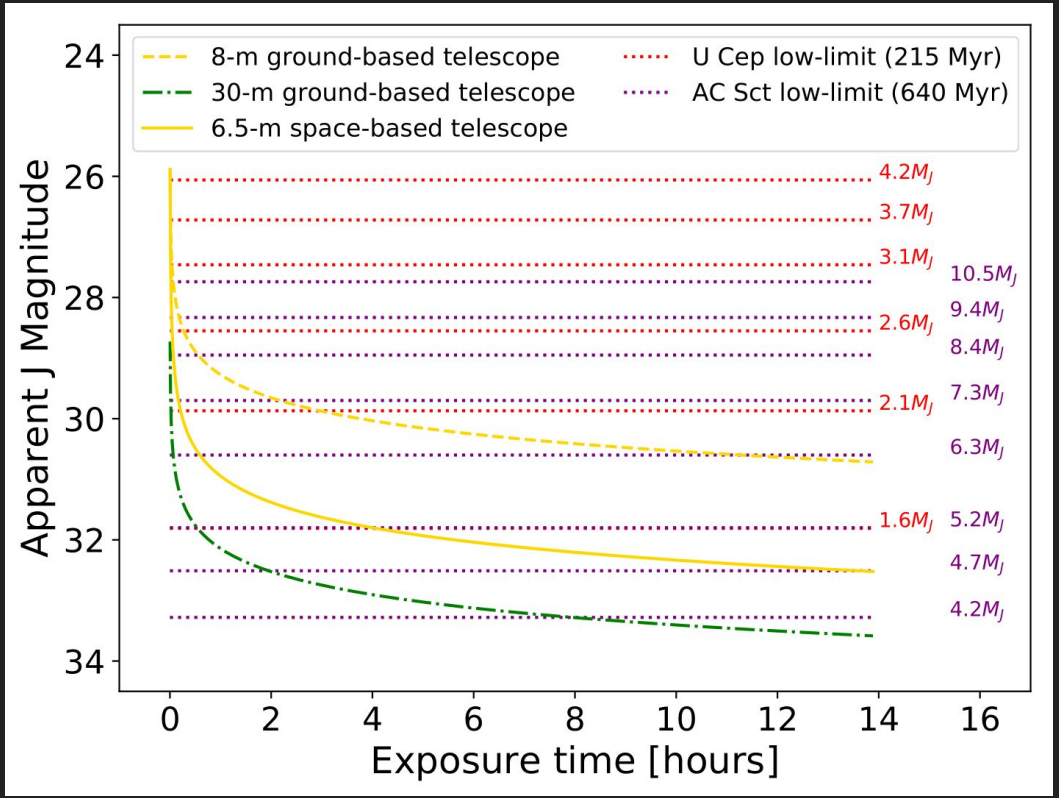
Self-luminous planets

- Further selection: age (i.e. total mass)
- Two targets: U Cep and AC Sct
- Planets: mass grid between 0.5 M_J to ~10 M_J
- We compute IR contrast levels and compared them to instrumental capabilities



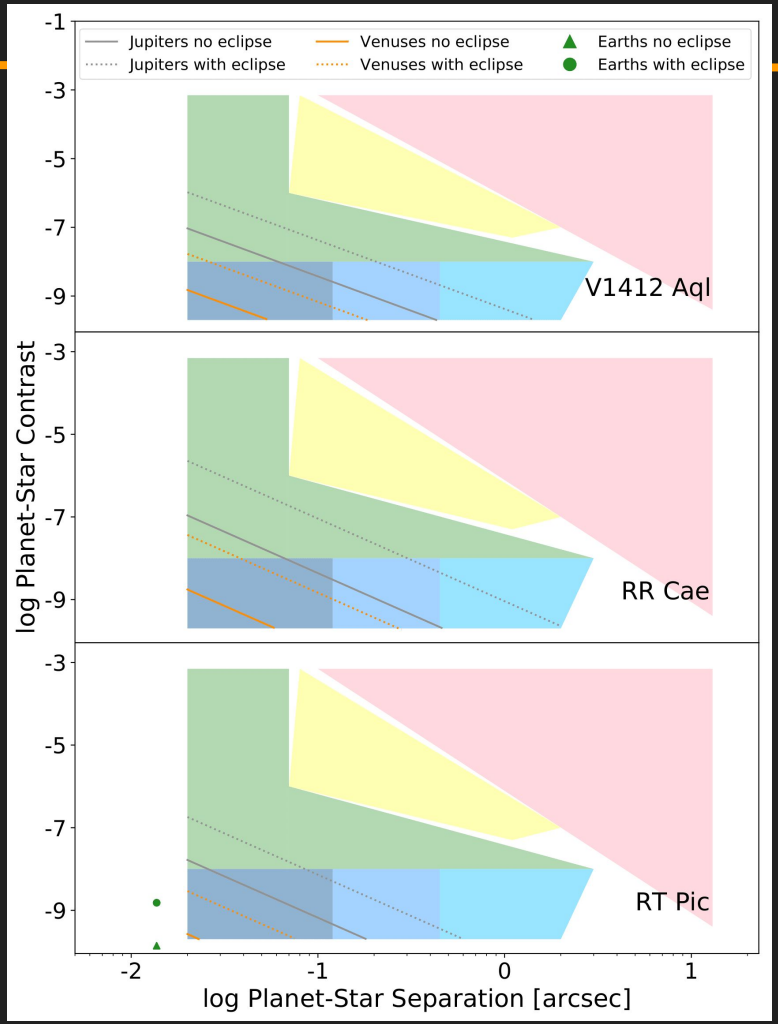
Self-luminous planets

- Are these planets visible? We compare their IR magnitude with instruments' detection limits
- For U Cep: 4.5 M_J with current ground- or near-future space-based, while ~1.5 M_J with future ground-based
- For AC Sct: 9 M_J with current ground- or near-future space-based, while 6 M_J with future ground-based



Reflected light planets

- Further selection: distance (<50 pc)
- Three targets: V1412 Aql, RR Cae and RT Pic
- Planet: Jupiter, Venus and habitable Earth
- We compute contrast levels and magnitudes similarly to SL case, for a range of achievable separations, and compared them to instrumental capabilities



Stefano Bellotti PhD student

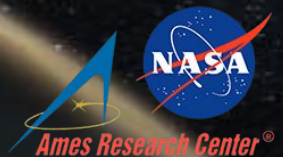
Summary

- Eclipsing binaries represent interesting targets when it comes to improve the contrast level in a direct imaging observation.
- In the SL case, we found two targets (U Cep and AC Sct) around which detections are feasible. If a planet existed around them, we would expand the parameter space of the host stars.
- In the RL case, there is the additional benefit that the planet is brightened by both components of the binary, while the binary itself appears pointlike during eclipse. This can put specific targets within contrast levels that will be achievable in the future.
- Outlook: increase sample of targets, and follow-up SL targets.

Detecting Extrasolar Planets Using Eclipsing Binaries as Natural Starshades

Stefano Bellotti, PhD student, IRAP, Toulouse
Ann Zabludoff, University of Arizona
Olivier Guyon, University of Arizona, NAOJ
Ruslan Belikov, NASA Ames
Maxwell Moe, University of Arizona
Chirag Rathi, University of Arizona

Lunar and Planetary Laboratory Conference 2020



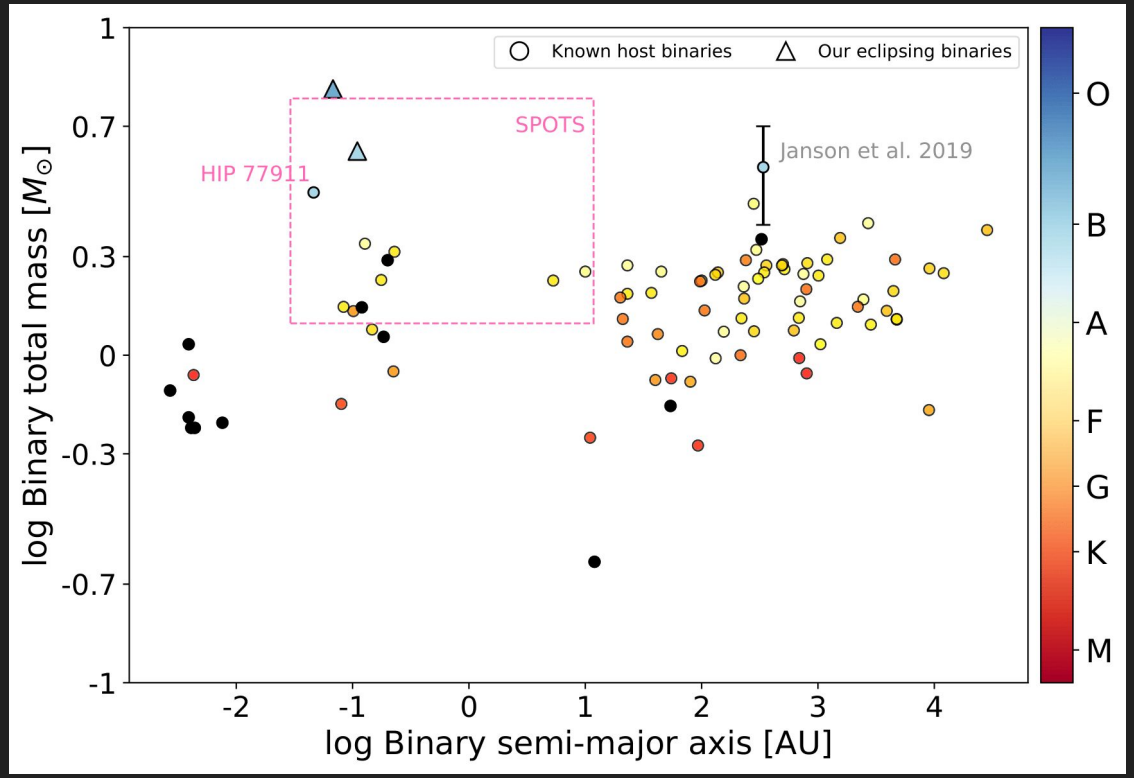
References

-Avvakumova, E. A., Malkov, O. Y., & Kniazev, A. Y. 2013, Astronomische Nachrichten, 334, 860

-Budding, E., Erdem, A., Çiçek, C., et al. 2004, A&A, 417, 263

Extra: SL planets - stellar host niche

Comparison of U Cep and AC Sct, with known host binaries: short-separation and more massive



Extra: RL planets - optical and IR detection limits