Orbits & Inclinations of Planet Host Binaries

Katie Lester, Steve Howell, Rachel Matson, & David Ciardi

NASA Ames, USNO, NExScI kathryn.v.lester@nasa.gov https://kvlester.github.io/

Introduction

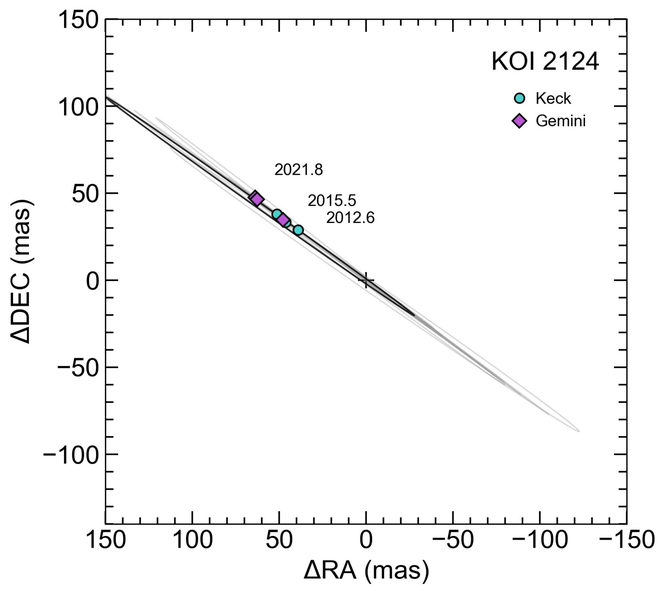
- Stellar companions can greatly affect planet formation & evolution.
- Since 50% of planet hosts have companions (Horch+ 2014), we need to study how planet formation is different in single- versus multi-star systems to get the full picture!
- But the dynamical properties of planet host binaries (e.g., inclination and eccentricity) have not been well studied observationally.

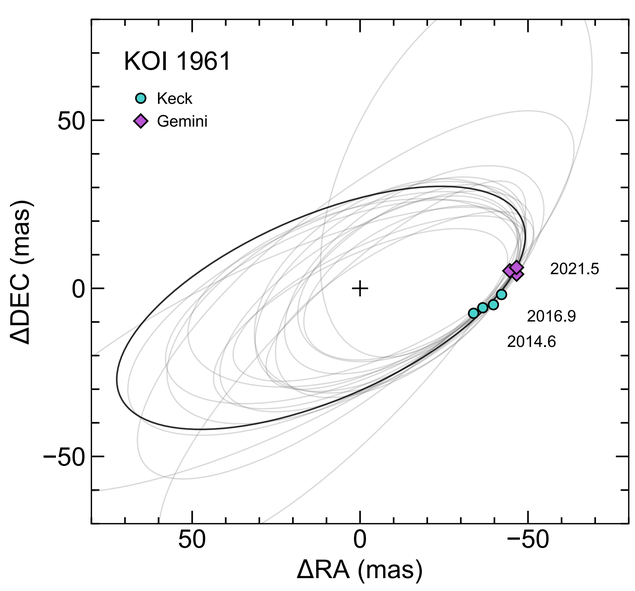
Observations

- We are monitoring 40 planet host binaries from Kepler & TESS (with a<100 AU) to measure their visual & spectroscopic orbits.
- New astrometry from speckle interferometry with Gemini, + past astrometry from Keck & WIYN (Furlan+ 2017, Dupuy+ 2022, Howell+ 2021)

⟶ 11 systems with preliminary visual orbits

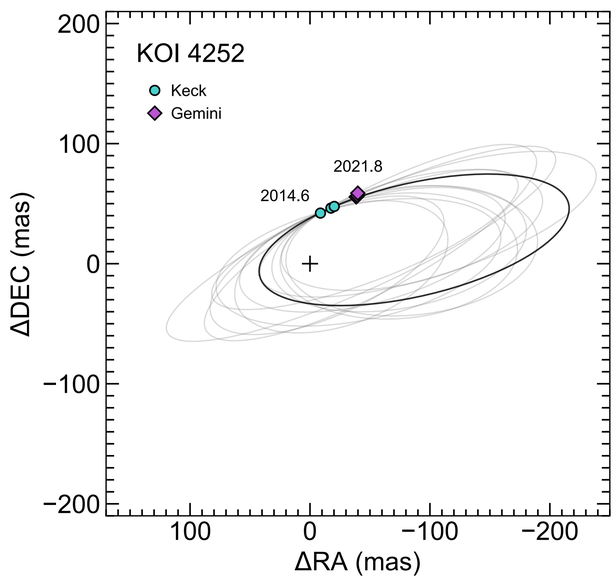
Example Visual Orbits



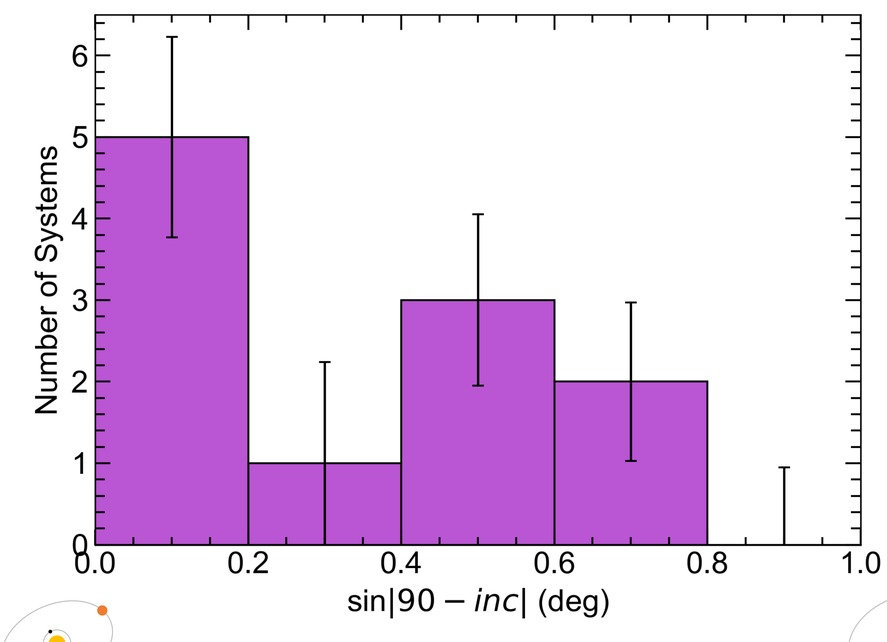


Orbit fitting:

- Created random orbital parameters
- Determined predicted positions and χ^2 for each parameter set
- Found best fit solution (black line) and other possible solutions within 1σ limit (grey lines)



Binary – Planet Orbital Alignment

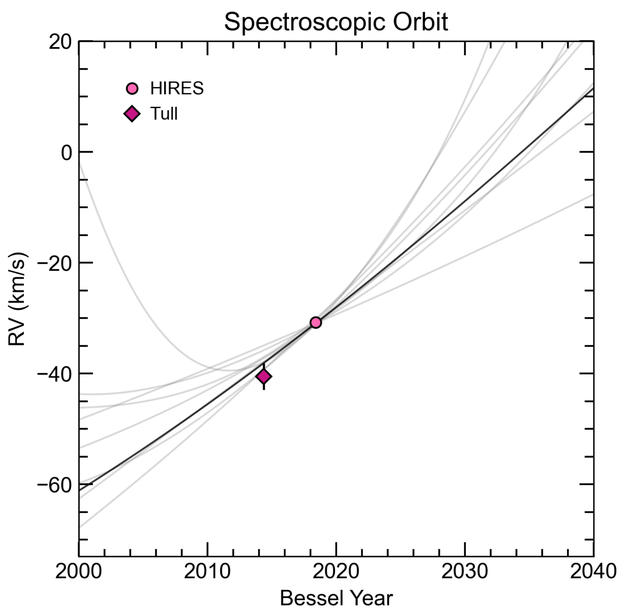


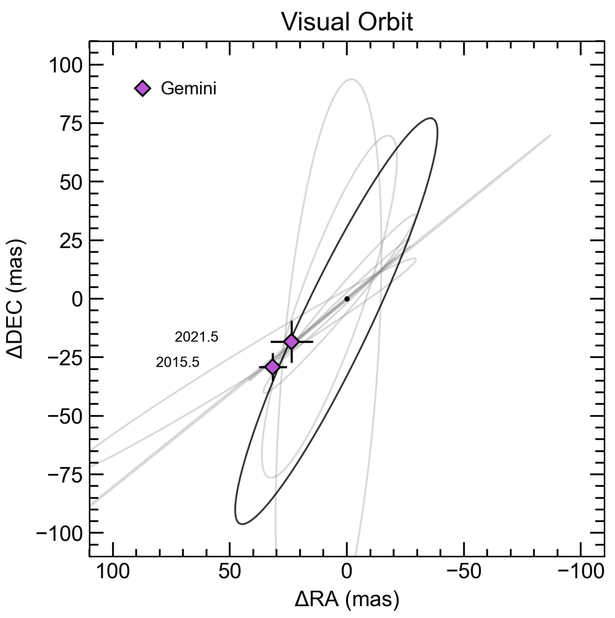
- We found that our initial sample of close binary hosts (a < 100 AU) shows preferential alignment between the binary & planet orbital planes.
- This is consistent with the results for wide binary hosts (a ~ 1000 AU) from Christian+ 2022.

(Note – this is the *minimum* alignment, because we do not know the on-sky orientation of the planet.)

Future Work

- Measuring binary-planet alignments for full sample
- Spectroscopic follow-up with NEID, HIRES, CHIRON in 2023A
- Combined spectroscopic & visual orbital solutions
- Determining binary environments amenable to planet formation!





Preliminary VB+SB1 orbital solution for KOI 5971... but we need more observations to constrain the orbit!

References

Christian et al. 2022, AJ, 163, 207

Dupuy et al. 2022, MNRAS, 512, 648

Furlan et al. 2017, AJ, 153, 71

Horch et al. 2014, ApJ, 795, 60

Howell et al. 2021, AJ, 161, 164

Acknowledgements

KVL is supported by a NASA Postdoctoral Fellowship, administered by ORAU. 'Alopeke & Zorro were funded by the NASA Exoplanet Exploration Program.