Exoplanet classification probabilities from initial detections in a direct imaging mission

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Title slide:
- Objectives
- Solar System Δmag vs s, i=0, 10 AU
- Probabilities
- Exoplanet Joint Distributions by Sub-type
- Acknowledgements & References

Objectives:
- A directly imaged exoplanet has photometric and astrometric properties Δmag and s, which can belong to many different classifications of planets.
- 1. If we directly imaged our solar system, could our planets be confused for one another? (Can Earth and Uranus have the same Δmag and s?)
- 2. What do the Δmag vs s distributions of exoplanets classified by the Kopparapu et al. 2018 sub-populations look like?
- 3. Show our method of calculating exoplanet classification probability and demonstrate it works for an Earth Analog

Solar System Δmag vs s, i=0, 10 AU:
Δmag vs s curves of Solar System with phase curves from Mallama et al. 2018 Planet properties from JPL HORIZONS, σΔmag = 1% and σs = 5 mas at 10 pc

Probabilities:
- We assume the underlying population of planets is consistent with the SAG13 planet population implemented in Keithly et al. (submitted)
- Use 3σ bounds for integration
- Classification Probability
  \[ P(ij, \Delta mag, s, \sigma_{\Delta mag}, \sigma_s) = \frac{f_{\text{meas}}(s, \Delta mag)f_{ij}(s, \Delta mag)dsd\Delta mag}{f_{\Delta mag}(\Delta mag)} \]
- Normalized Classification Probability
  \[ P_n(ij, \Delta mag, s, \sigma_{\Delta mag}, \sigma_s) = P(ij, \Delta mag, s, \sigma_{\Delta mag}, \sigma_s) N_{ij}/N_{\text{tot}} \]
- Takeaway: Combining the planet sub-pop and instrument capabilities enables us to calculate a probability a detected planet belongs to any given sub-population

Exoplanet Joint Distributions by Sub-type
- Exoplanet classification probabilities from initial detections in a direct imaging mission
- Demonstrate it works for an Earth Analog
- Objective of calculating exoplanet classification probabilities
- Exoplanet classification probabilities
- Hot Jovians
- Hot Neptunians
- Cold Neptunians
- Hot Super Earths
- Warm Super Earths
- Cold Super Earths
- Hot Rocky Planets
- Warm Rocky Planets
- Cold Rocky Planets

Underlying SAG13 distribution implemented in Keithly et al. (submitted) overlaid by Kopparapu et al. 2018 classification grid.
We can give different reward value for detected planets of different types. Many in the science community place sole value on Earth-Like detections.

Acknowledgements & References
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Takeaway:
- Many in the science community place sole value on Earth-Like detections.
- We can give different reward value for detected planets of different types.
- Many in the science community place sole value on Earth-Like detections.
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