

ExoPAG SIG#2: Exoplanet Demographics

Co-Chairs

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&

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SIG#2's Goals: Building on SAG13

SAG13's Goal:

- **Primary:** Evaluate what we currently know about planet occurrence rates, and especially etaEarth, by consolidating, comparing, and reconciling discrepancies between different studies.
- **Secondary:** To establish a standard set of occurrence rates accepted by as much of our community as possible to be used for mission yield estimates for missions to be considered by the [2010] decadal survey.



[SAG13 Final Report](#)

SIG#2 Foundational Goal:

“To extend the SAG#13 work over a wider parameter space, by bringing together groups in the community to discuss their cross-technique and cross-population results, and identify work needed to move forward.”

SIG#2 Meta-Studies Report


Enabling Exoplanet Demographics Studies with Standardized Exoplanet Survey Meta-Data



- Report completed April 2023 under the leadership of J. Christiansen and M. Meyer
- The report finds that demographics re-analyses or meta-analyses are stymied by the lack of survey meta-data
- It presents a list of data and products to include when publishing exoplanet survey data that would enable other to better utilize their results




Leadership & Logistics

- **Current Chairs:** Rachel Fernandes (PennState) and Kiersten Boley (Carnegie EPL)
 - **ExoPAG Executive Committee approved Steering Committee:**
 - Natalie Batalha (UCSC)
 - Bertrand Mennesson (JPL)
 - Samuel Quinn (Harvard/CfA)
 - Elisa Quintana (NASA Goddard)
 - Regular meetings on the Second Friday of the Month at 1 pm Eastern time
 - Significant recruitment efforts have increased member numbers by 30%
 - Especially focused on recruiting ECRs, which makes up the majority of new members
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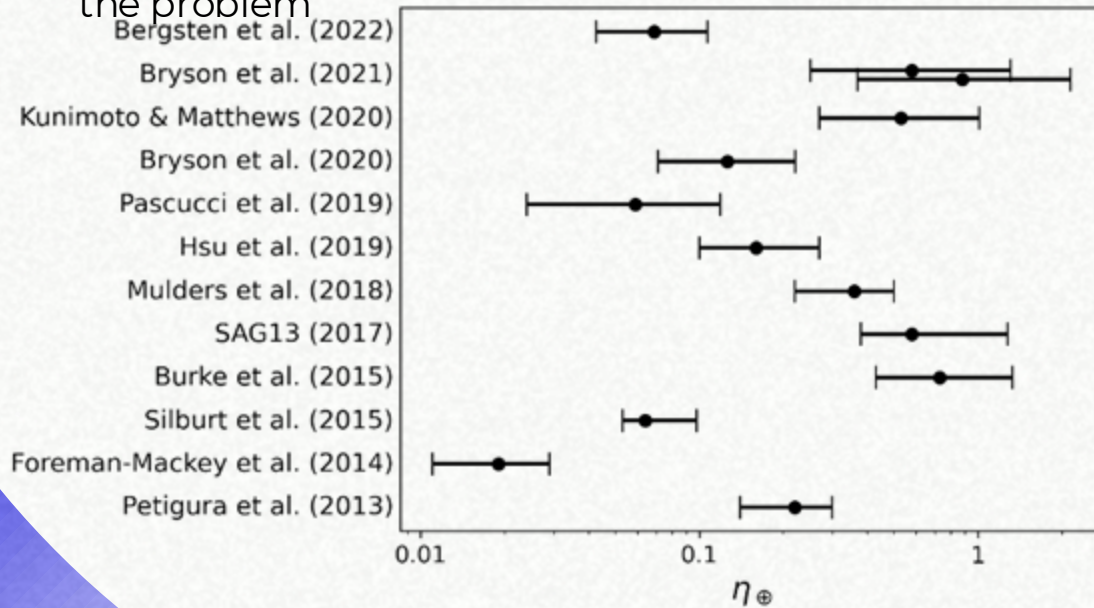


Code of Conduct

- Established a short Code of Conduct included in meeting reminder emails focusing on
 - Respectful Communication
 - Active Listening
 - Constructive Critique
 - Harassment-Free Zone
 - Inclusivity
 - Confidentiality
 - Timeliness
 - Tech Etiquette
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New from SIG2: A Review of η_{\oplus}

- We curated a review of past efforts to determine eta-Earth, and have a first order discussion of how different approaches/assumptions can affect eta-Earth and its error bars
- We don't have the scope to duplicate SAG13, but want to shed some light on the problem



Sun-Like Stars

Earth-size/
mass planets

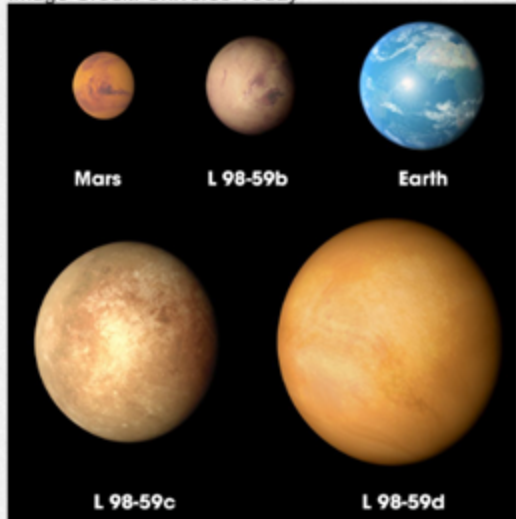
Extrapolation

Habitable
Zone

Dissecting the Definition of η_{\oplus}

Earth Analogs: Planets that are similar to the Earth in size and mass

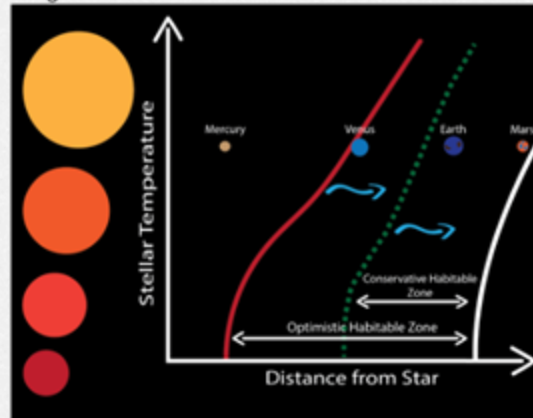
Image Credit: Universe Today



Earth Analogs: anything from ~ 0.5 to $2 R_{\oplus}$ i.e. Mars to Super-Earths

Habitable Zone: Distance from the star that liquid water can exist on the planet's surface

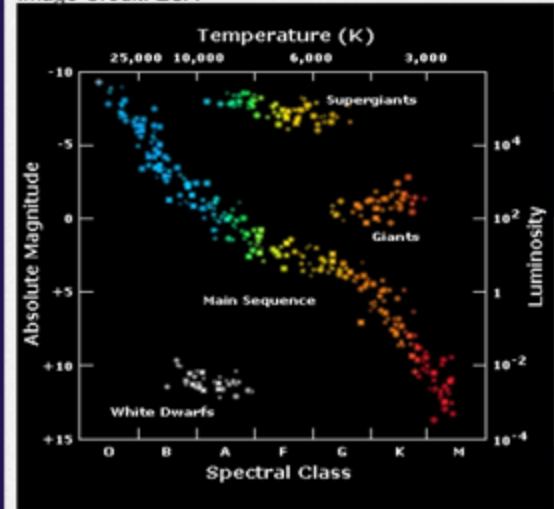
Image Credit: Jones et al 2024



Habitable Zone: can range from optimistic (e.g., recent Venus to early Mars) to conservative (liquid water only under ideal conditions)

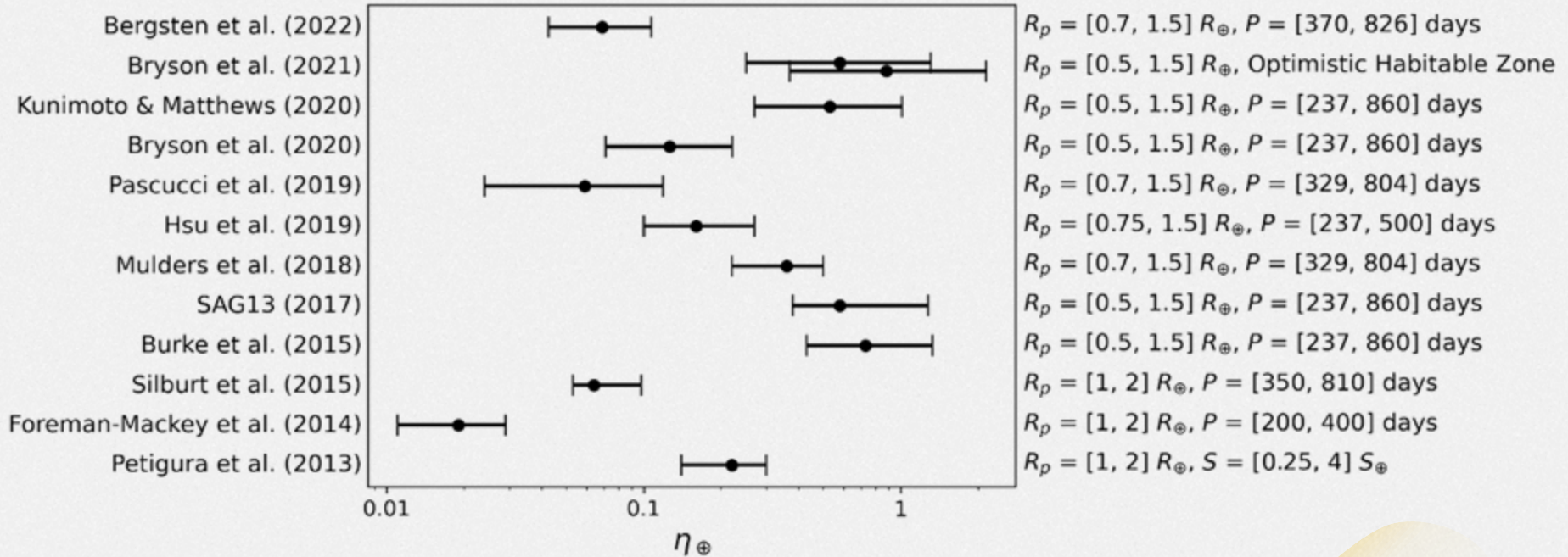
Sun-Like Stars: Stars that about the same age, size, mass, and temperature of the Sun

Image Credit: ESA



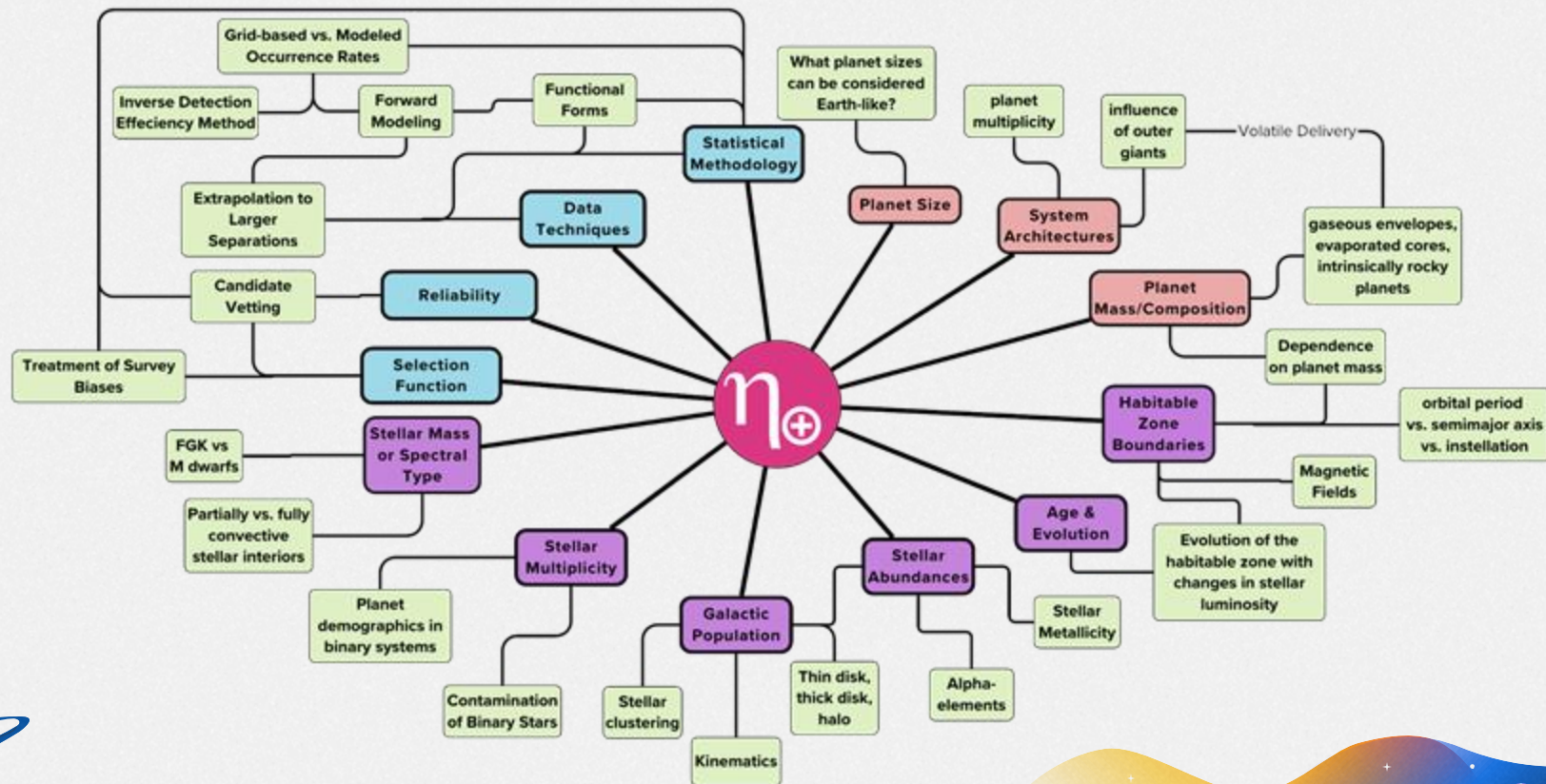
Sun-Like Stars: might mean just G2V stars like the Sun, or a wider range of FGK dwarfs

Current State of η_{\oplus} estimates



Fernandes et al. 2025c

Our estimates of η_{\oplus} are incomplete because no study yet fully integrates all these complex factors

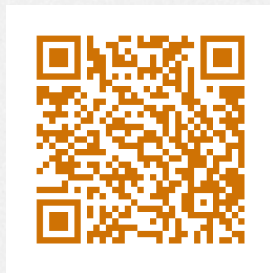


Overview of η_{\oplus} review

- First half is dedicated to **consolidating definitions and summarizing past efforts to measure frequency of Earth-analogs**
 - Identify cause of chronological changes and (attempt) to collate results in an “apples-to-apples” comparison
- Second half **identifies pathways forward**
 - Identify sources of systematics that are not fully accounted for
 - E.g., planet multiplicity, stellar multiplicity, stellar metallicity, etc.
 - Future constraints on eta-Earth from different detection techniques
 - How close are each of the detection techniques (current + upcoming missions) to finding Earth and/or placing constraints on eta-Earth



EtaEarth Review Paper:
Fernandes et al. 2025c



Kepler-centric EtaEarth Review
Paper: Bryson et al. 2025

Looking Forward



- **Guide Document on How to generate metadata from surveys in order to do demographics**
- White paper highlighting exoplanet demographic opportunities with Roman Space Telescope
- White paper synthesizing exoplanet demographics using multiple detection techniques

If you are interested in joining SIG#2, email us:

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