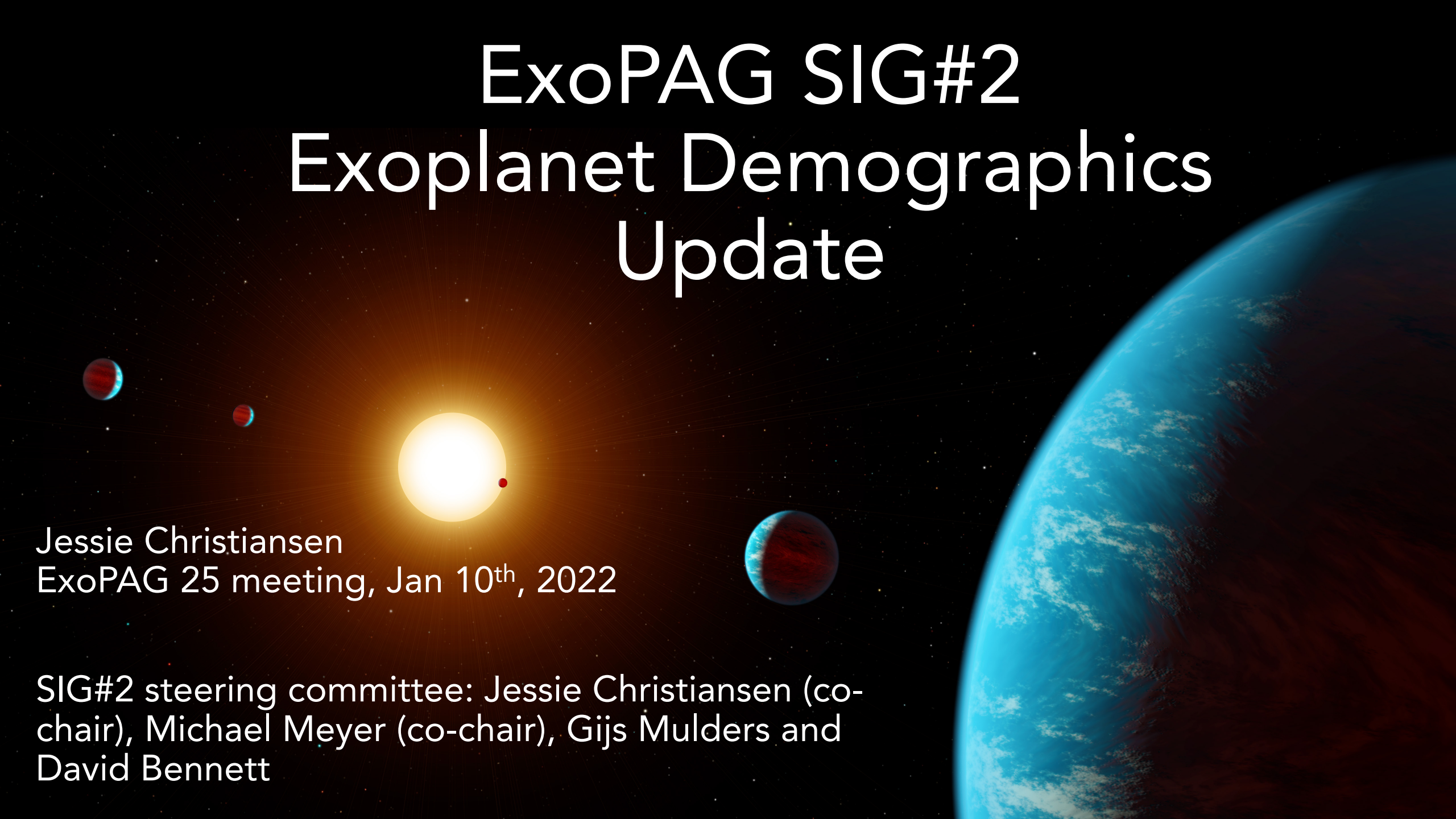
ExoPAG SIG#2 Exoplanet Demographics Update



Jessie Christiansen
ExoPAG 25 meeting, Jan 10th, 2022

SIG#2 steering committee: Jessie Christiansen (co-chair), Michael Meyer (co-chair), Gijs Mulders and David Bennett

SIG#2 goals

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

(i) Members prepared an Astro2020 white paper outlining a road map for furthering the census of exoplanets (May 2019, closed)

(ii) Hosted a demographics mini-symposium at ExoPAG 21 (January 2020, closed), which ultimately became the Exoplanet Demographics conference (November 2020; closed)

(iii) Created a demographics "gap list" (January 2021; closed)

(iv) Analyzing what is needed to enable meta-studies (draft findings complete)

(v) Analyzing the need for a public demographics repository (draft findings complete)

(vi) Facilitating a Kepler data challenge across multiple teams in the community with controlled inputs (planned)

SIG#2 Report – Draft Ready for Community Comment

"Enabling Exoplanet Demographics Studies with Standardized Exoplanet Survey Meta-Data"

Our 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 that would be valuable to include when publishing exoplanet survey data

The report is aimed at survey architects, authors, referees and funding agencies

Report process

- Small tiger teams for each of 5 detection techniques (transit, RV, microlensing, imaging and astrometry) assembled preliminary lists of data products they thought would be useful
- These lists were then evaluated by the other teams, each trying to imagine how they would incorporate those data in their calculations
- Several rounds of feedback were held to refine the lists
- Full report drafted by tiger teams, open for internal feedback by SIG#2 membership
- Final report now available for community feedback

Report structure

Two data 'tiers':

- ***Tier I products*** enable rudimentary incorporation of published exoplanet survey data into other analyses, using either the same or different detection techniques
- ***Tier II products*** greatly enhance the community's ability to incorporate published exoplanet survey data into their analyses, using either the same or different detection techniques

Three data 'types': Stellar sample properties, survey properties, planet catalog properties

Finding: keep products as model-independent/close to the data as possible

- Keep products in native parameters (radius, mass, mass-ratio)
- Include any model assumptions (mass-radius relation to translate transit survey results to radial velocity space, luminosity function to translate microlensing results, etc)

Transit Surveys: example draft text

3.1. *Tier I Data Products*

1. **Stellar sample properties**
   (a) Description of stellar sample that was searched, including target selection criteria and number of stars in survey.
   (b) Provenance of stellar parameters, in case multiple catalogues are available.
   (c) Description of the properties of stars that were removed from the parent sample (e.g. possible evolved star or binary, lack of high quality data, etc.)
2. **Survey parameters**
   (a) Description of criteria used for signal detection and planet candidate vetting (SNR threshold, minimum number of transits required, etc.)
   (b) Survey-level summary of observational coverage such as a window function, or duty cycle and time coverage
   (c) Description of treatment of planet multiplicity. Procedure to search the lightcurve for additional transit signals.)
   (d) Detection and vetting efficiency of survey (estimated or based on injection-recovery tests).
   (e) Treatment for stellar binarity and flux dilution/contamination from nearby or background stars.
3. **Planet catalog properties**
   (a) Properties of each host star: mass, radius, effective temperature, and surface gravity. If available, the limb darkening coefficients used for deriving the planet to star radii from the transit depth.
   (b) Observed properties of each planet candidate: orbital period, transit depth (or planet-to-star radius ratio), and transit duration. If available, estimates of the impact parameter or orbital eccentricity.
   (c) Sample reliability (measured or estimated, or assumptions made), including both the astrophysical false positive probability and the instrumental false alarm rate.

3.2. *Tier II Data Products*

1. **Stellar sample properties**
   (a) Full list of surveyed stars with fundamental properties (identifier, radius, mass, effective temperature, limb darkening coefficients, age estimates, etc.)
   (b) Stellar properties used in defining the survey sample, if those are updated during or after the survey.
2. **Survey properties**
   (a) Per-target detection efficiency, either estimated or from injection-recovery tests. In terms of orbital period and planet-to star radius ratio (or depth). Alternatively, the per-target detection efficiency can also be expressed in terms of the measured signal-to-noise (or MES) and the number of transits observed.
   (b) Per-target observing window length including gaps, or 1-sigma depth functions
   (c) The detection efficiency of additional planets in the system.
3. **Planet catalog properties**
   (a) Simulated data sets. Inputs and results of a large suite of simulated data sets based on the pipeline used to generate the planet catalog. Simulated data sets might be based on an astrophysical model plus a model for the noise, or make use of alternative strategies such as scrambling the data.

Draft Ready for Community Comment

Final draft report ready for feedback from the wider community

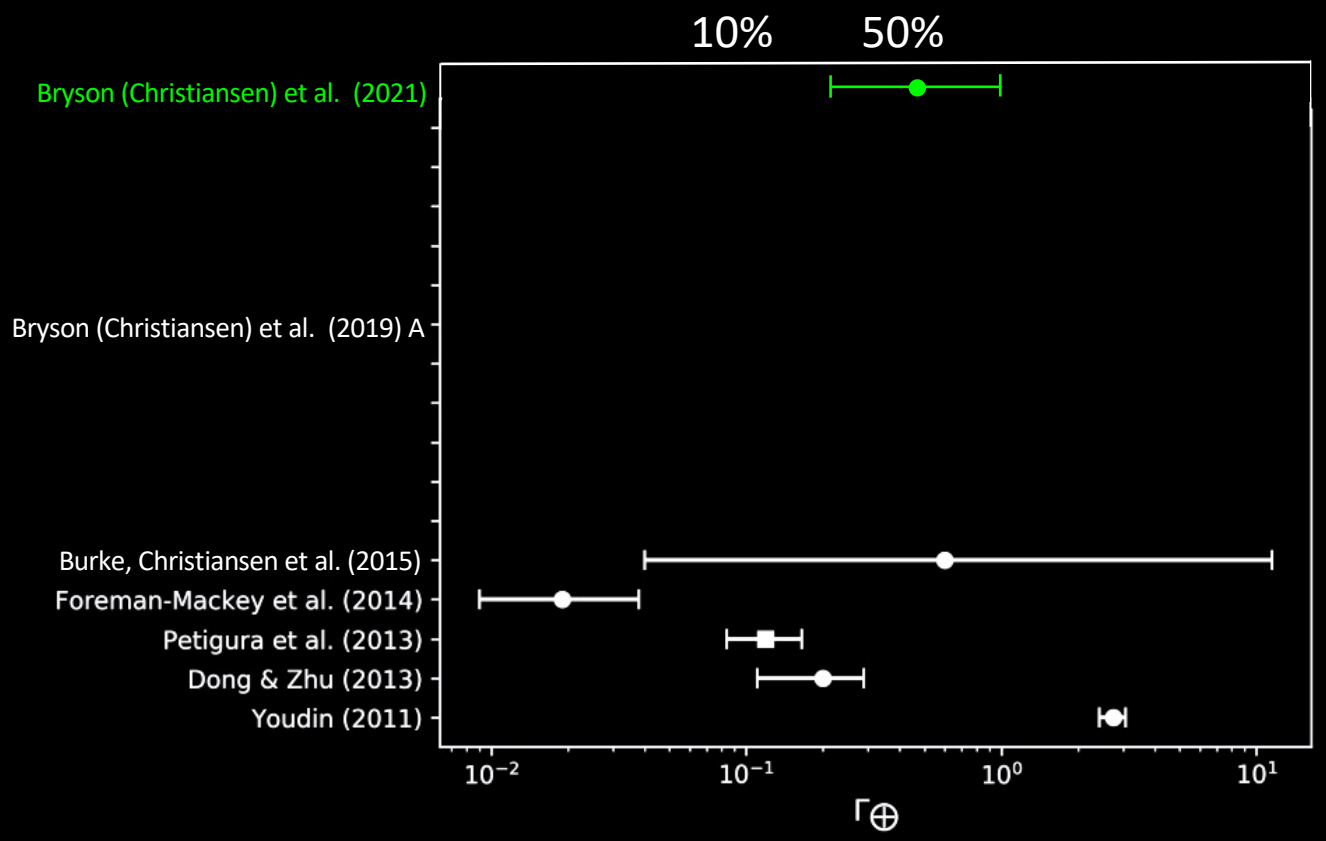
Report available from the ExoPAG SIG#2 website:
https://exoplanets.nasa.gov/exep/exopag/sigs/

Comment period: Jan 10th to Mar 2nd

Feedback can be sent to myself (christia@ipac.caltech.edu) or the SIG#2 mailing list (exopagsig2@jpl.nasa.gov)

Please make sure this addresses your needs!

What's next: Kepler Data Challenge



The plan:

- To use the Kepler injected and scrambled data sets to construct a synthetic planet population that matches a prescribed (but secret!) underlying planet population model.
- To keep the stars and planets the same for everyone, and to make the same assumptions where possible (e.g. regarding false positives, multiplicity)
- To calculate occurrence rates in two regions – a high completeness/reliability region, and eta_Earth, for comparison