

ExoPAG SIG#2

Exoplanet Demographics

Update

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

Our goals

To extend the SAG#13 work over a wider parameter space, by, e.g.:

- (i) Bringing together groups in the community to discuss their cross-technique and cross-population results (ongoing)
- (ii) Identifying the overlaps between the parameter space from different studies, and what is needed to enable meta-studies (ongoing)
- (iii) Analyzing the need for a public demographics repository (ongoing)
- (iv) Facilitating a Kepler data challenge across multiple teams in the community with controlled inputs (planned)
- (v) Members prepared an Astro2020 white paper outlining a road map for furthering the census of exoplanets (closed)
- (vi) Hosted a demographics mini-symposium at ExoPAG 21 (which ultimately became the Exoplanet Demographics conference in November 2020 with 500+ attendees; closed)
- (vii) Created a demographics "gap list" (presented Jan 2021; closed)

“I published an exoplanet survey – now what?”

SIG#2 Report: On the Publication of Exoplanet Survey Demographics Data

For 4 detection techniques (transit, RV, microlensing, and imaging*) we have compiled a list of products you should make available:

Two data 'tiers': *Minimum* data products, and *Recommended* data products

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

As model-independent/close to the data as possible

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

(*astrometry could potentially be added)

Transit Surveys: example draft text

2. TRANSIT SURVEYS

2.1. *Minimum 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
- (c) Description of the properties of stars that were removed from the parent sample

2. **Survey parameters**

- (a) Description of criteria used for detection (SNR threshold, number of transits 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 (search for additional signals and lightcurve masking)
- (d) Detection and vetting efficiency of survey (estimated or based on injection-recovery tests)
- (e) Treatment for binarity and flux dilution/contamination

3. **Planet catalog properties**

- (a) Properties of each host star: mass, radius, effective temperature, surface gravity)
- (b) Observed properties of each candidate: period, transit depth (or R_p/R_s), a/R_s .
- (c) Sample reliability (measured or estimated)
- (d) Astrophysical false positive probability
- (e) Instrumental false alarm rate

2.2. *Recommended Data Products*

1. **Stellar sample properties**

- (a) Full list of surveyed stars with fundamental properties (Identifier, Radius, Mass, effective temperature, limb darkening, age, etc.)
- (b) If updated, reflecting current best knowledge

2. **Survey properties**

- (a) Per-target detection efficiency (estimated or from injection-recovery tests) either in terms of period and radius (or depth or R_p/R_{star}) and/or in terms of measured parameters, e.g., SNR/MES and number of transits observed
- (b) Per-target observing window length including gaps, or 1-sigma depth functions
- (c) Planet multiplicity detection efficiency
- (d) 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 report process

- Small teams for each detection technique (led by Peter Plavchan, Gijs Mulders, Dave Bennett, and Eric Nielsen) went away and came up with preliminary product lists
- (The two-tier/three-type structure emerged from these lists)
- 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 to refine the lists
- Final draft report being prepared now – likely to be circulated for comment in the wider community

Audience for report

- ExoPAG: a 'finding' something along the lines of "that the field will make more rapid progress towards addressing the ExEP science gaps if more and more homogeneous data are published by exoplanet surveys as described in the report"
- The exoplanet community: a handy guide for the products that will maximize the utility of your hard-won survey data
- Journals: a handy guide for reviewers to consult to help understand what products a survey might consider publishing

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 η_{Earth} , for comparison