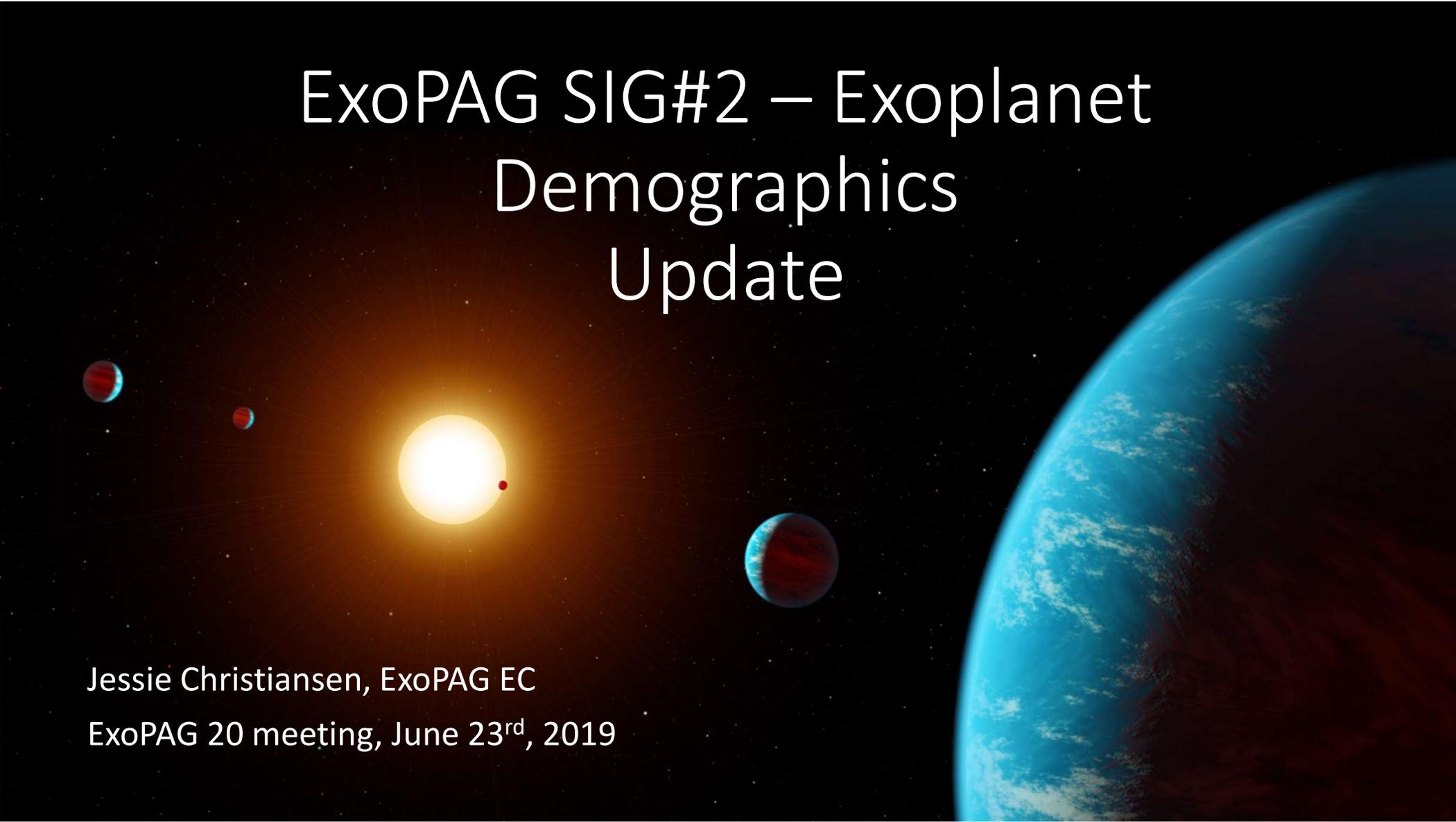


ExoPAG SIG#2 – Exoplanet Demographics Update

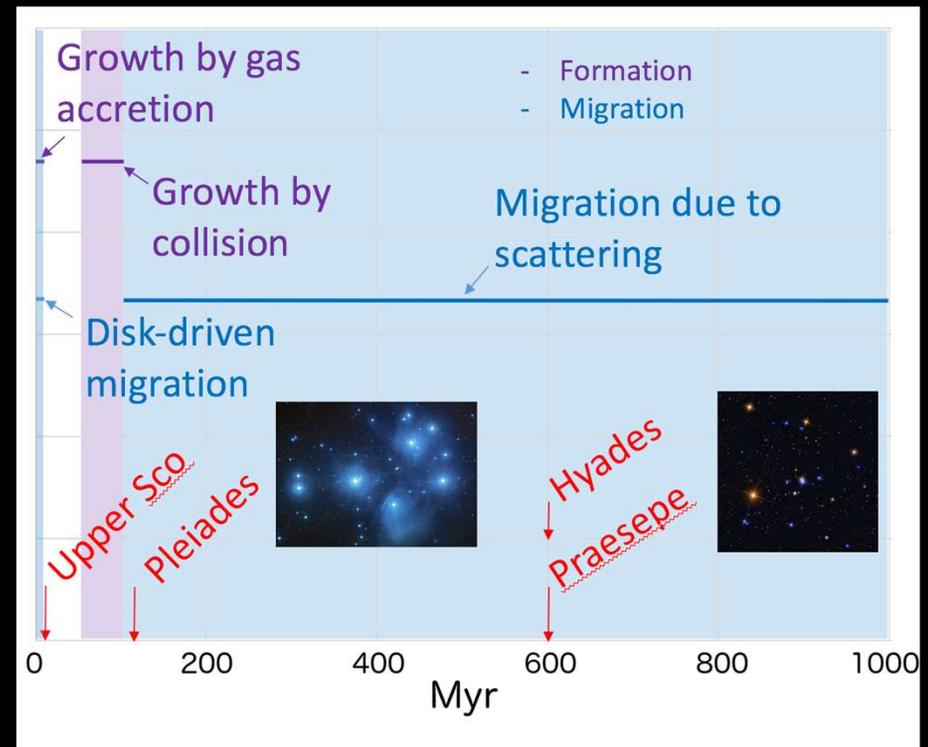
Jessie Christiansen, ExoPAG EC
ExoPAG 20 meeting, June 23rd, 2019



Motivation – scientific

Broad, open questions in exoplanets, including:

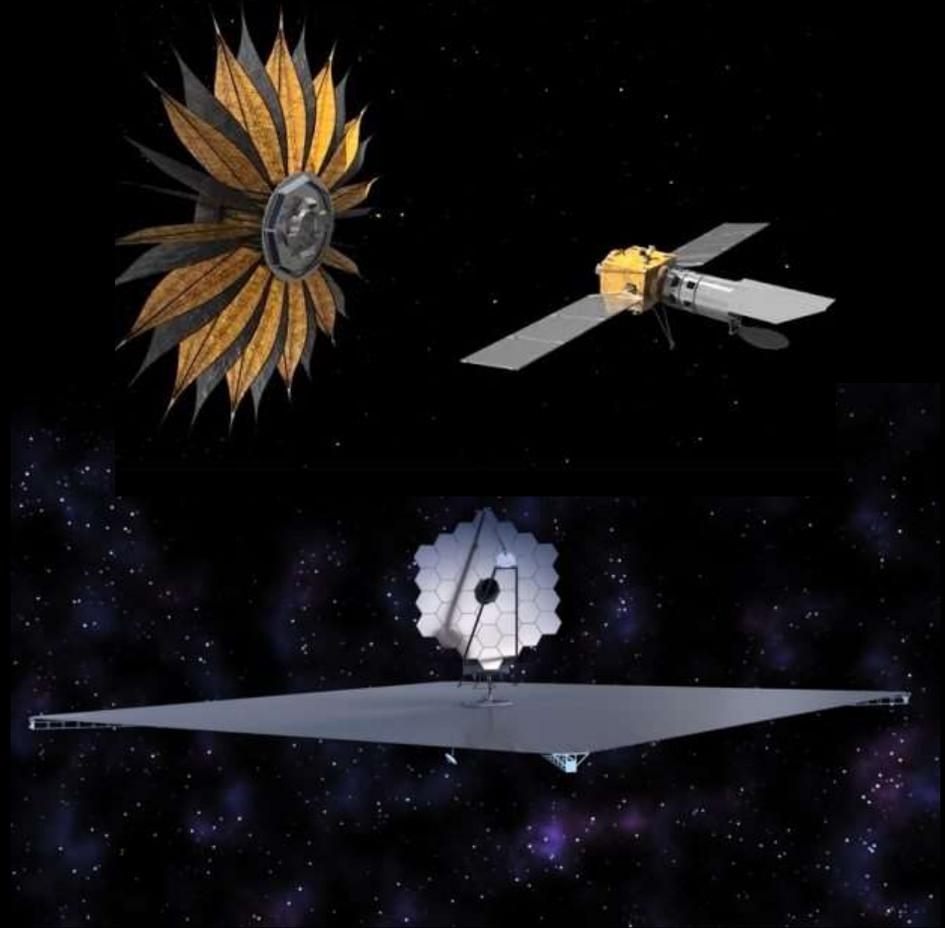
- What is the dependence of exoplanet formation on the natal environment and host star?
- What are the mechanisms and timescales for planet formation and migration?
- What drives the evolution and diversity in the resulting exoplanet systems?
- How can the observation and theory communities best work together to answer these questions?



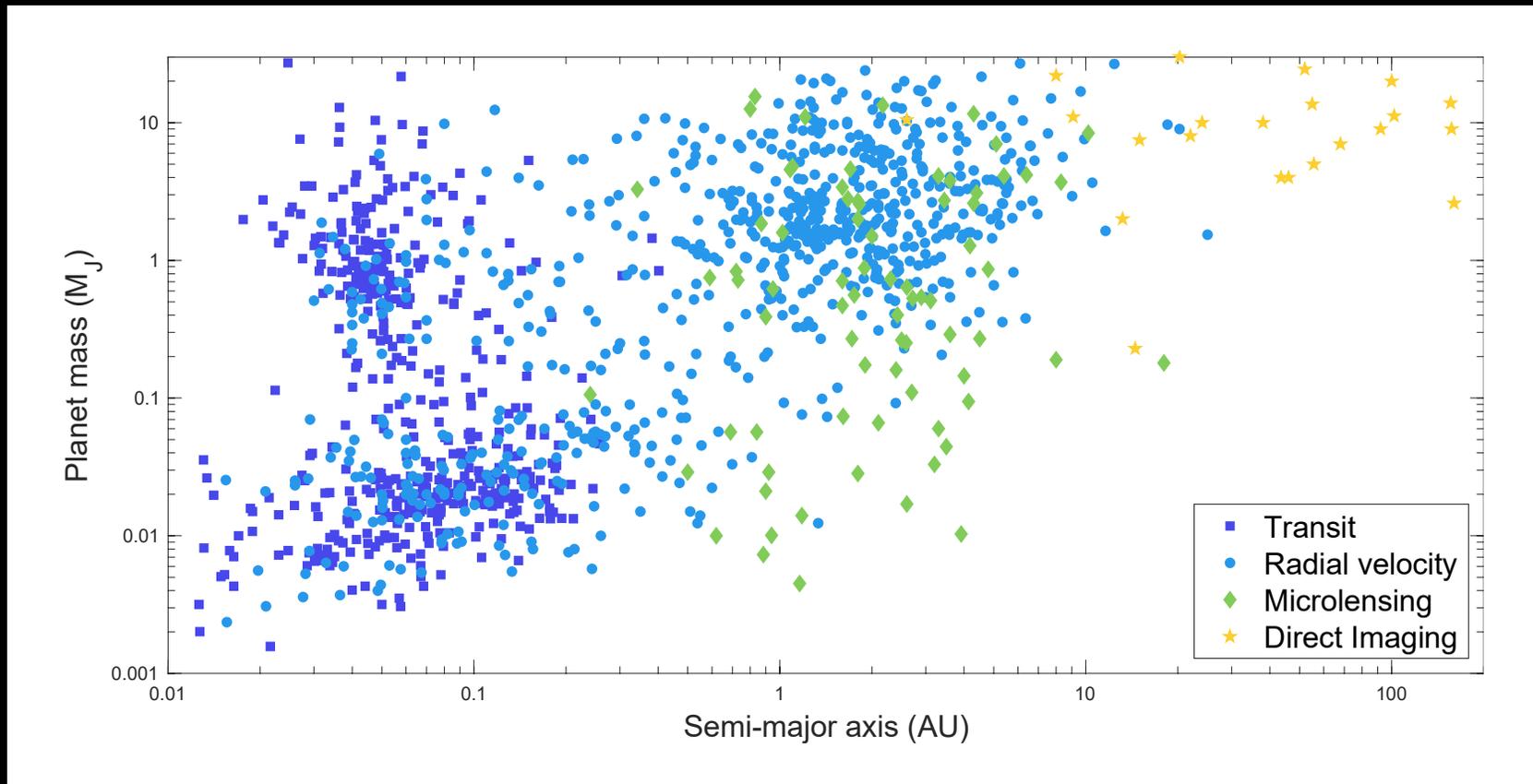
Motivation – programmatic

NASA's Decadal Flagship Mission Studies

- Three (Origins, HabEx and LUVOIR) have significant exoplanet science drivers (with various weightings compared to general astrophysics)
- LUVOIR and HabEx have agreed to use the SAG#13 occurrence rates so their yield predictions are on an equal footing
- These studies (and future mission planning) would benefit from occurrence rates addressing a broader parameter space



How?



Progress

We are holding monthly telecons with a growing list of occurrence rate practitioners (please feel free to join!)

- Identified a need for RV occurrence rates that probe lower mass stars for better comparison of results with microlensing, and will reach out to a couple of RV teams working on cool stars – **Tuomi+2019!**
- SIG#2 members participated in writing a white paper on wide orbit demographics for the Astro2020 call, led by David Bennett
- Generated a Demographics ‘Gap List’
- Scoping out a Demographics Database

Demographics 'Gap List'

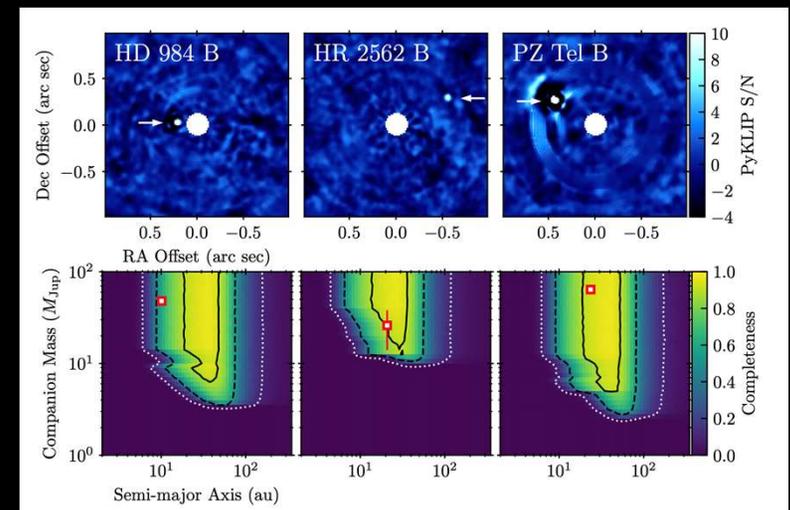
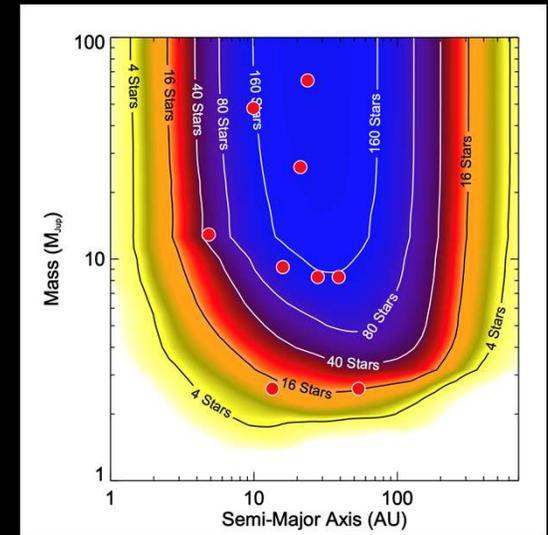
What is needed to extend demographics calculations to wider orbits?

There are data available

- Published RV survey results (e.g. Mayor+2011, Tuomi+2019)
- Publicly available RV data (e.g. HARPs/SERVAL, CPS (Keck, Lick))
- Microlensing (e.g. Suzuki+2018, UKIRT survey data)
- GPIES first-half sample (e.g. Nielsen+2019)

But that's only *part* of the necessary information

- Individual detection efficiencies for targets – sometimes not published, sometimes lost
- Understanding the stellar selection criteria



Demographics 'Gap List'

Incorporating physics

- Need to start incorporating stability/dynamics in multi-planet systems
- Internal composition physics in the joint mass/radius/period distribution to capture the mass/composition distribution

Producing completeness and reliability estimates for updated transit surveys (K2, TESS)

Recomputing mission yields (Gaia, WFIRST, HabEx/LUVOIR)

Multiplicity (stellar AND planetary) – effects on detection efficiencies

Public Demographics Database

An open-source database for exoplanet demographics products
(modelled on the success of Kepler)

- For each detection technique, recommend a set of standard products in standard formats
- 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)
- Include stellar meta-data (why selected, detections vs. non-detections)
- Allow for flexibility of grid (e.g. radius/period) choices, as compared to prescribing a set grid

White paper

We are crafting a white paper outlining a road map for furthering the census of exoplanets in the 2020s. The paper will cover:

- Theoretical predictions of exoplanet population distributions (formation and migration), identifying parameter space where the predictions differ in a testable way in the coming decade
- Discussion of which techniques will explore that parameter space in the next decade (and the missions/projects they are associated with), with emphasis on the detection biases that need to be taken into account (RV, astrometry, microlensing, imaging)
- Discussion of if/where the techniques will overlap in parameter space, and best practices for deriving occurrence rates to allow comparison across techniques
- Identification of any usefully discriminatory parameter space that is NOT being addressed by current or upcoming missions that would help distinguish between theoretical models for input to future planning

Science symposium, maybe at ExoPAG 21?

ExoPAG 21 will be attached to the AAS meeting in HI, January 2020

SIG#2 is planning a half-day science symposium to bring together people working on exoplanet demographics across multiple techniques to report on the progress and identify synergies

Once approved, we will be distributing a call for abstract submissions so keep an eye out for that!