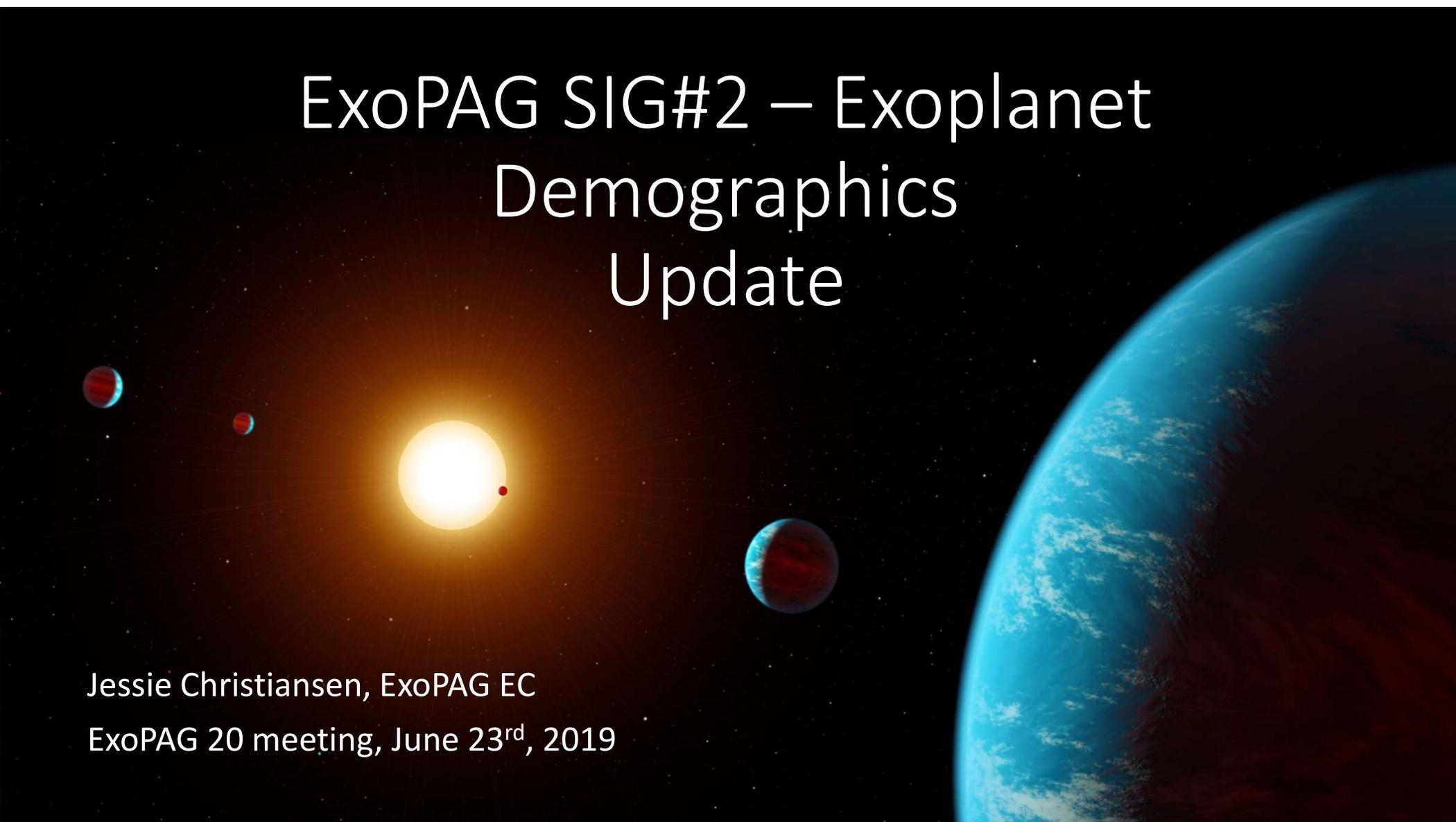


# ExoPAG SIG#2 – Exoplanet Demographics Update

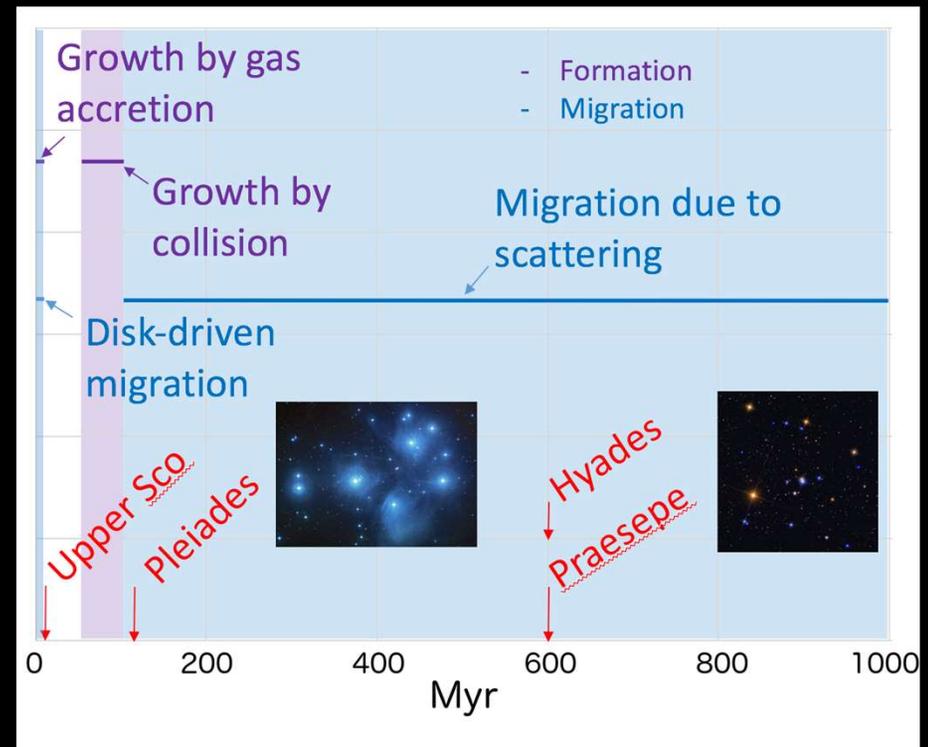
Jessie Christiansen, ExoPAG EC  
ExoPAG 20 meeting, June 23<sup>rd</sup>, 2019



# Motivation – scientific

Broad, open questions in exoplanets, including:

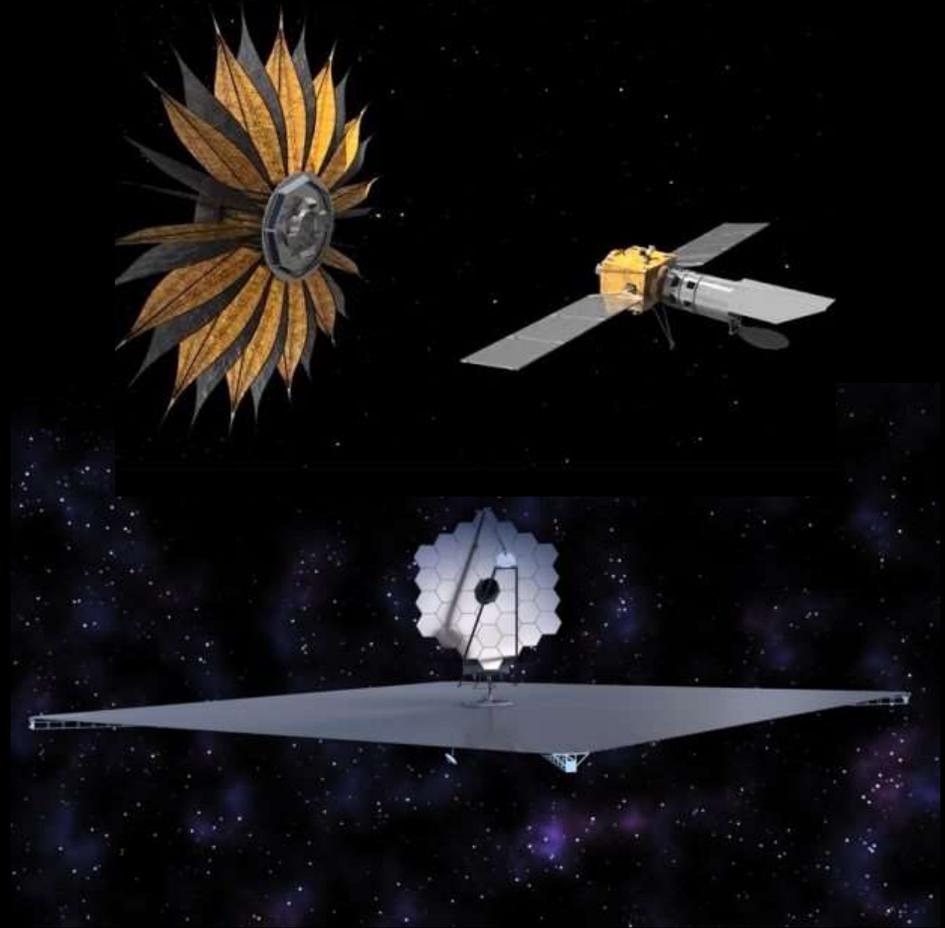
- What is the dependence of exoplanet formation on the natal environment and host star?
- What are the mechanisms and timescales for planet formation and migration?
- What drives the evolution and diversity in the resulting exoplanet systems?
- How can the observation and theory communities best work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



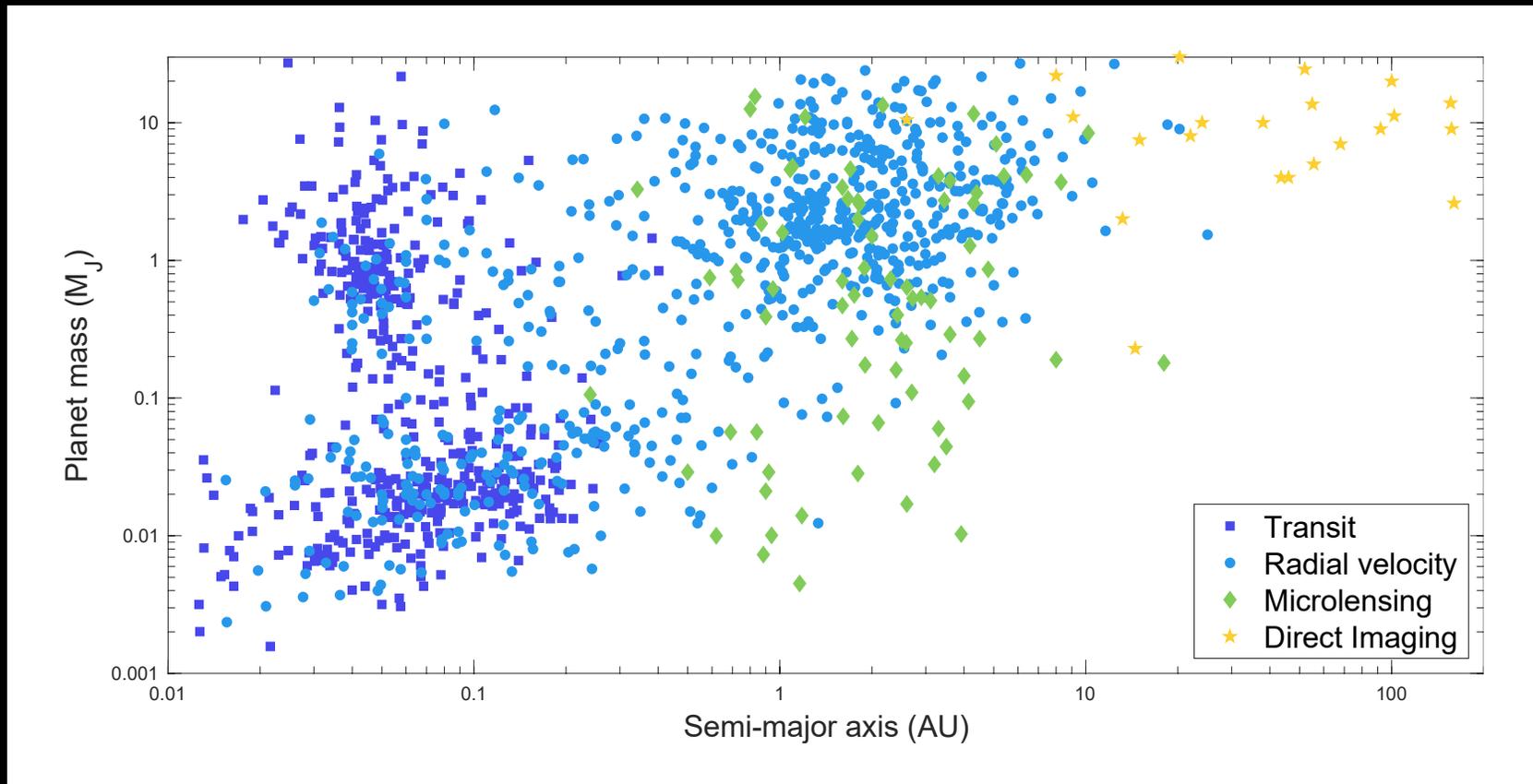
# Motivation – programmatic

## 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'

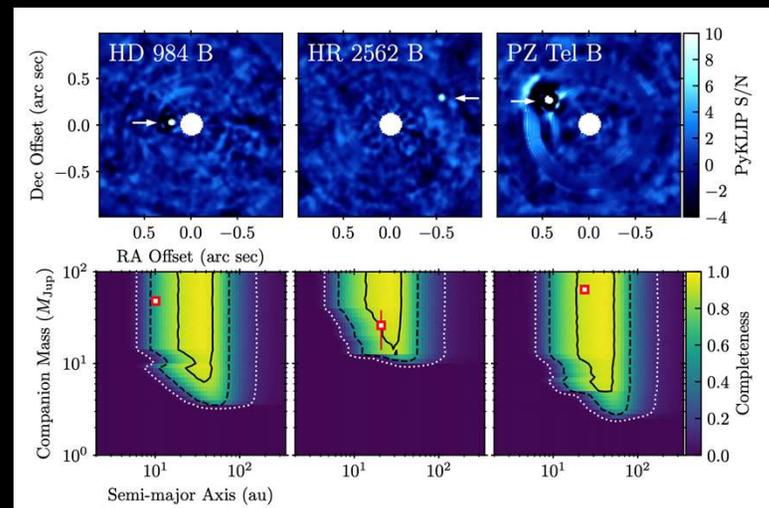
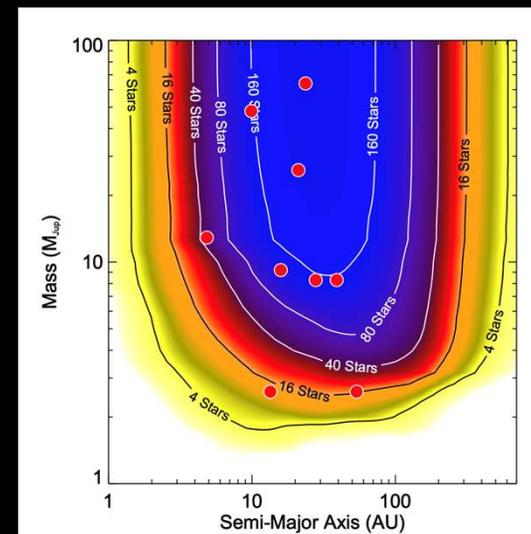
What is needed to extend demographics calculations to wider orbits?

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!