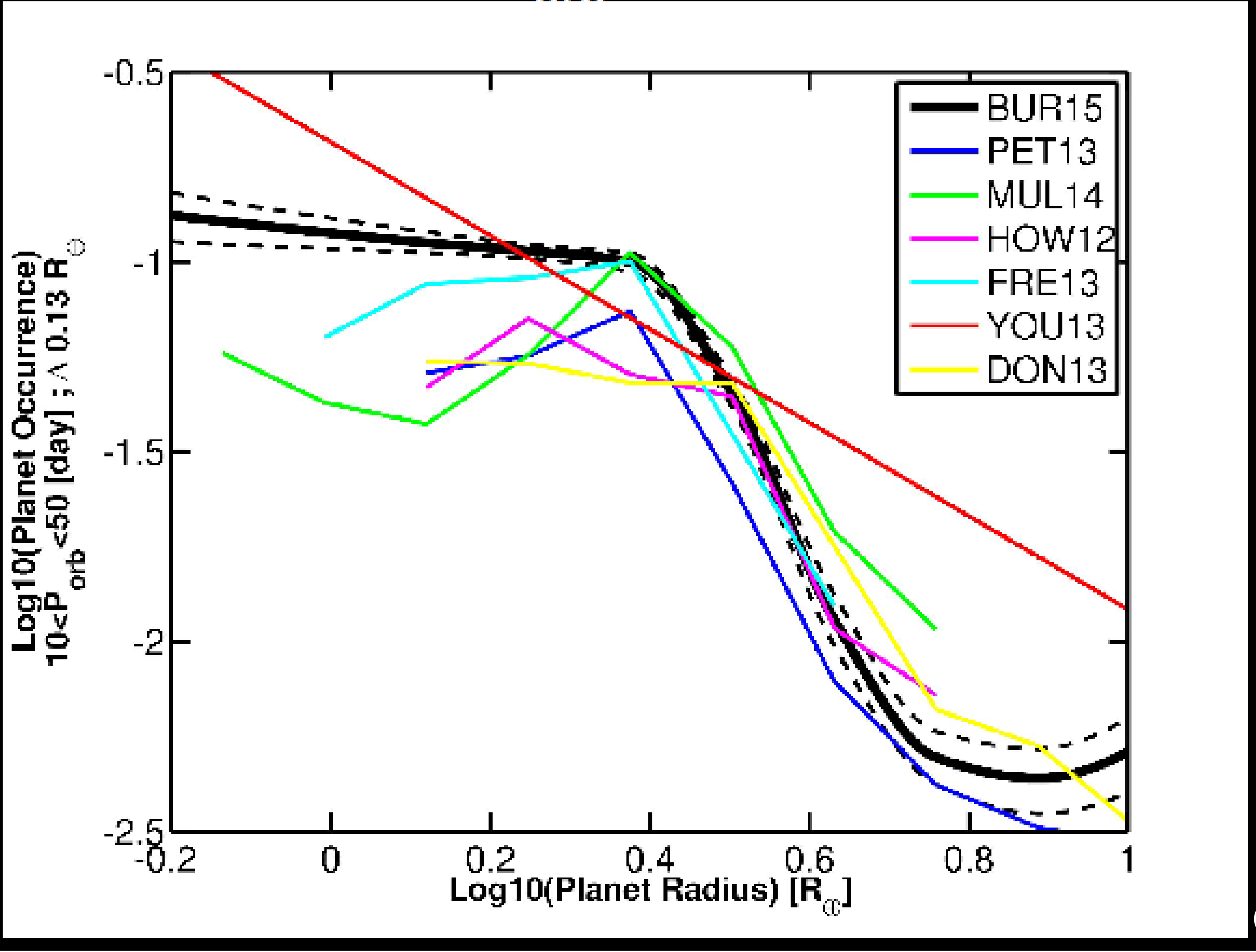
Comparison To Literature

GK Dwarf

10 < P_{orb} < 50 day

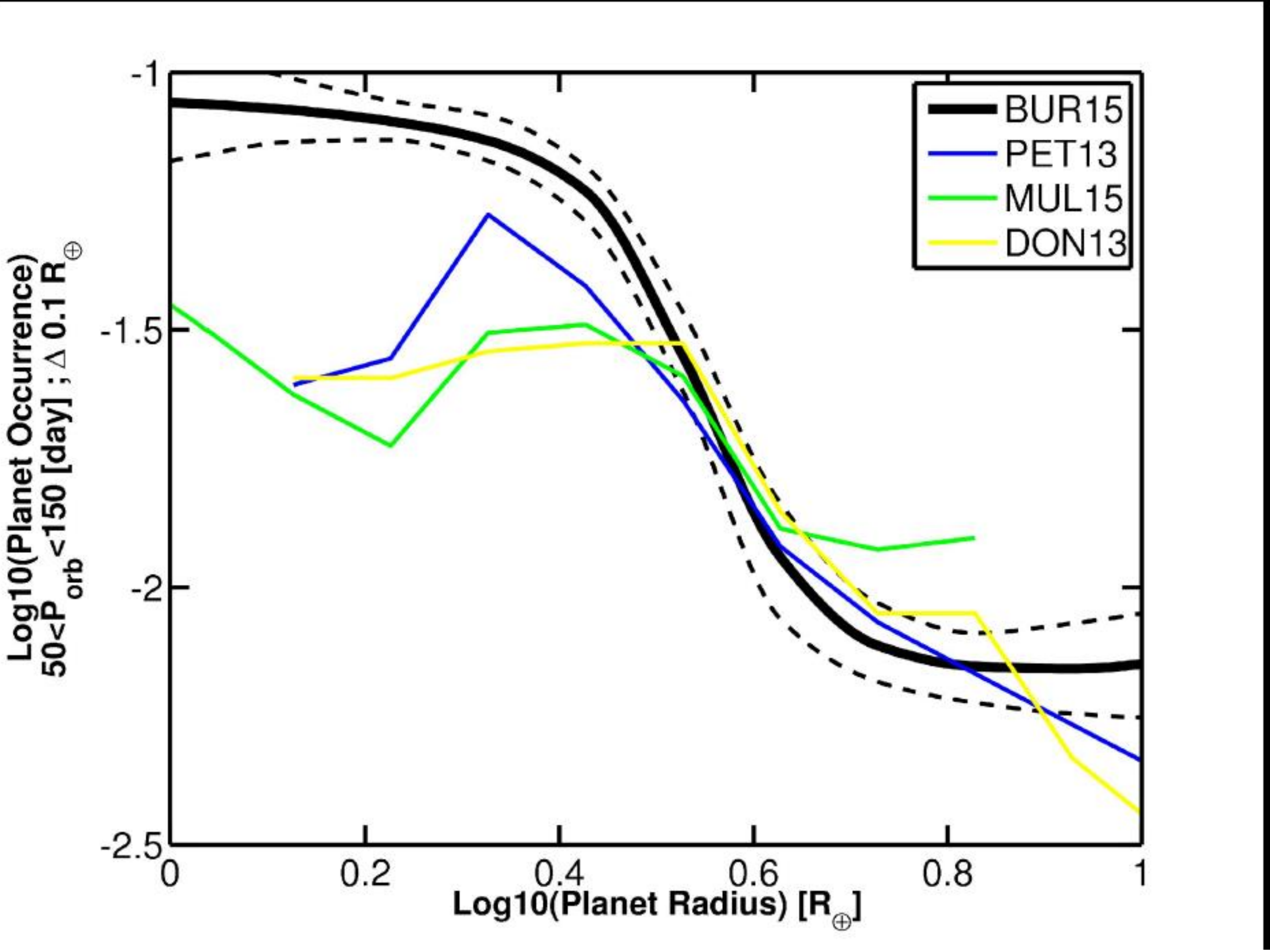


Chris Burke

Comparison To Literature

GK Dwarf

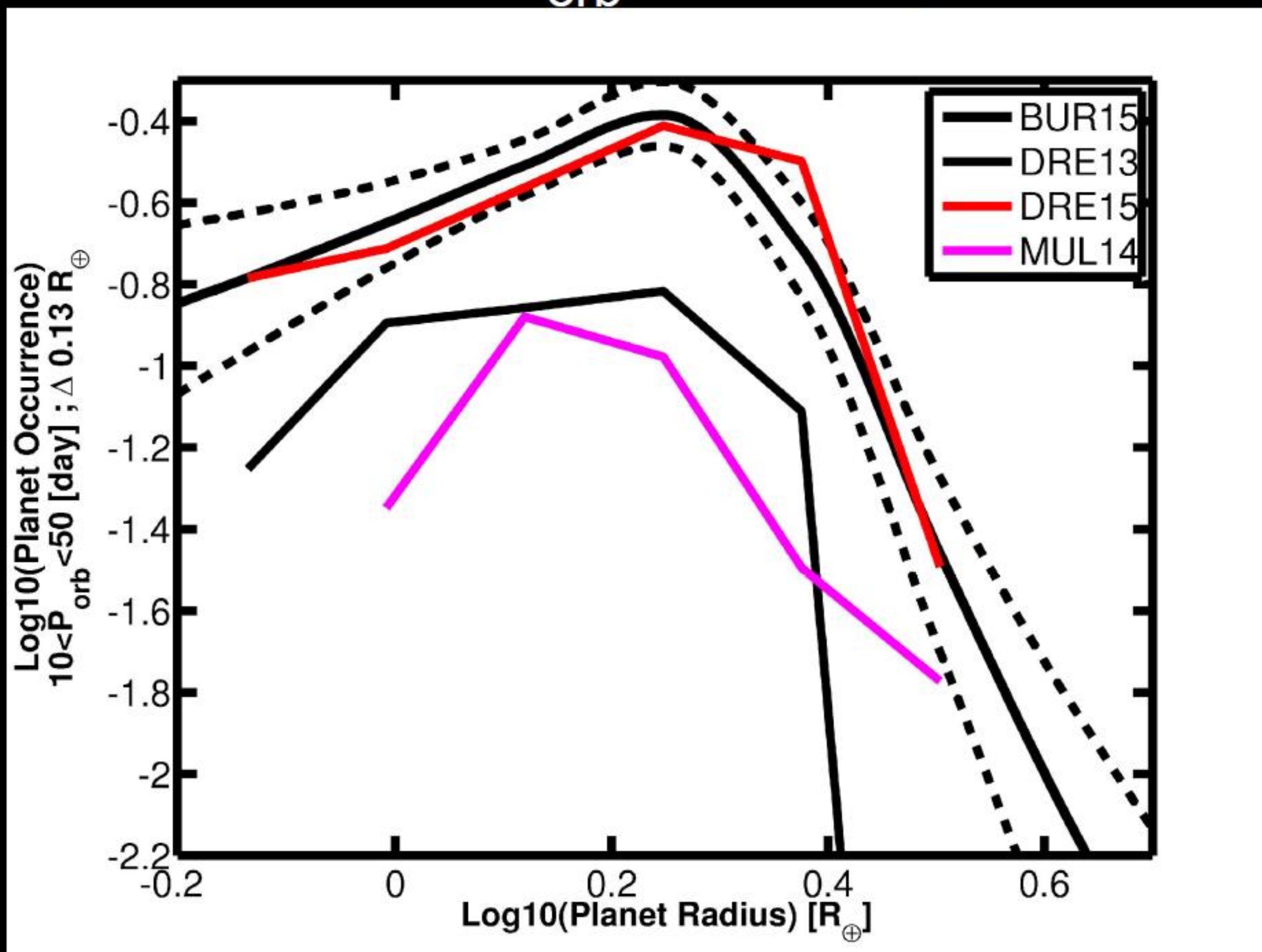
50 < P_{orb} < 150 day



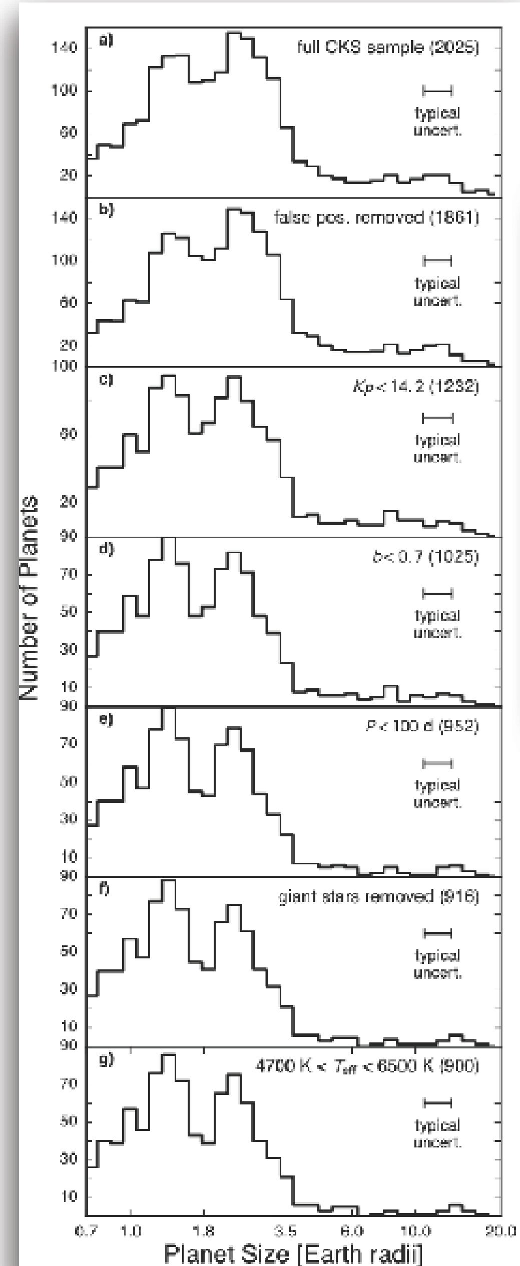
Comparison To Literature

M Dwarf

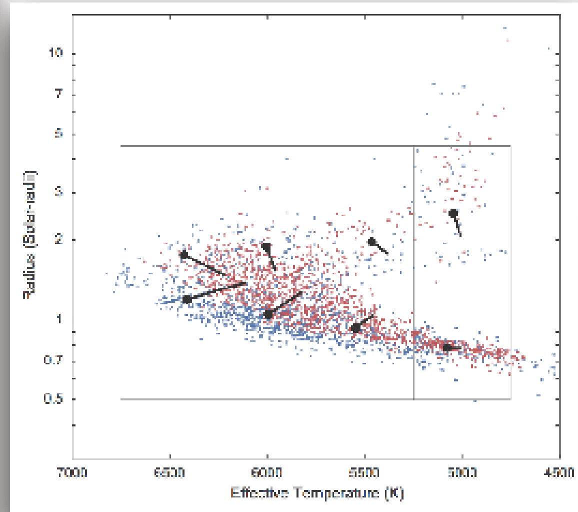
10 < P_{orb} < 50 day

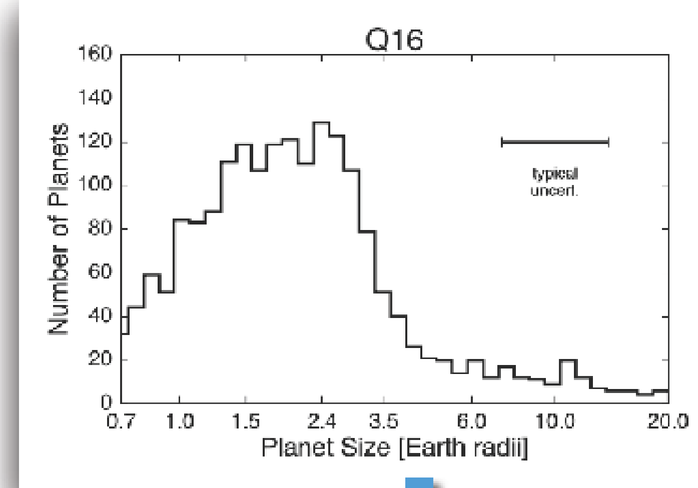


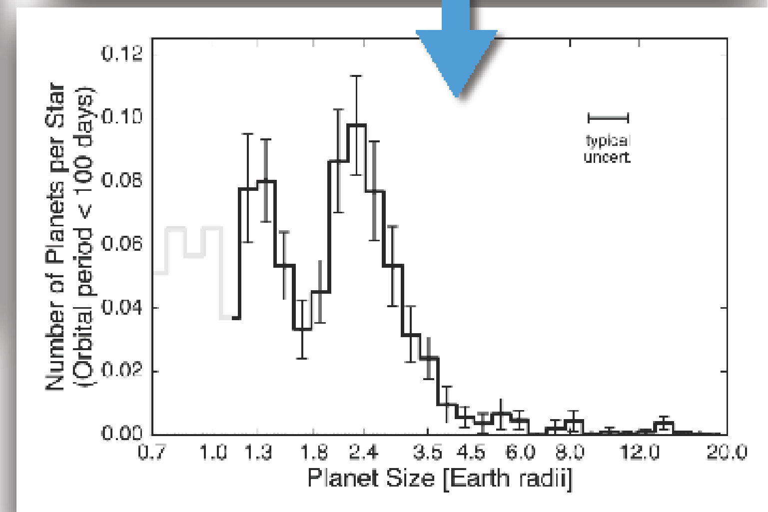
Sample Selection

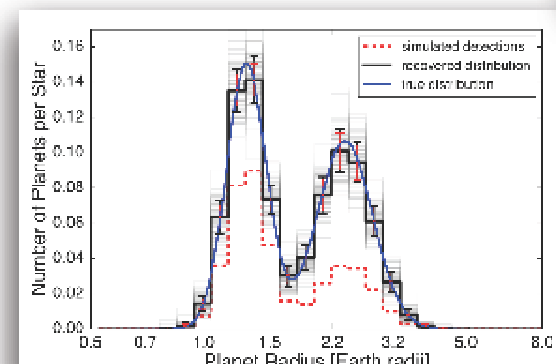


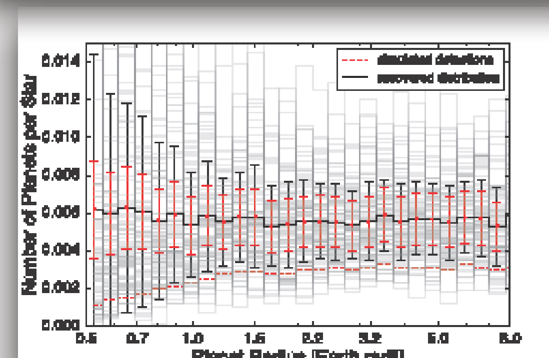
High-precision, Homogeneous Stellar Parameters









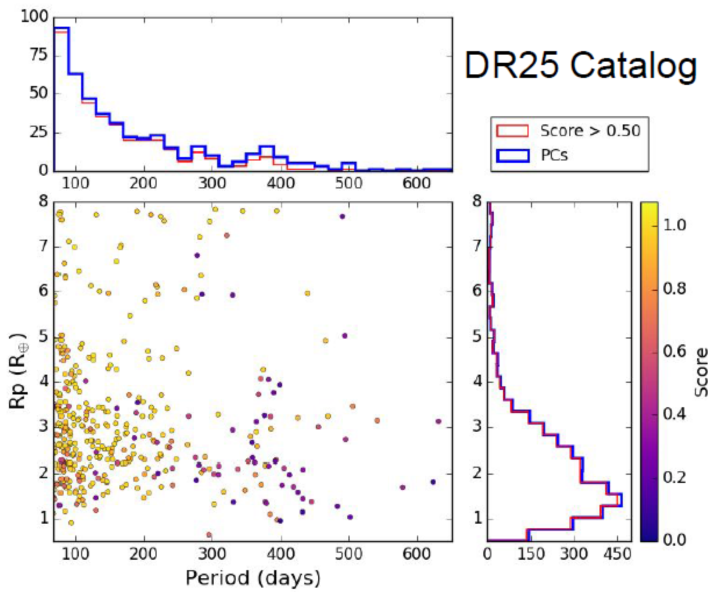


BJ Fulton

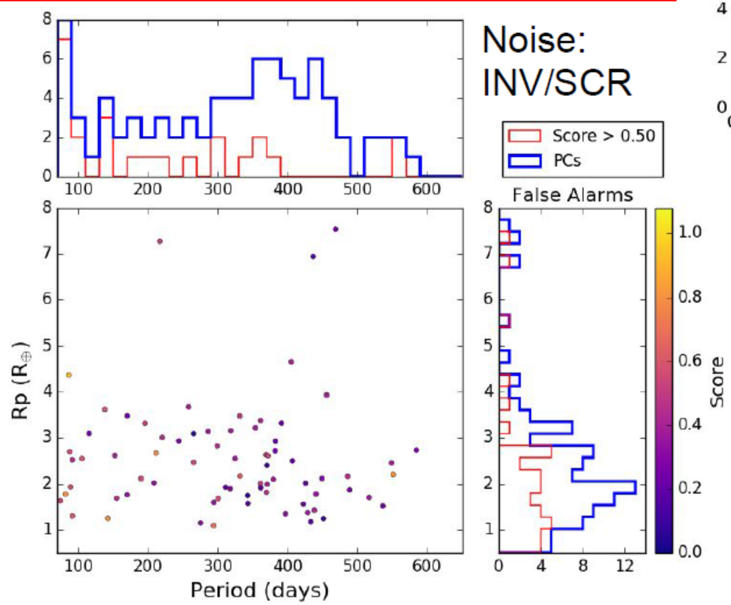
DR25 Candidate Catalog:

Numbers and Reliability

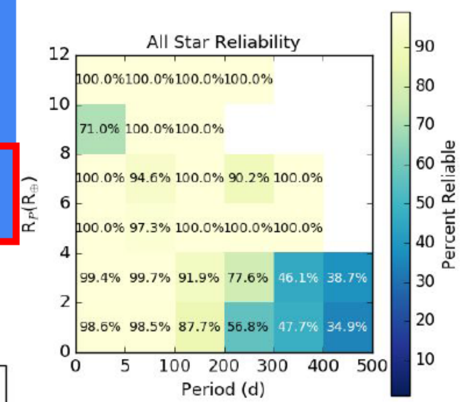
You must consider reliability of long period, low snr candidates.



True Candidates + Mistaken Candidates



Candidates created from searching pure noise light curves. (~Twice as many light curves searched as Observed data.)



How to incorporate reliability is left as an exercise for the reader.

Susan Thompson

Occurrence: Kepler Field vs. Nearby Stars

Radius	Period	Fressin+ (2013)	Petiugra+ (2013)	Mulders+ (2015)	Fulton+ (2017)
1.4–2.8 R_E	< 100d	35%	33%	27%	44%
2–4 R_E	< 100d	24%	24%	23%	36%

	Howard+ (2012) *Kepler*	Wright+ (2012) *RV*
"Hot Jupiters" P < 10 d	0.4% R_P = 8–32 R_E	1.2% M_P = 0.1 M_J

- Multiple occurrence studies agree at the ~50% level
- Fulton results differ due to spectroscopic radii
- Hot Jupiter rates differ by 3x.
- Future surveys must plan for factor of 2-3x variations in planet occurrence rate

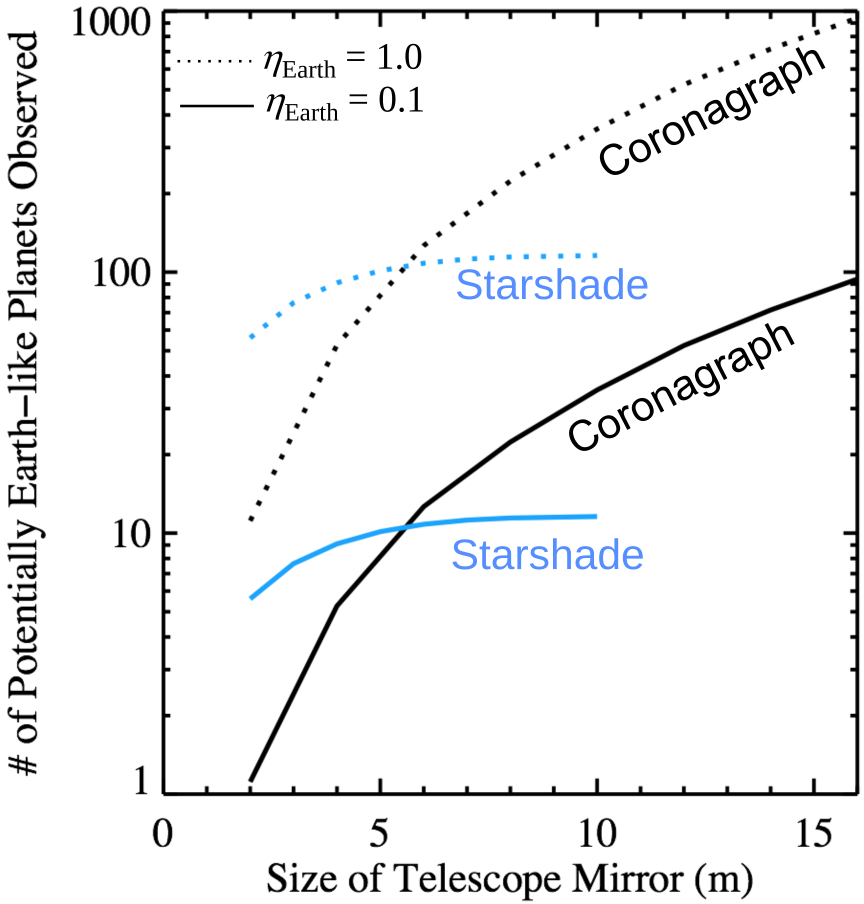
Factors Influencing Occurrence Rate Estimates

Ingredients	Importance + Variance		Status
	Past	Future	
Planet candidate catalog: Dataset & Pipeline	Hi	Lower variance	DR25 1st homogenous catalog; Move from binary to probabilistic catalog?
Completeness model	Hi	Hi	Should incorporate uncertainty in completeness model
Statistical methodology	Hi	Important	Hierarchical Bayesian Models to avoid biases, particularly for small planets
Occurrence rate model	Med	Med	Non-parametric models for formation; Parametric may be ok for mission yields
Planet Reliability	Med	Med	Need to model as function of size & period
Dilution affecting radii	Med	Low	Have data needed to model, just time/$
Stellar properties	Med	Low	GAIA will improve dramatically
Target selection & follow-up process	Small	Increasing	Will want to predict for different populations & compare to different surveys

Eric Ford

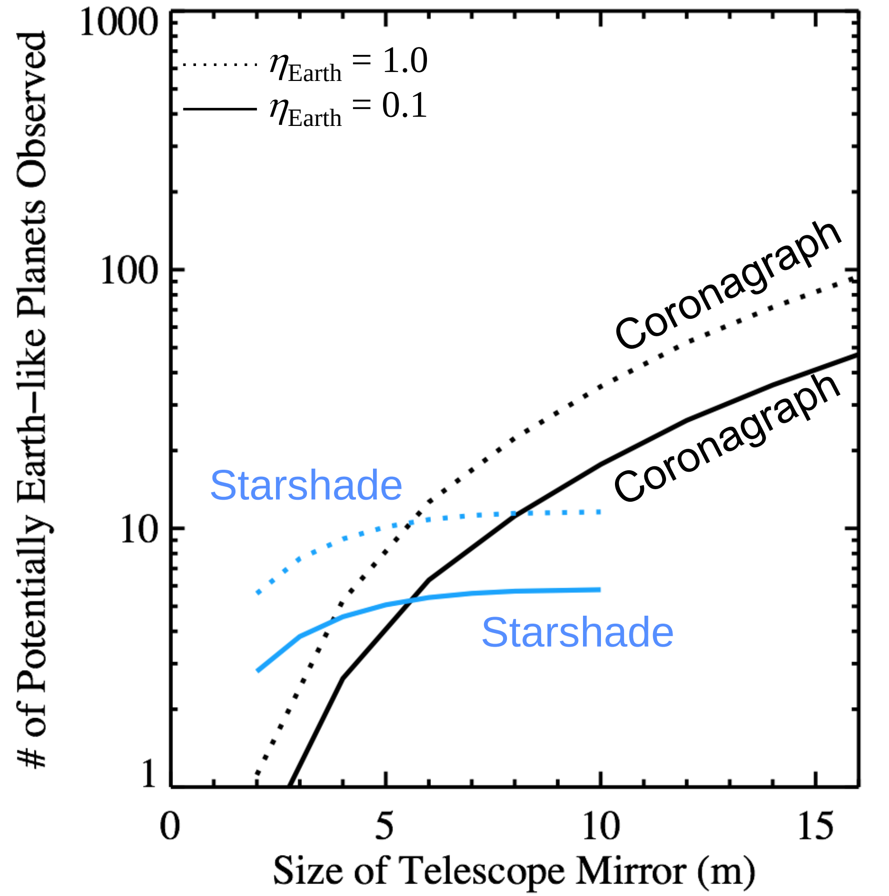
Yield for Search Only

(curves are qualitative examples only)



Yield for Search + Characterization

(curves are qualitative examples only)



Instrument	Search	Spectra	Orbits
Coronagraphs	😐 / 😃	😐	😃
Starshades	😐 / 😃	😃	😐

Chris Stark

ExEP Yield Modeling for HabEx with SAG-13 Power Law Distribution

Dr. Rhonda Morgan

Jet Propulsion Laboratory, California Institute of Technology

EXOSIMS by D. Savransky, C. Delacroix (Cornell) with contributions by Michael Turmon (JPL), Walker Dula (JPL), Rahul Patel (IPAC)

June 16, 2017

SAG13 Power Law parameters are Yield Simulation Inputs

Parametric fit (for G-dwarfs)

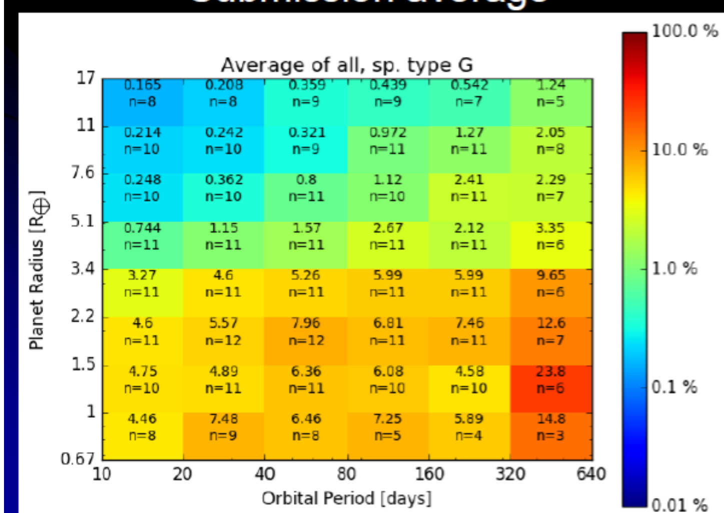
$$\frac{\partial^2 N(R,P)}{\partial \ln R \, \partial \ln P} = \Gamma_i R^{\alpha_i} P^{\beta_i} \quad \text{in region } R_{i-1} \le R < R_i$$

(R in Earth radius, P in years)

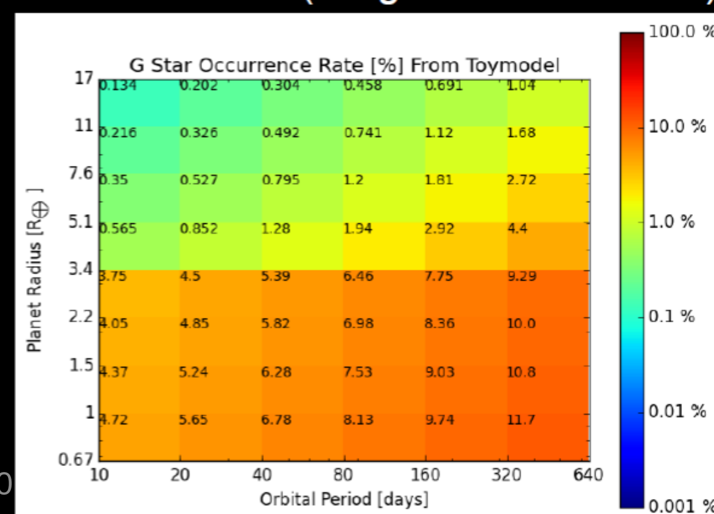
Two-piece broken power law →

i	Γ_i	α_i	β_i	R_i
1	**0.38**	**-0.19**	**0.26**	**3.4**
2	0.73	-1.18	0.59	Inf

Submission average



Parameteric fit (integrated across bins)

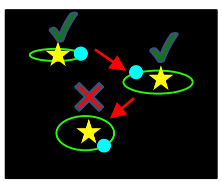


What is EXOSIMS?

https://github/dsavransky/EXOSIMS

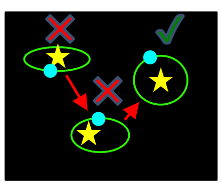
- EXOSIMS
  - Modular: just added SAG13Universe to synthesize a universe based on the SAG13 power law model
  - Creates ensembles of DRMs which can be analyzed statistically.

Universe n



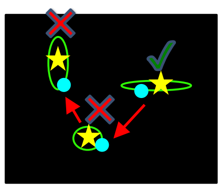
2 Detections

Universe n+1

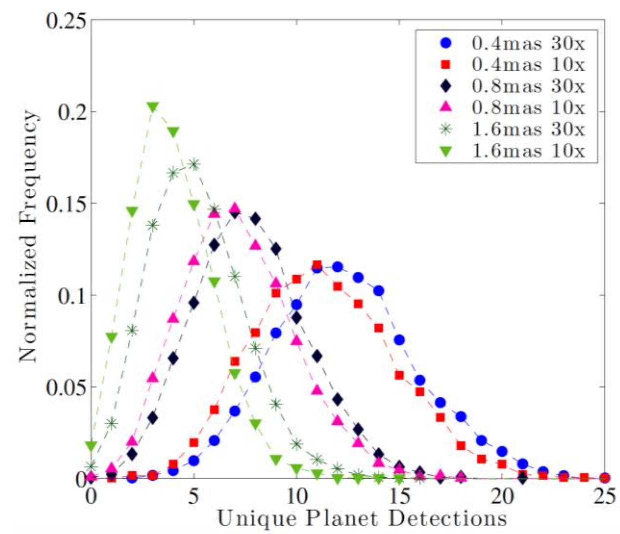


1 Detection

Universe n+2



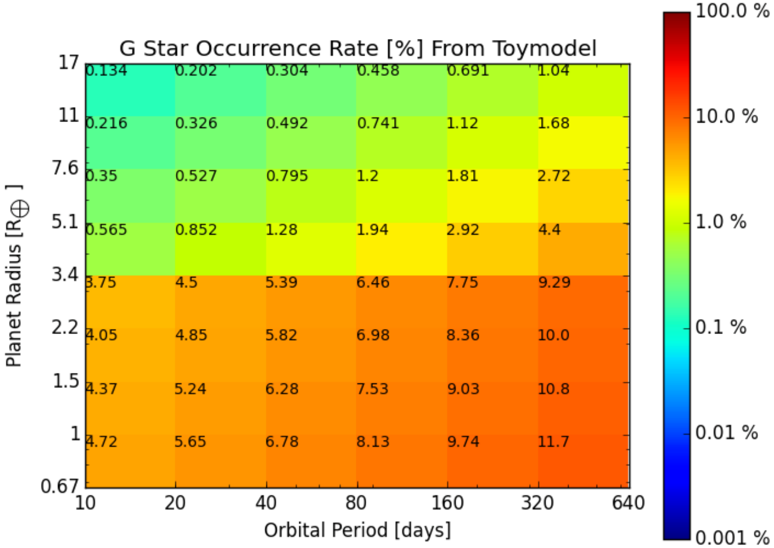
1 Detection

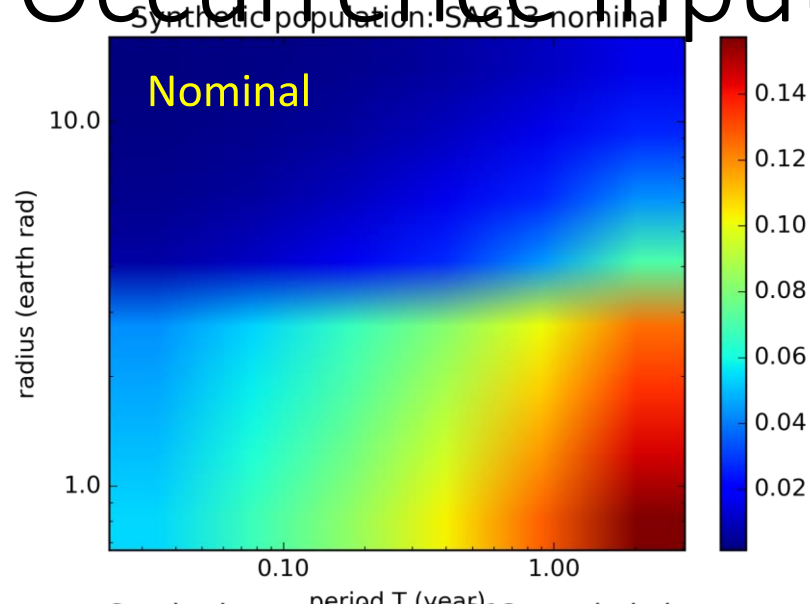


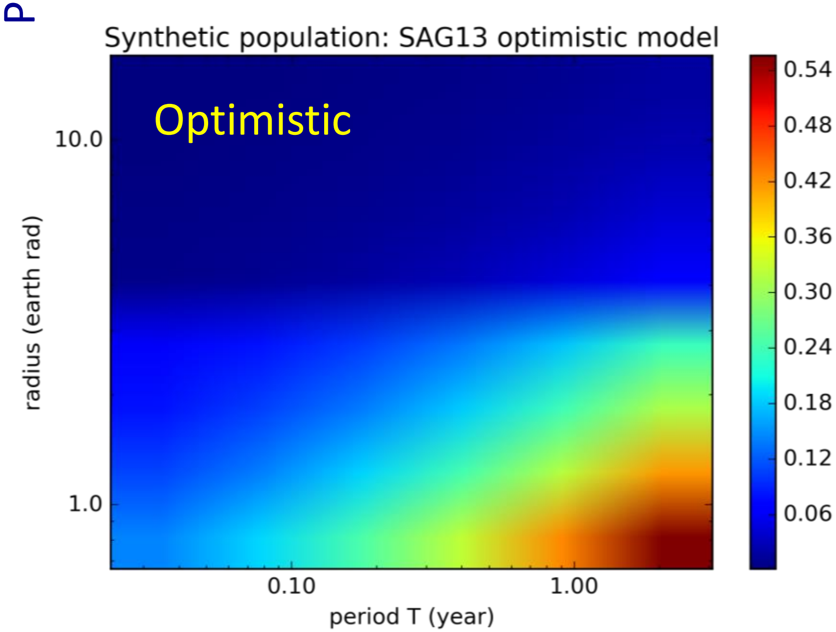
D. Savransky, et al., JATIS 2(1) 2016

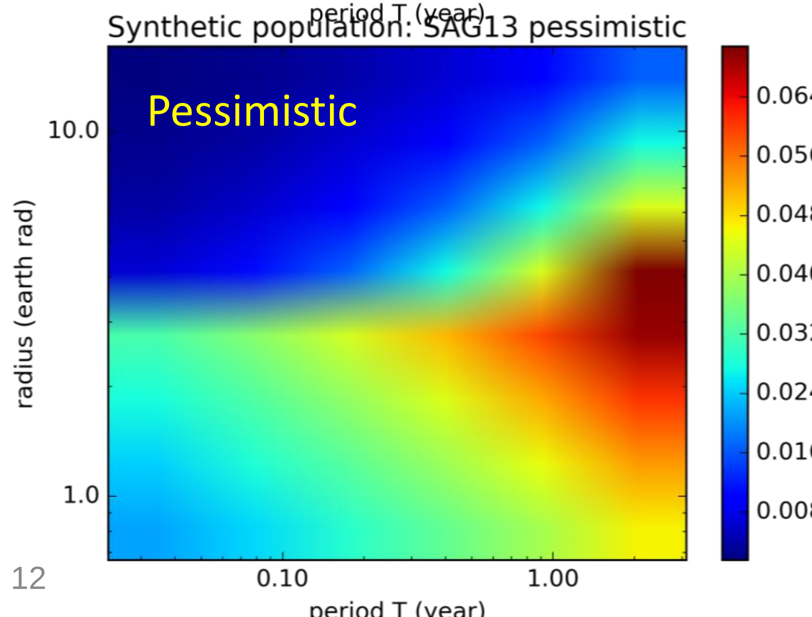
SAG13 Model as Occurrence Input

Preliminary SAG13 Models



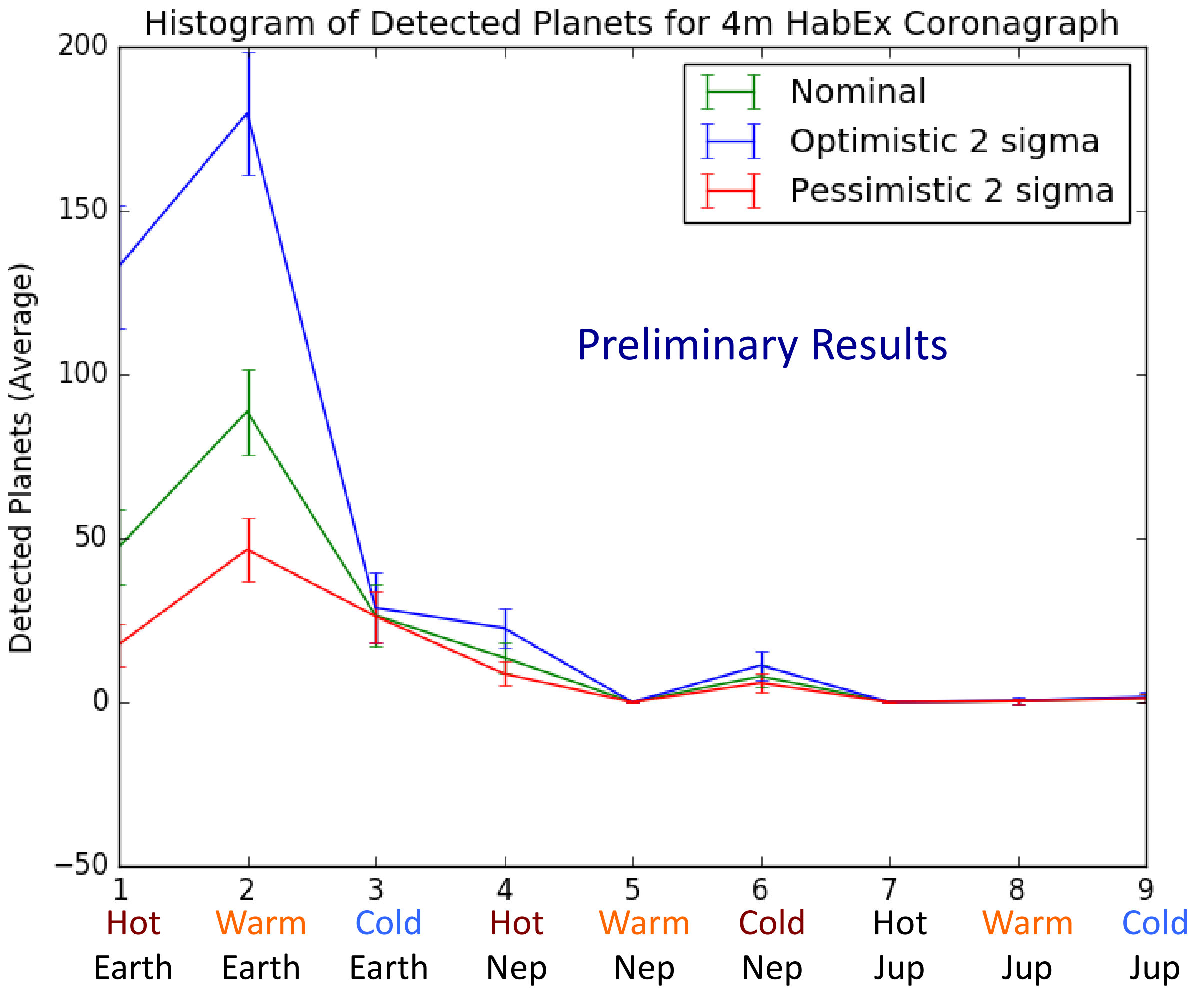






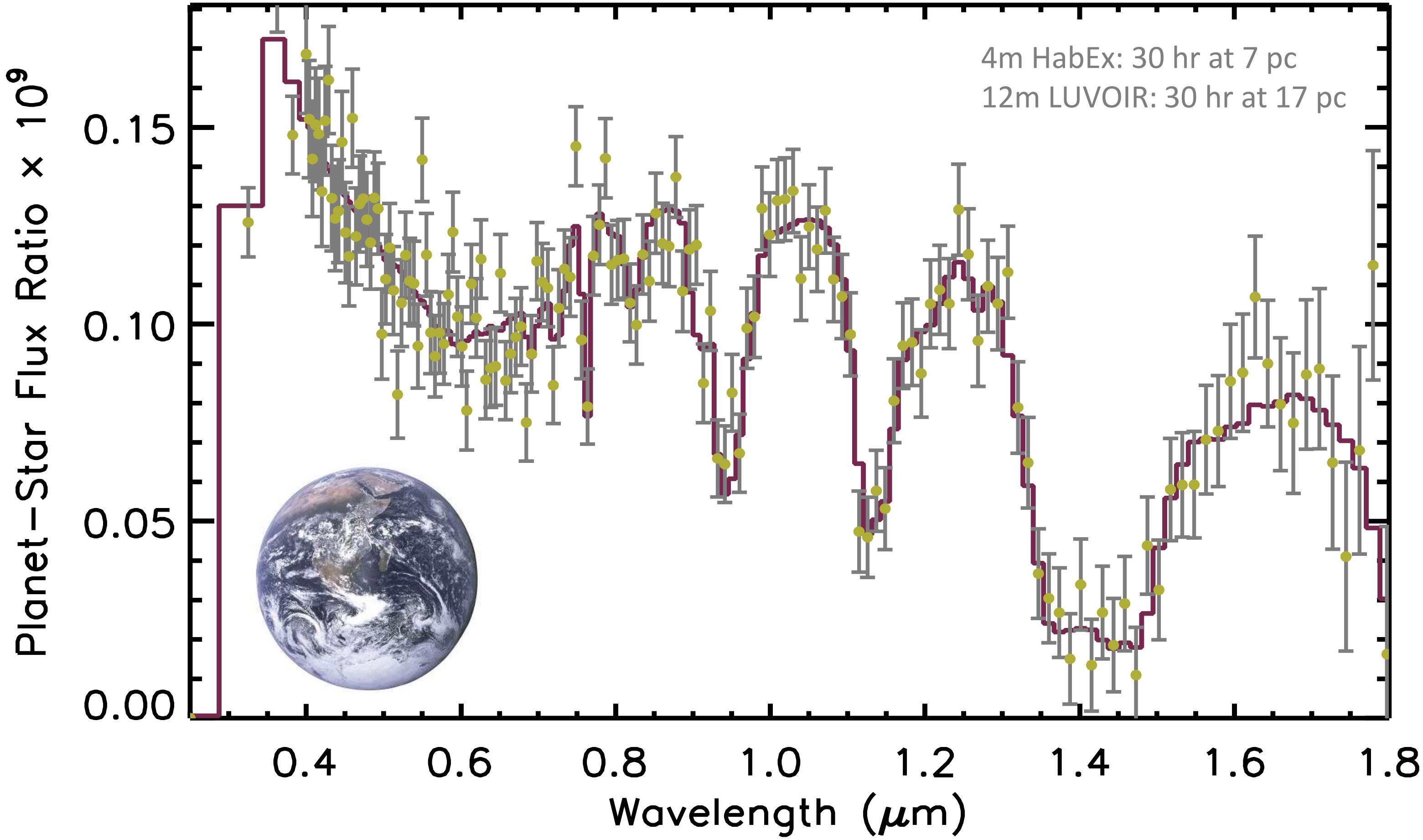
~3600 planets per Synthetic Universe

HabEx Yield Results by EXOSIMS



- HabEx
  - 4m unobscured, τ=0.3
  - Vector Vortex Charge 6 Coronagraph
    - 500 nm
    - BW: 0.1
    - dMagLim: 26
    - PostProc: 0.1
  - Detector
    - QE: 0.9
    - sread: 1.7e-6
    - idark: 3e-5
    - CIC: 1.3e-3
    - texp: 100
  - Geom. Albedo: 0.4
  - Mission
    - 1 year, 100%
    - sunKeepout 45 deg

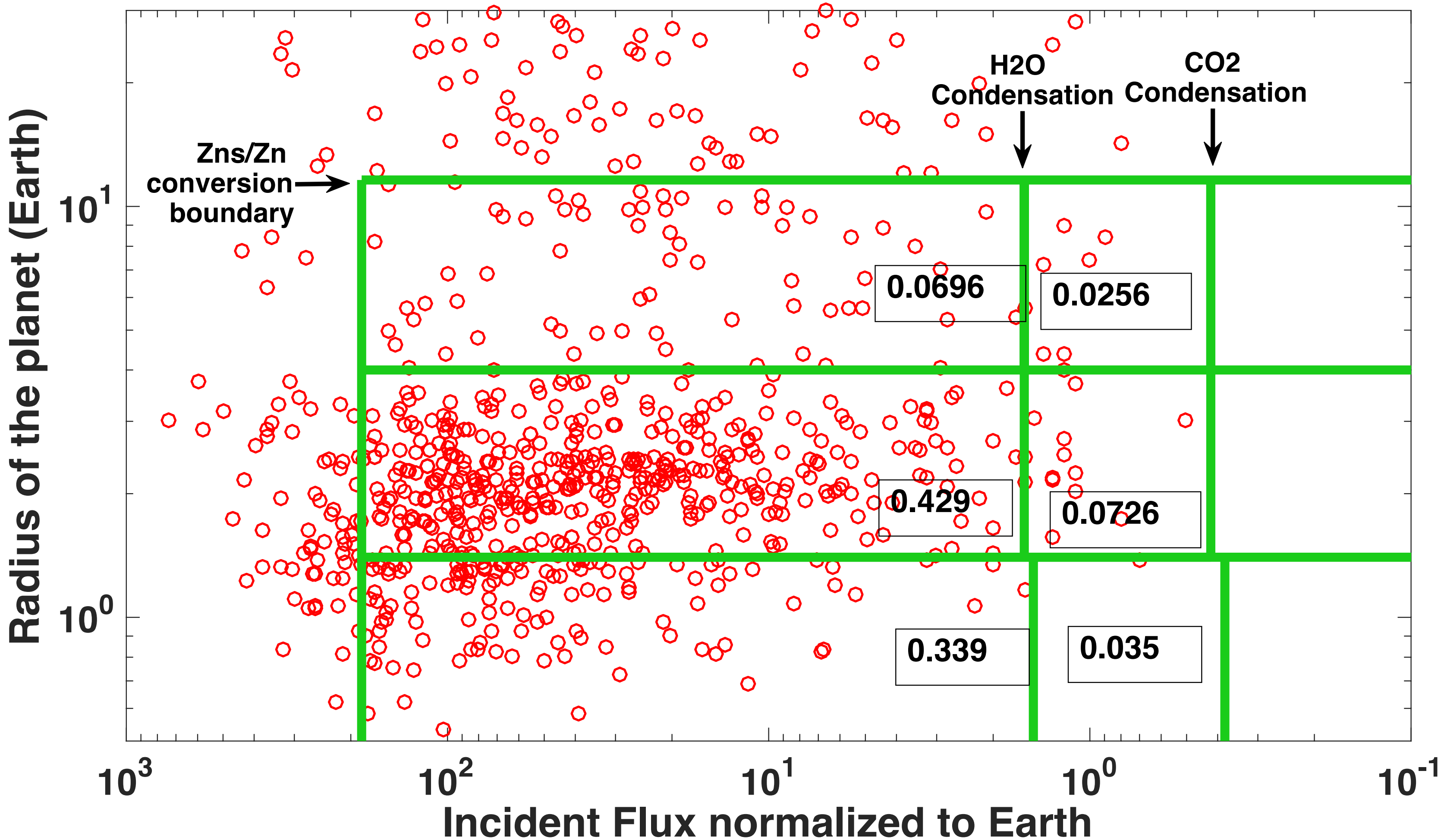
Each ensemble > 500 DRMs
G-dwarf model used for all star types
Pessimistic model = broken power law fit to avg – 2sigma
Optimistic model = broken power law fit to avg + 2sigma



Shawn Domagal-Goldman

A Word on *WFIRST*

- Many great targets (Jupiter-like planets at 1-3 au from Sun-like hosts) have already been discovered by RV.
- Occurrence rates for survey component are well-constrained by RV data.
- Largest source of uncertainty is albedo models of Jupiter-like planets.
  - Haziness of targets isn't modeled.
  - Location (in insolation) of coming/going of water clouds is key.
    - E.g., warm targets with few water clouds are expected to be very low-albedo.
  - Coverage of water clouds hasn't been modeled.



Shawn Domagal-Goldman

Parameter Choice for

- How to choose a parameter value for design?
  A. Worst case (nominal, protected by margin)
  B. Most likely, and consider impacts of
     1. Risks (likelihood and consequence)
     2. Opportunities (likelihood and benefit)

- Importance of common parameter definitions, vs common parameter value