

DIRECT DETECTION AND CHARACTERIZATION OF EXOPLANETS WITH METIS



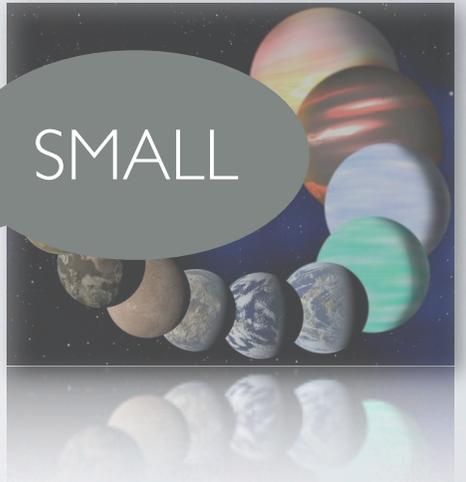
Sascha P. Quanz (ETH Zurich)

I. Crossfield (MPIA), M. Meyer (ETHZ), E. Schmalzl (Leiden), J. Held (ETHZ)

“EXOPLANET OBSERVATIONS WITH THE E-ELT”

ESO, Garching, 3-6 February 2014

DIRECT DETECTION ~~AND~~ ~~CHARACTERIZATION~~ OF EXOPLANETS WITH METIS



Sascha P. Quanz (ETH Zurich)

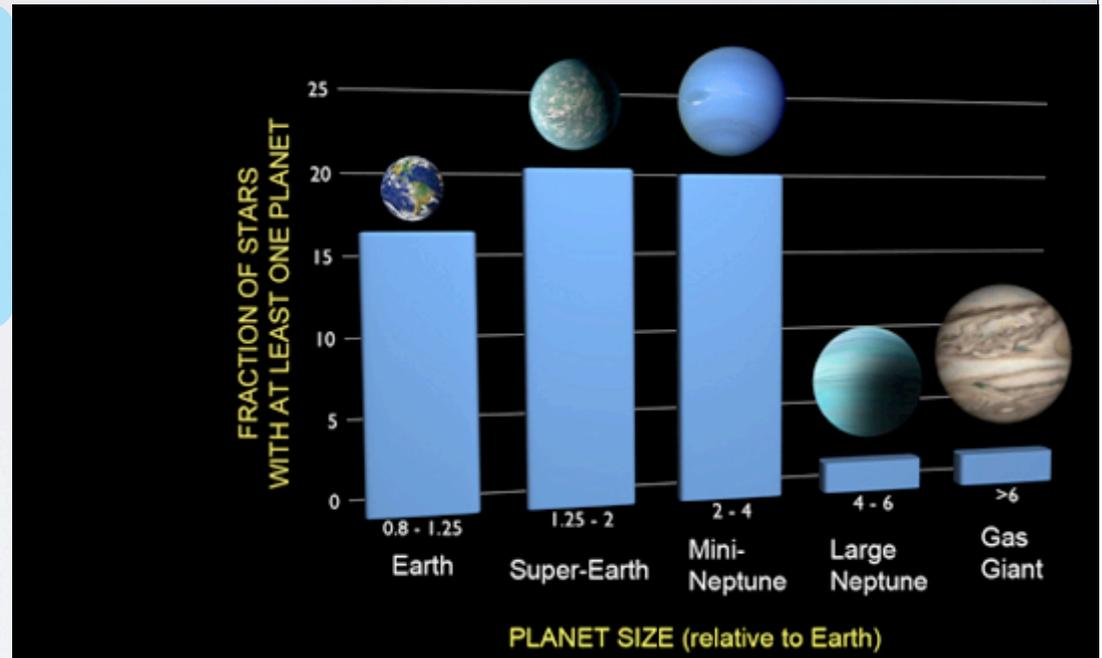
I. Crossfield (MPIA), M. Meyer (ETHZ), E. Schmalzl (Leiden), J. Held (ETHZ)

“EXOPLANET OBSERVATIONS WITH THE E-ELT”

ESO, Garching, 3-6 February 2014

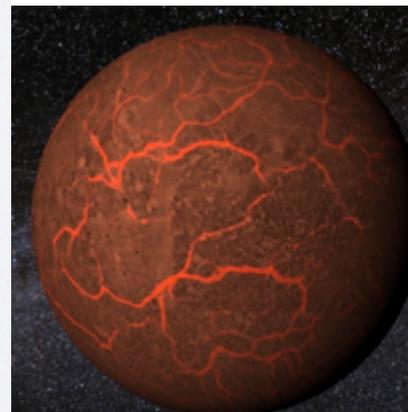
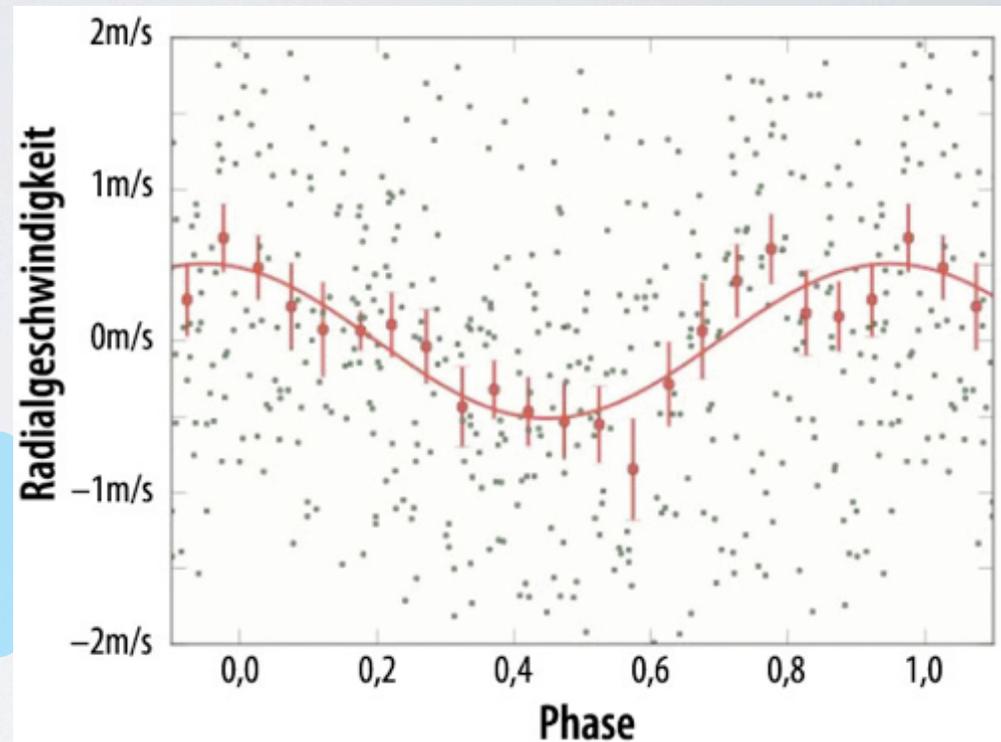
WHAT'S THE SCIENTIFIC MOTIVATION?

- Small, close-in planets are ubiquitous
- Small planet around Alpha Cen B
- METIS wavelength range probes thermal emission



WHAT'S THE SCIENTIFIC MOTIVATION?

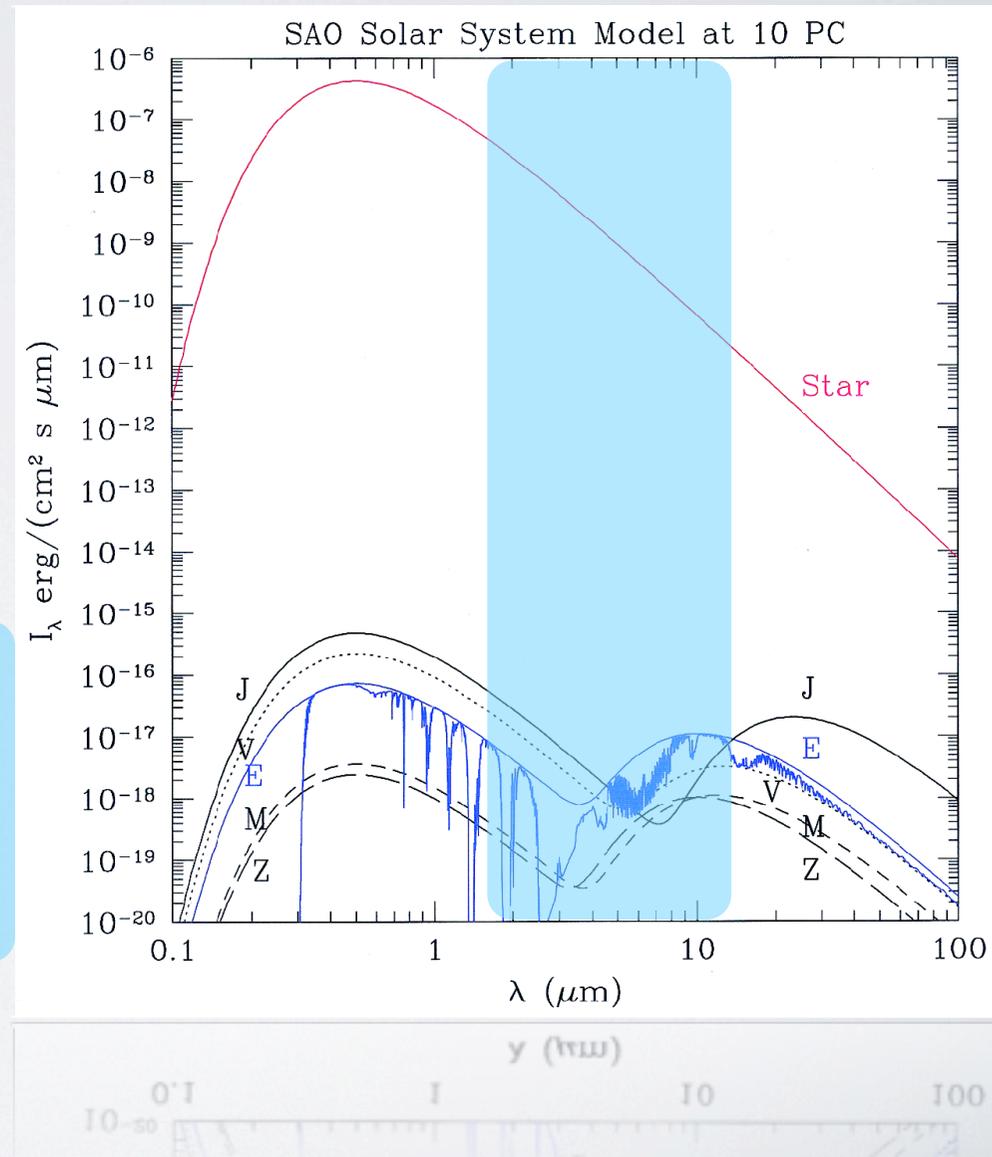
- Small, close-in planets are ubiquitous
- Small planet around Alpha Cen B
- METIS wavelength range probes thermal emission



Type	Hot Terran
Habitability	non habitable
Mass	$\geq 1.13 M_E$
Radius	$\sim 1 R_E$
Period	3.24 days
Dist. to Star	0.04 AU
Temperature	$\sim 870^\circ\text{C}$

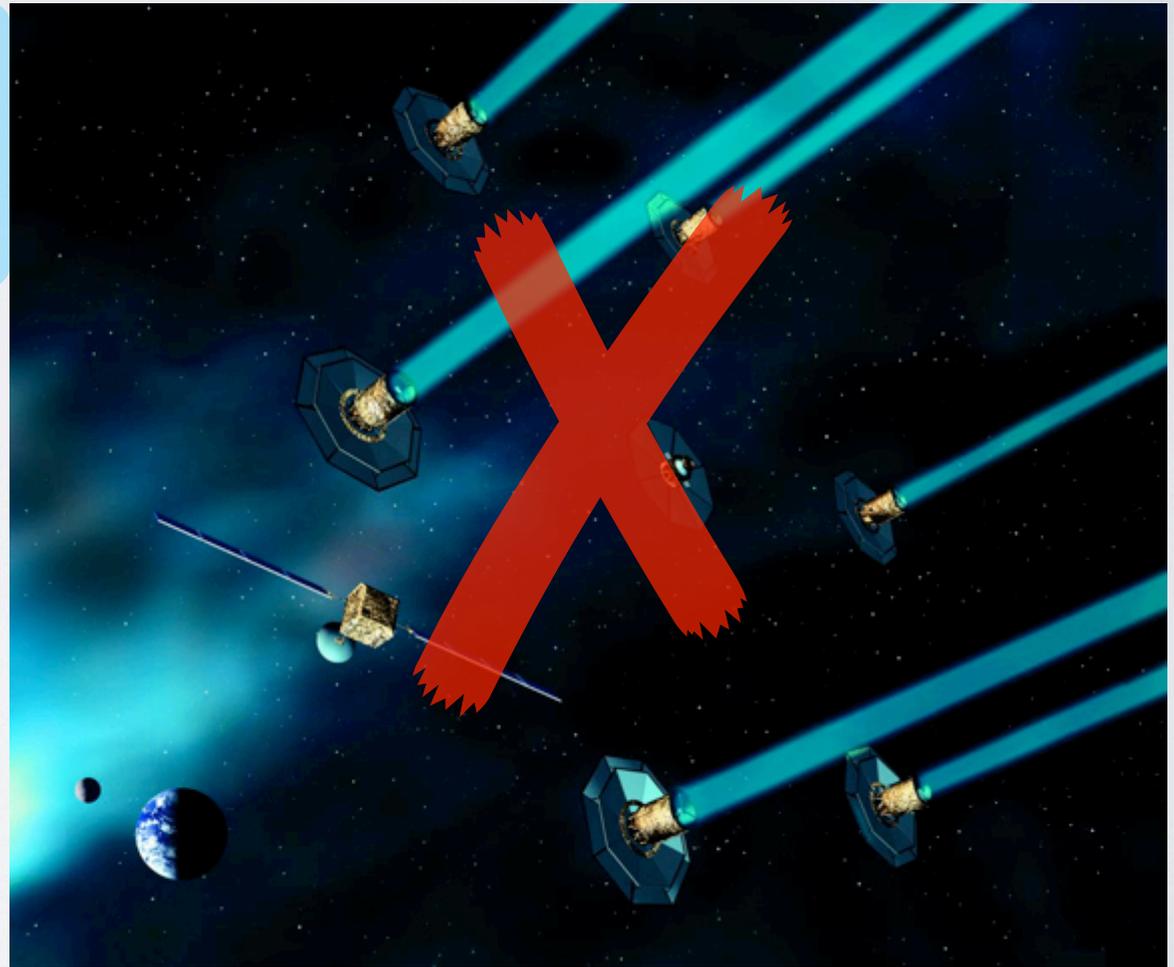
WHAT'S THE SCIENTIFIC MOTIVATION?

- Small, close-in planets are ubiquitous
- Small planet around Alpha Cen B
- METIS wavelength range probes thermal emission



WHAT'S THE PERSONAL MOTIVATION?

- No large space mission on horizon
- PCS still far away; need for SPHERE experience
- Significant gain in sensitivity ($\sim D^4$)



WHAT'S THE PERSONAL MOTIVATION?

- No large space mission on horizon
- PCS still far away; need for SPHERE experience
- Significant gain in sensitivity ($\sim D^4$)

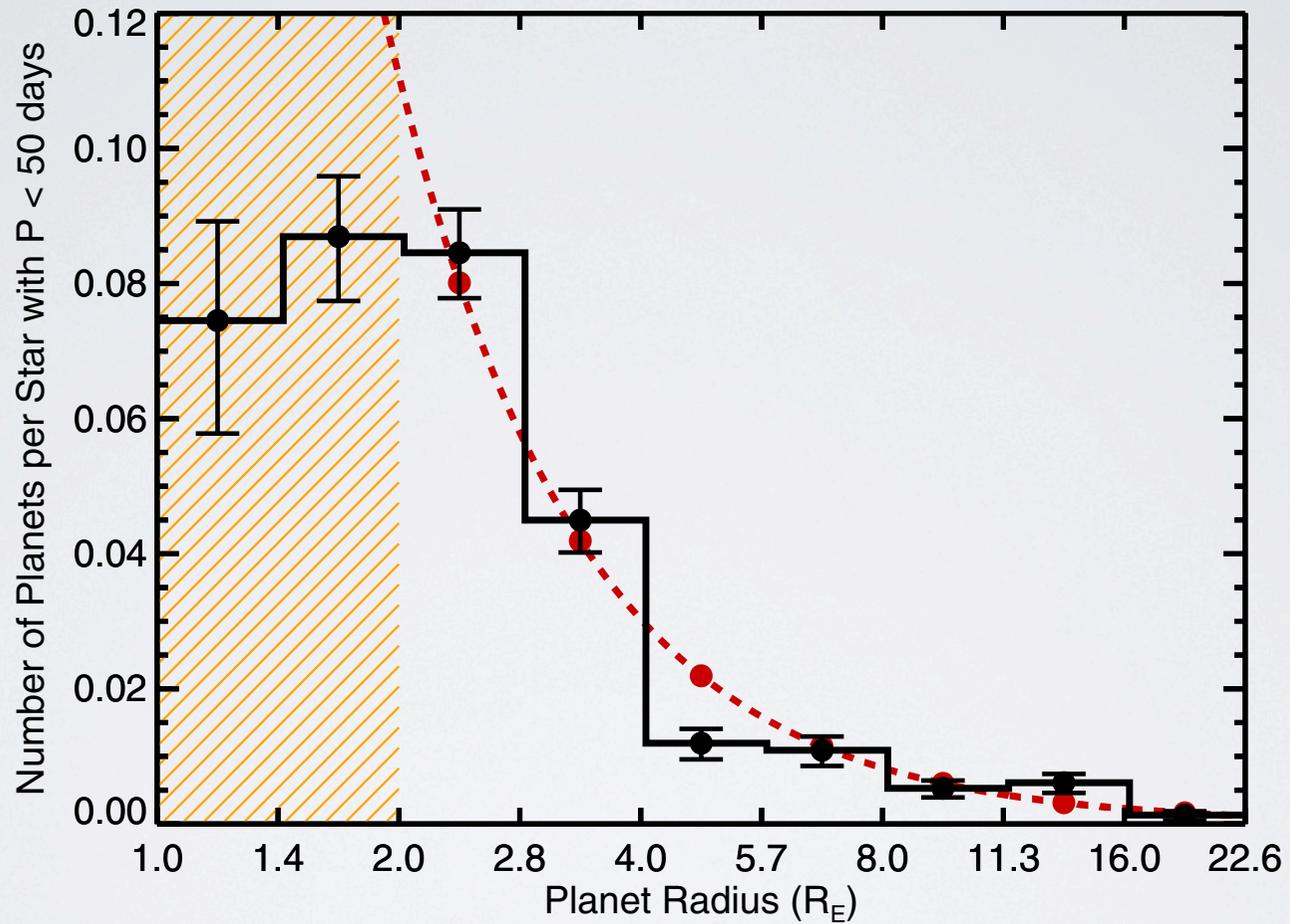


WHAT'S THE PERSONAL MOTIVATION?

- No large space mission on horizon
- PCS still far away; need for SPHERE experience
- Significant gain in sensitivity ($\sim D^4$)

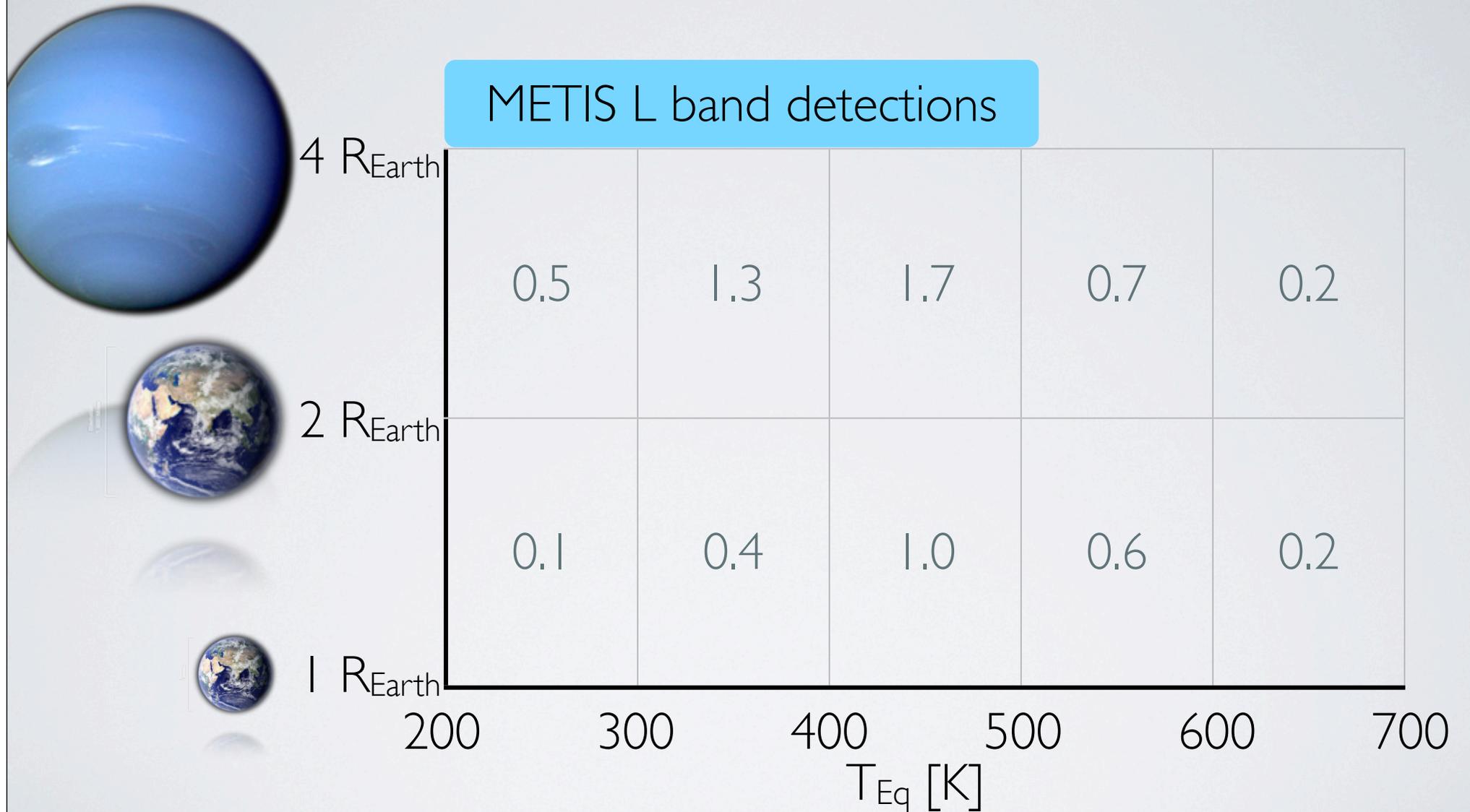
$$t \sim \frac{\lambda^2}{D_e^4} (SNR)^2$$

WHAT WAS THE APPROACH?



WHAT DID WE FIND?

METIS L band detections



WHAT DID WE FIND?

Name	Catalog name	Sp. Type	Dist. [pc]	p_L	p_M	p_N
alpha Cen B*	HD 128621	K1V	1.3	0.59	0.65	0.74
alpha Cen A	HD 128620	G2V	1.3	0.51	0.63	0.67
epsilon Eri*	HD 22049	K2V	3.2	0.47	0.32	0.32
epsilon Ind A	HD 209100	K4V	3.6	0.46	0.26	0.14
tau Cet*	HD 10700	G8.5V	3.7	0.34	0.29	0.18
Proxima Cen	HIP 70890	M5.5V	1.3	0.33	–	–
G1 166 A	HD 26965 A	K0.5V	5.0	0.32	0.17	–
delta Pav	HD 190248	G8IV	6.1	0.32	0.24	0.12
Procyon A	HD 61421	F5IV-V	3.5	0.31	0.31	0.28
G1 887	HD 217987	M0.5V	3.3	0.28	–	–
GJ 139*	HD 20794	G8V	6.0	0.27	0.15	–
G1 825	HD 202560	K7V	3.9	0.26	–	–
beta Hyi	HD 2151	G0V	7.5	0.22	0.12	–
LTT 2364	HD 38393	F6V	9.0	0.22	0.13	–
Barnard's Star	HIP 87937	M4V	1.8	0.21	–	–
...

WHAT ARE THE KEY ASSUMPTIONS?

- Sensitivities

- Stars and planets are BBs
- Albedos
- Kepler results can be extrapolated
- Background-limited at 2 λ/D :
 - 0.04" in L
 - 0.05" in M
 - 0.11" in N

Filter	Sensitivity
L (3.6 μm)	0.27 μJy
M (4.8 μm)	2.6 μJy
N (10.6 μm)	9.84 μJy

WHAT ARE THE KEY ASSUMPTIONS?

- Sensitivities
- Stars and planets are BBs
- Albedos
- Kepler results can be extrapolated
- Background-limited at $2 \lambda/D$:
 - 0.04'' in L
 - 0.05'' in M
 - 0.11'' in N



WHAT ARE THE KEY ASSUMPTIONS?

- Sensitivities
- Stars and planets are BBs
- Albedos
- Kepler results can be extrapolated
- Background-limited at 2 λ/D :
 - 0.04'' in L
 - 0.05'' in M
 - 0.11'' in N

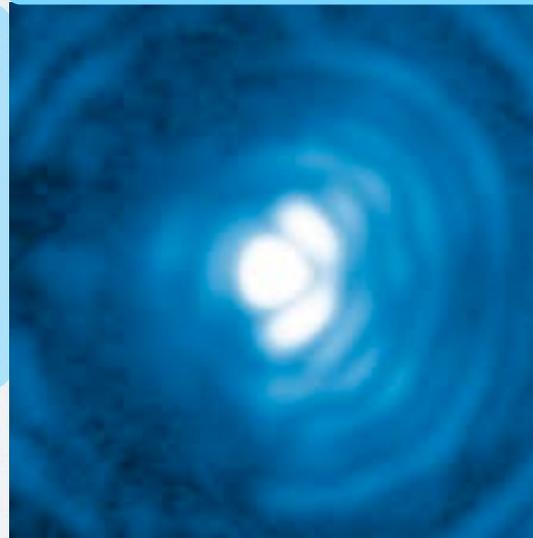


HOW CRAZY ARE THESE ASSUMPTIONS?

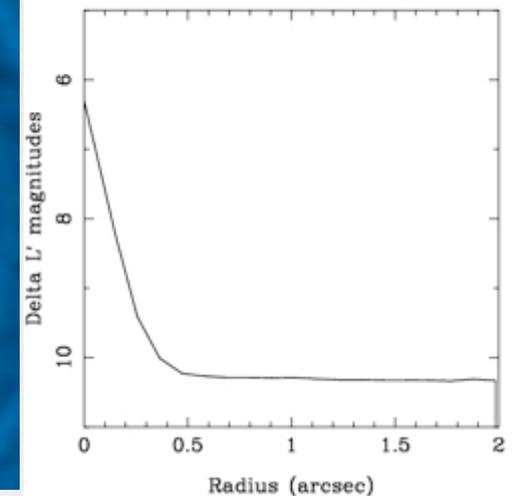
How to move the background limit to small separations:

- Technical progress, e.g.,
 - APP coronagraph (Quanz et al. 2010; Kenworthy et al. 2010)
 - AGPM coronagraph (Mawet et al. 2013; Absil et al. 2013)
- Data analysis progress, e.g.,
 - PCA based algorithm (Amara & Quanz 2012; Soumer et al. 2012)
 - Focal plane wavefront sensing (Codona & Kenworthy 2013)

NACO/APP background limit @ 5 λ/D in L band



5 sigma point source detection limit for VLT APP

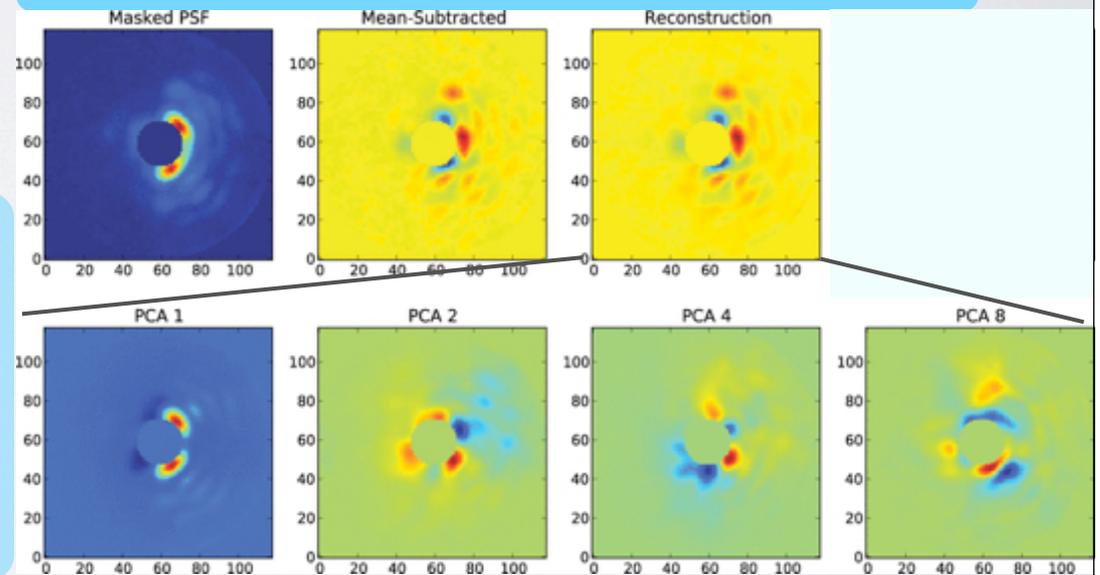


HOW CRAZY ARE THESE ASSUMPTIONS?

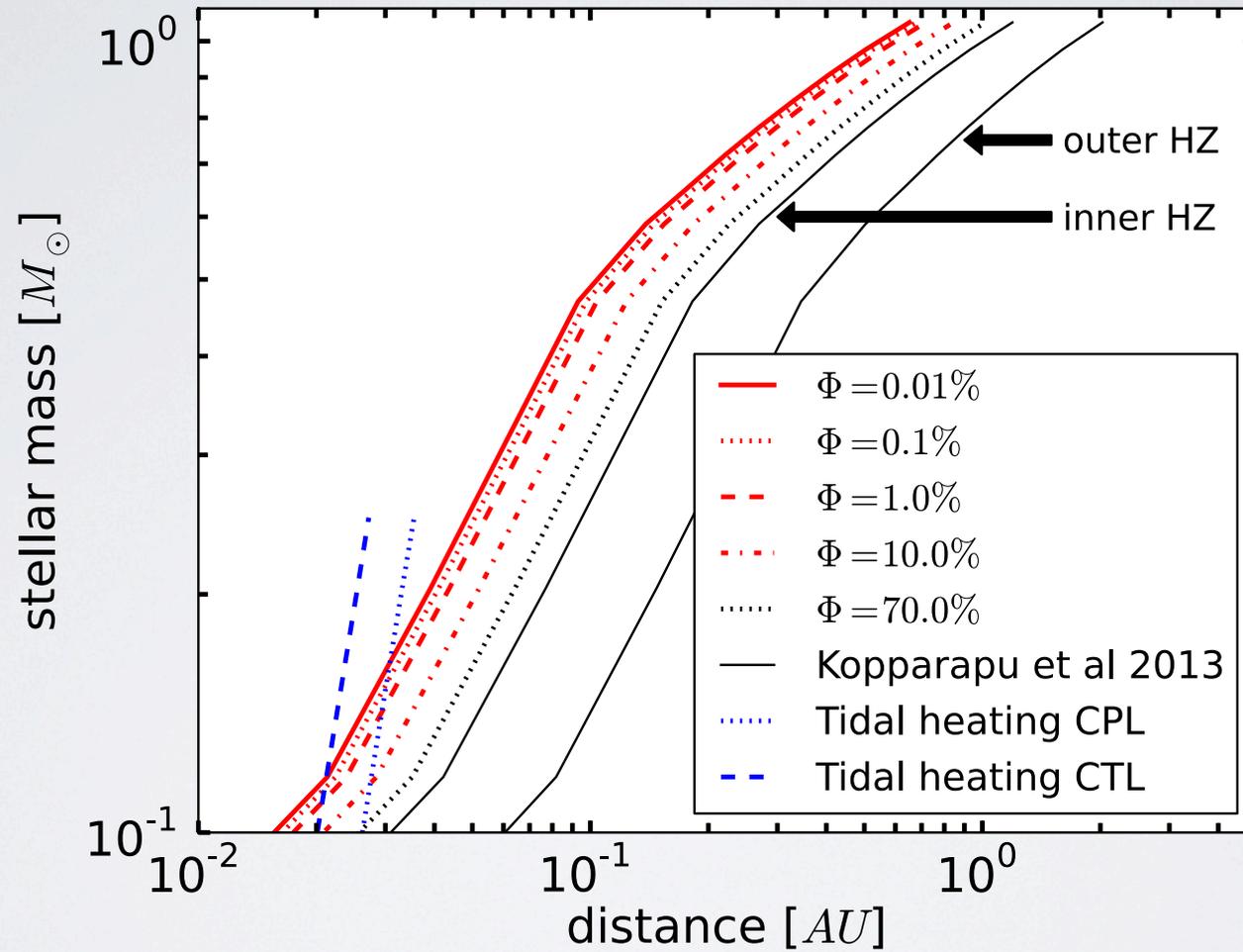
How to move the background limit to small separations:

- Technical progress, e.g.,
 - APP coronagraph (Quanz et al. 2010; Kenworthy et al. 2010)
 - AGPM coronagraph (Mawet et al. 2013; Absil et al. 2013)
- Data analysis progress, e.g.,
 - PCA based algorithm (Amara & Quanz 2012; Soumer et al. 2012)
 - Focal plane wavefront sensing (Codona & Kenworthy 2013)

PCA-based PSF subtraction



WHAT ABOUT HABITABILITY?



WHAT ARE THE TAKE HOME MESSAGES?

- Nearby, small, warm planets might be within reach of E-ELT METIS in particular in the L band
- These planets are likely also within reach of other E-ELT instruments (e.g., EPICS) and maybe VLT instruments (e.g., ESPRESSO tbc.)
- The underlying assumptions need to and will be validated

THANKS FOR
YOUR ATTENTION

