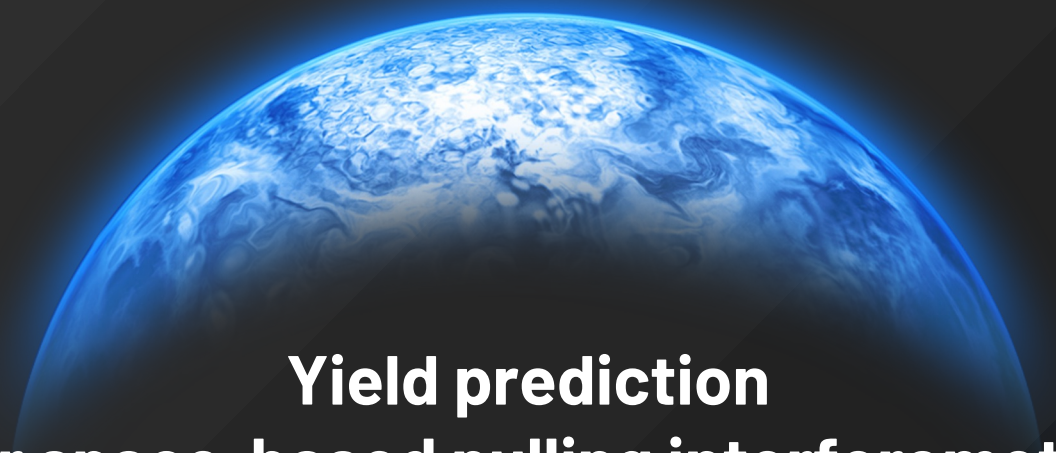
LARGE INTERFEROMETER FOR EXOPLANETS

LIFE
LARGE INTERFEROMETER FOR EXOPLANETS



Yield prediction for space-based nulling interferometry

For the LIFE Initiative:

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ETH zürich

PlanetS
National Centre of Competence in Research

Swiss National Science Foundation

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LARGE INTERFEROMETER FOR EXOPLANETS

Probing atmospheres in the mid-infrared: *Habitability*
Search for life

Why?

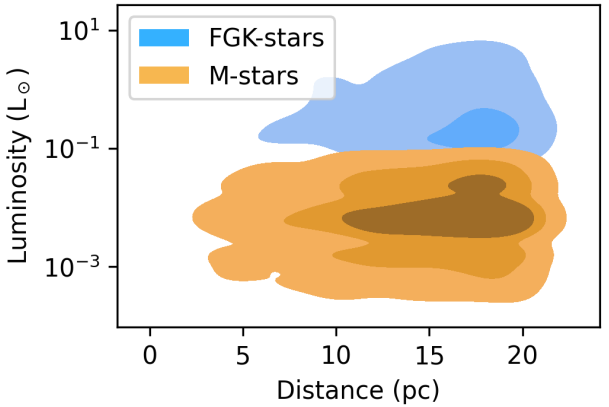
LIFE*sim*

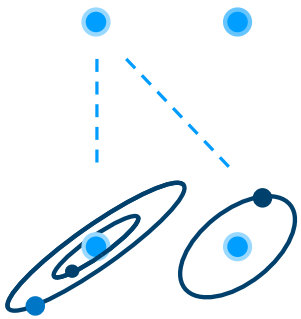
Kammerer&Quanz (2018)
Dannert&Ottiger et al. (2022)
Dannert et al. (in prep.)

Star Catalog

by **Fransika Menti** (ETH Zurich)

- Sourced from Simbad
- Main sequence stars within 20 pc
- Single stars and wide binaries





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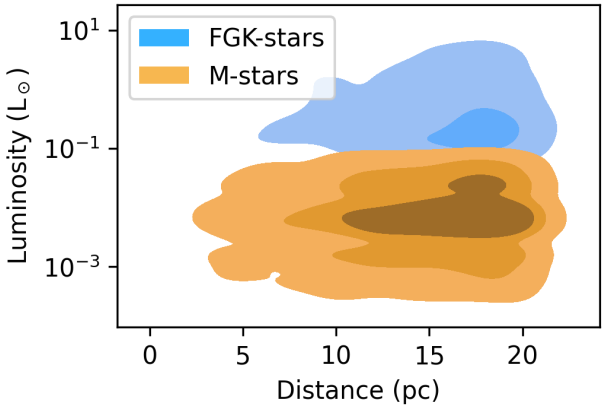
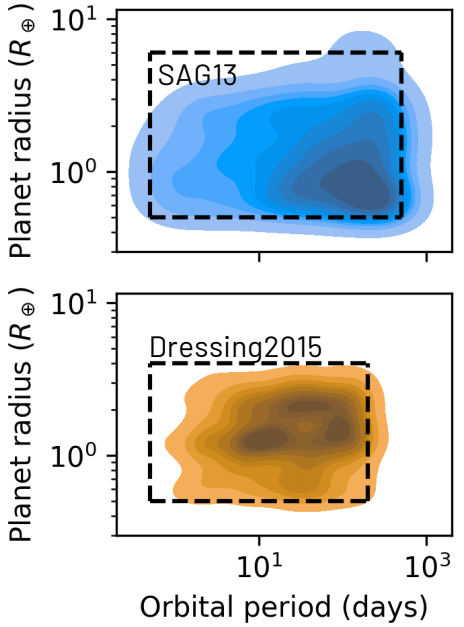


Synthetic Planets

- Planets randomly drawn using **P-Pop** (Kammerer&Quanz 2018)
- Uniformly drawn orbits
- Planets approximated as blackbodies, A_{Bond} uniform, mean = 0.4
- Exozodis based on HOSTS, median = 3
- 500 different populations drawn

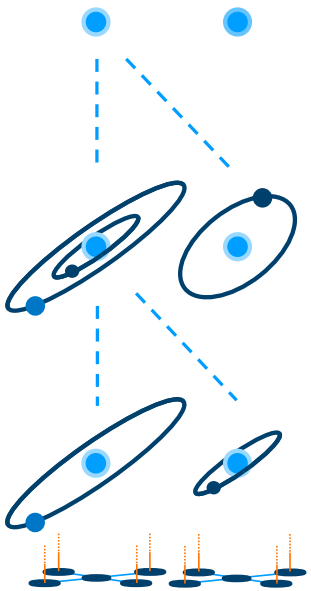


Star Catalog

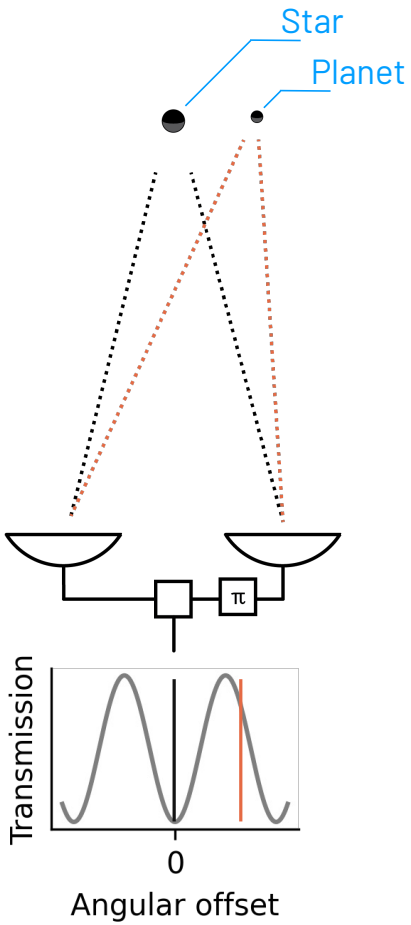
Synthetic Planets

Observation Simulation

Observation Optimization



Observation Simulation



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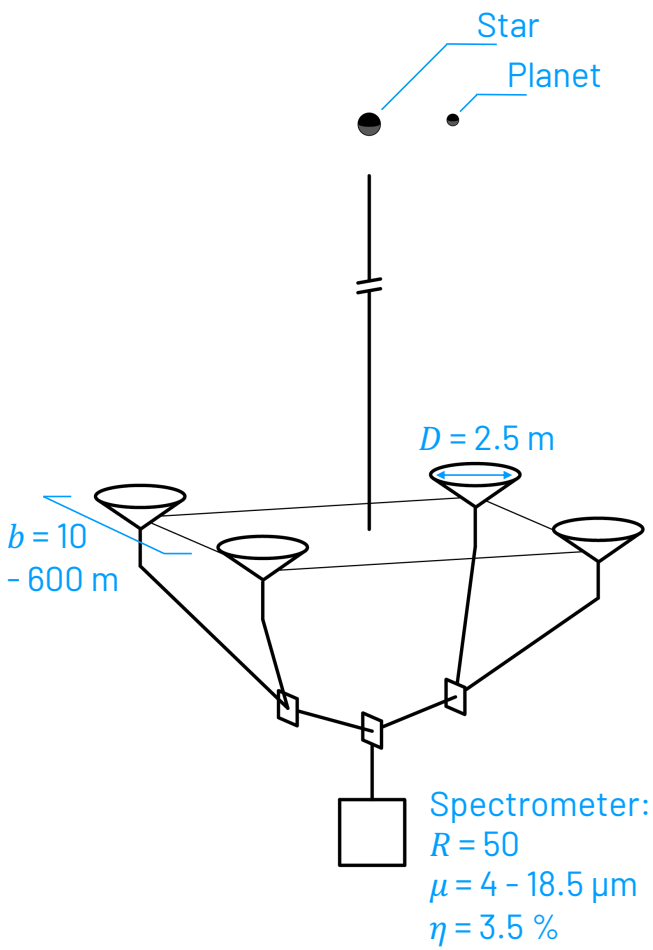
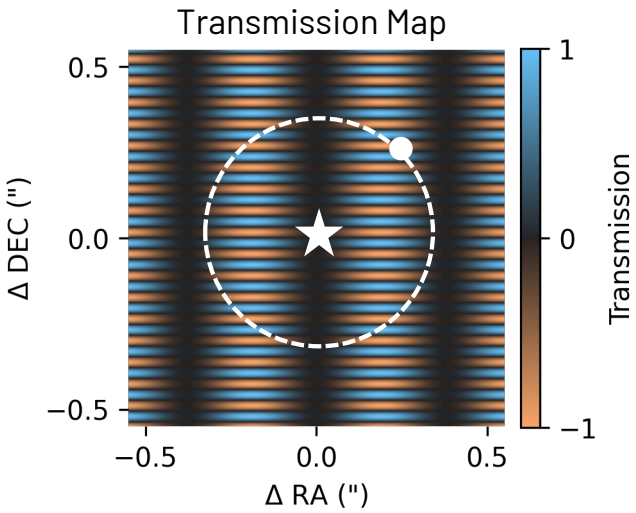
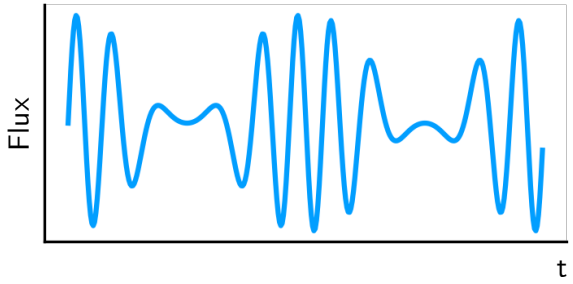


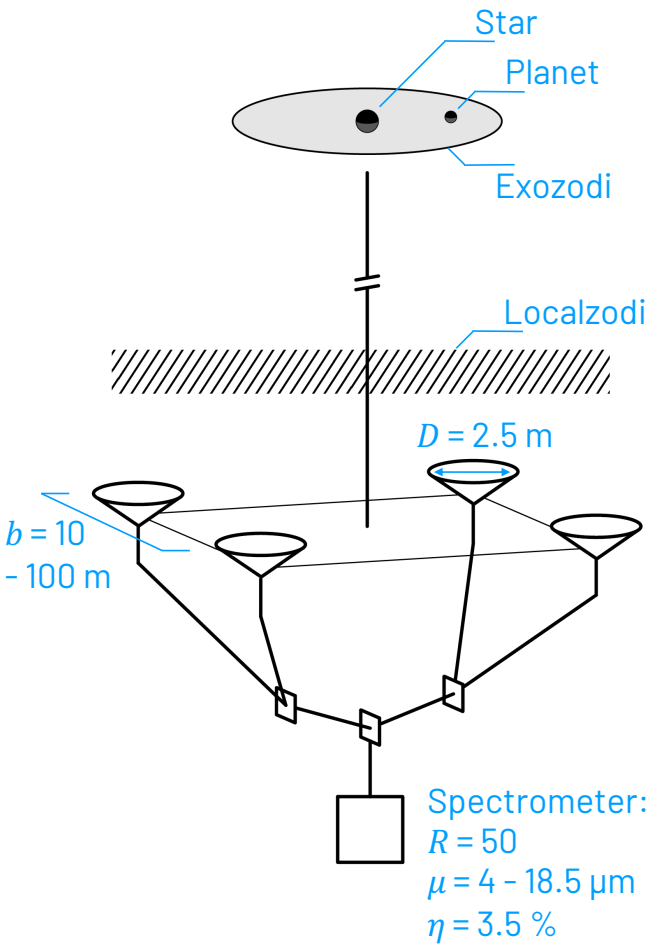
Signal



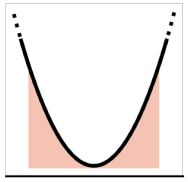
Rotation of array lead to the measurable **signal modulation**
Perfect signal extraction is assumed → **photon-noise only**



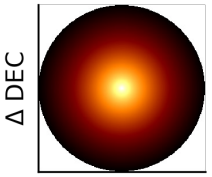
Observation Simulation



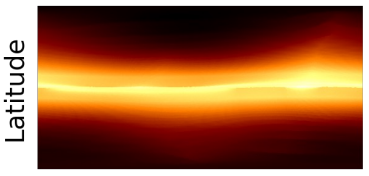
Noise



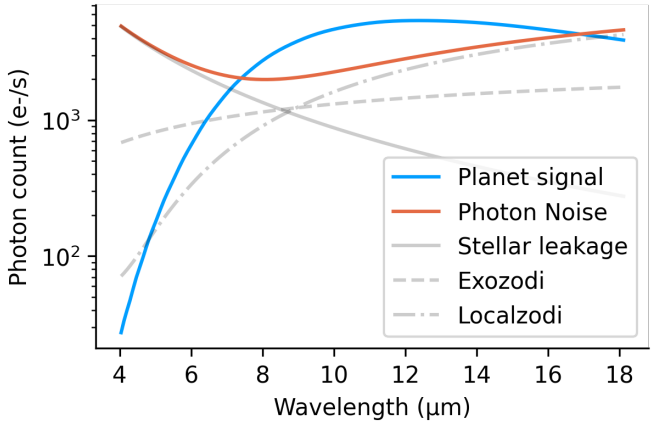
Stellar Leakage
Resolved star leaks through null



Exozodi Leakage
Thermal emission from warm dust in target system



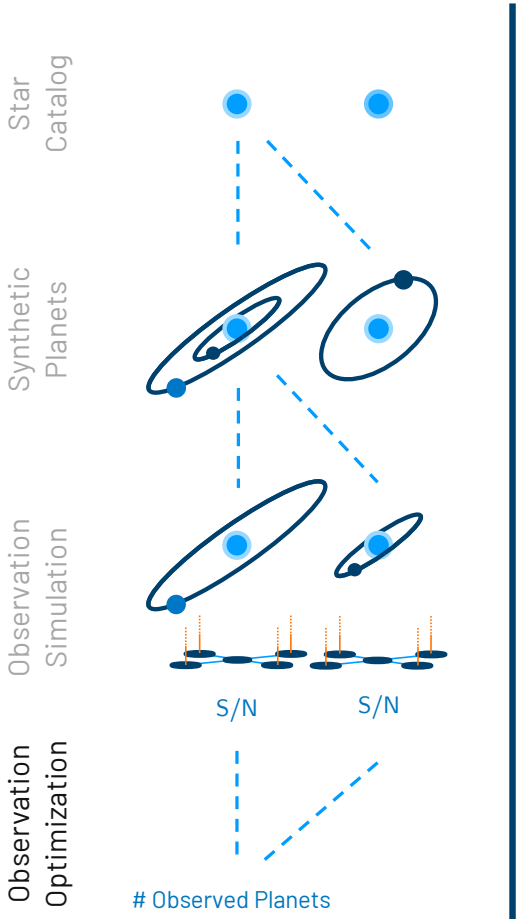
Localzodi Leakage
Thermal emission from warm dust in solar system

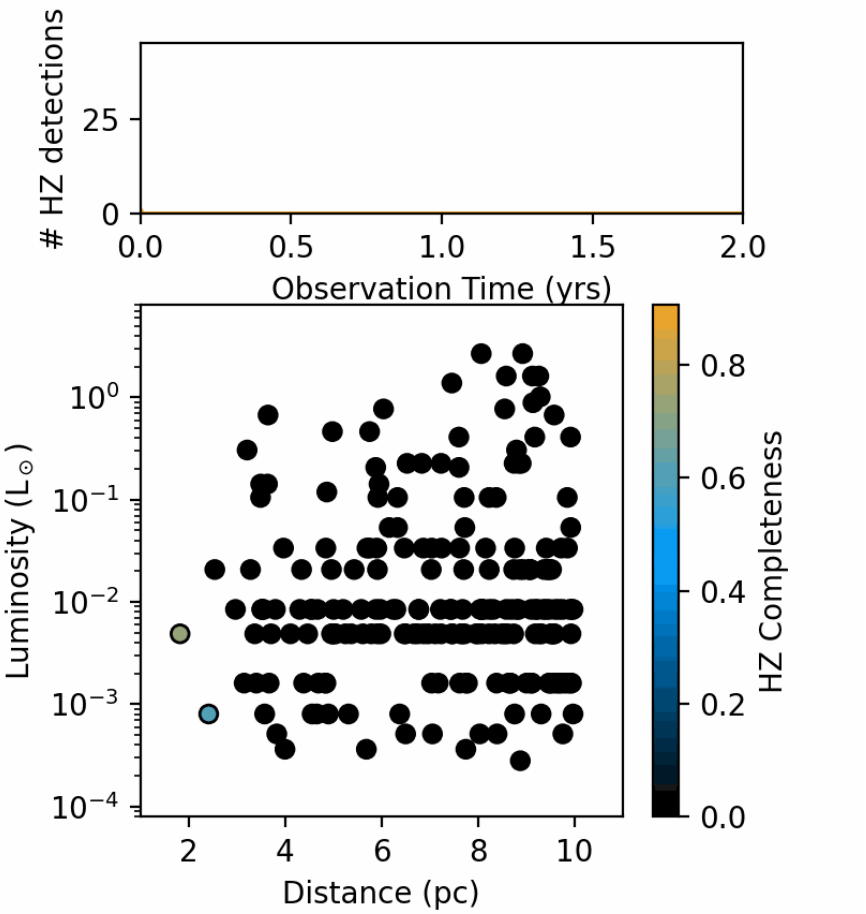


Results in **bulk SNR** for every synthetic planet

$$\mathrm{SNR} = \sqrt{\sum_{\lambda} \left(\frac{\mathrm{signal}_{\lambda}}{\mathrm{noise}_{\lambda}}\right)^2}$$

Observation Optimization

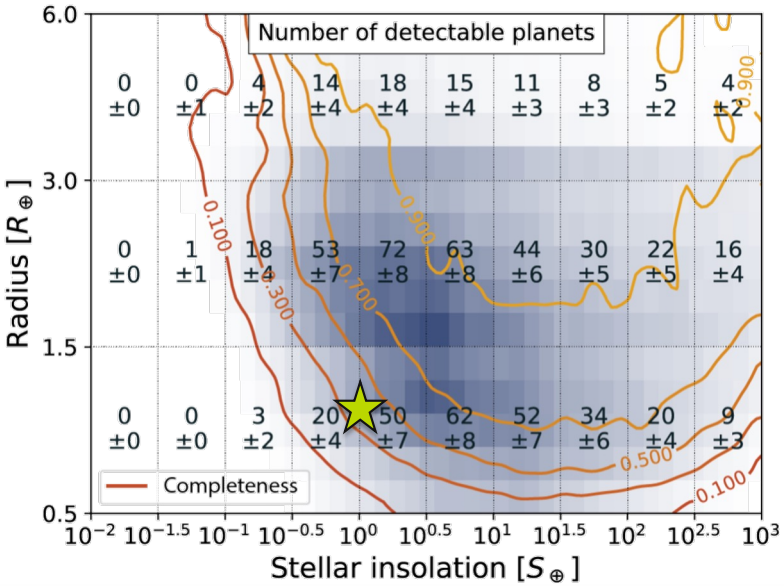


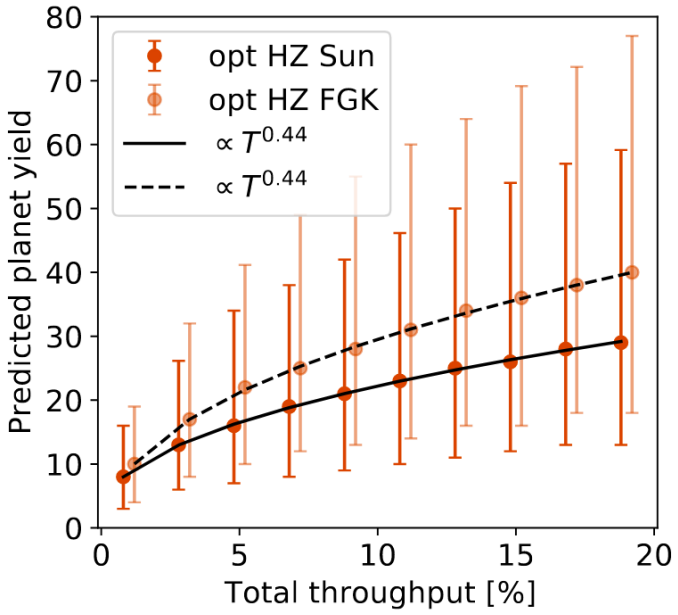


distribute 2.5 yrs of **blind search** time by observing stars giving most detections in the least amount of time

Exoplanet Yields & Requirements

Total number of detectable exoplanets: **550**
43 in rocky eHZ**, 20** Exo-Earth candidates

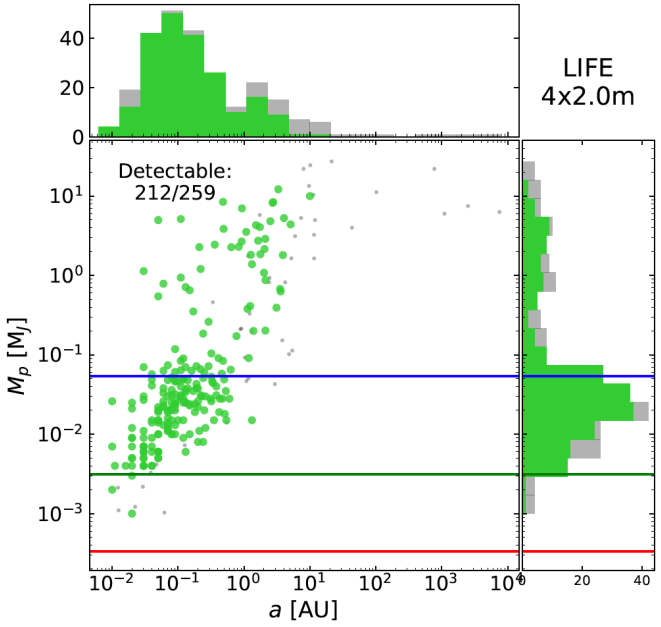


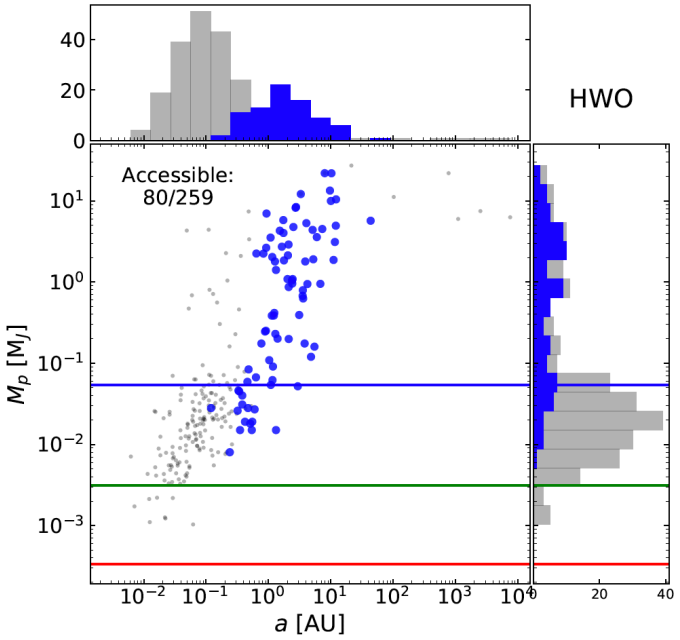


Work by **Jens Kammerer et al. (2022)**
(StSci)

Comparison to HWO

Can the same planets be accessed in reflected light and thermal emission?
Currently known Exoplanets within 20 pc:

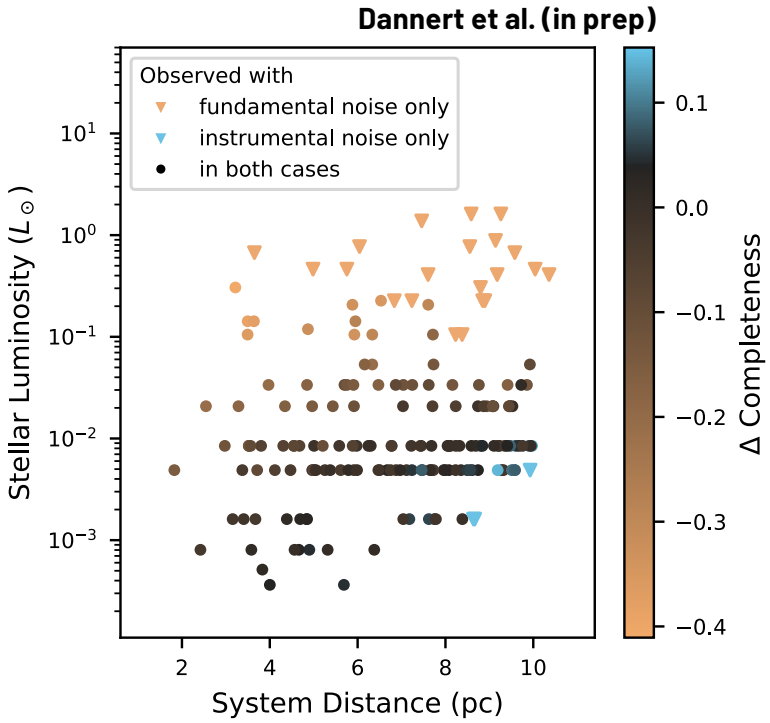




Work by **Óscar Carrión-González et al. (in subm.)**
(LESIA, Observatoire de Paris)

Current Limitations

Instrumental Noise
Nulling interferometry relies on exact co-phasing and amplitude control.
A real instrument will suffer from systematic instability noise.



> Therefore, launching a Large mission enabling the characterisation of the **atmosphere of temperate exoplanets in the mid-infrared should be a top priority for ESA** within the **Voyage 2050** timeframe.
>
> *-ESA Voyage 2050 Report-*

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Join the initiative

Write to life@phys.ethz.ch
or fdannert@phys.ethz.ch

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