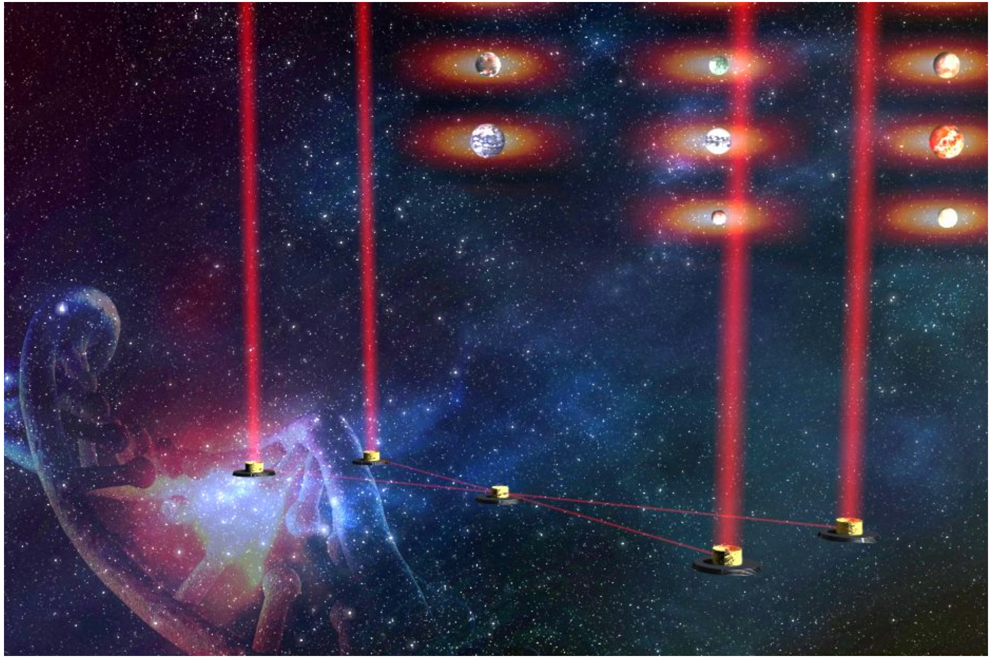
LIFE Target Database



Franziska Menti
ETH Zürich, fmenti@ethz.ch
27.05.21

Image credit LIFE initiative

Abstract

What?
LIFE Target Database Introduction

Why?
My goal:
- Motivate people to contribute to this project

Your goal?
- See example of project trying to work with IVOA standards
- Learn about LIFE

How?
- LIFE mission introduction
- State of the Target Database
- Participation Possibilities

Terms

- LIFE (Large Interferometer for Exoplanets)
- WG (Working group)
- Target Database (data collection about stars targeted by LIFE as well as other relevant objects in the systems)

LIFE

LIFE in a nutshell

The LIFE initiative has the goal to **develop** the **science and technology** for a **future space mission** designed to characterize **terrestrial** exoplanet **atmospheres** and **search for life** outside the solar system.

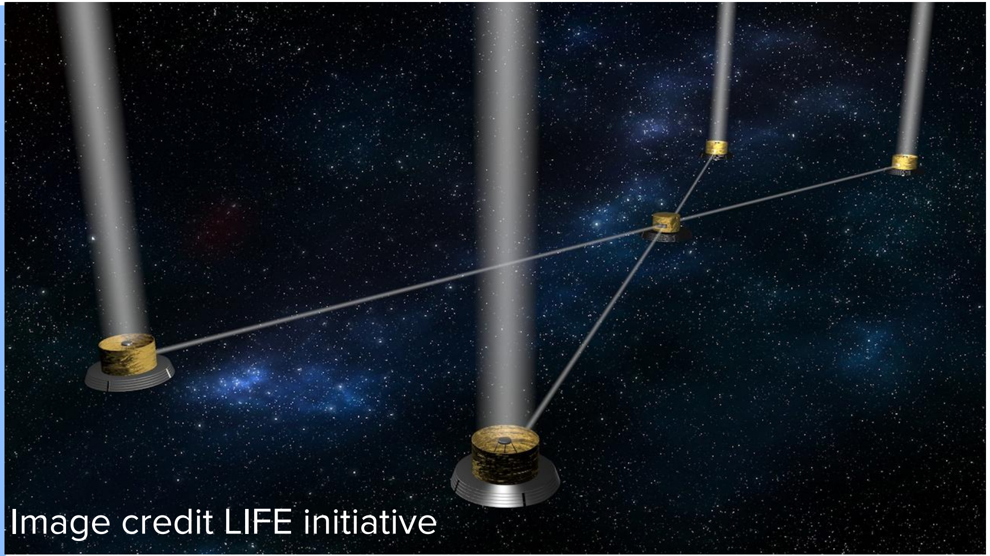


Image credit LIFE initiative

Roadmap

Heritage
Space based (MIR, nulling) interferometry is **not a new idea**.

- TPF Terrestrial Planet Finder (NASA)
- Darwin (ESA)

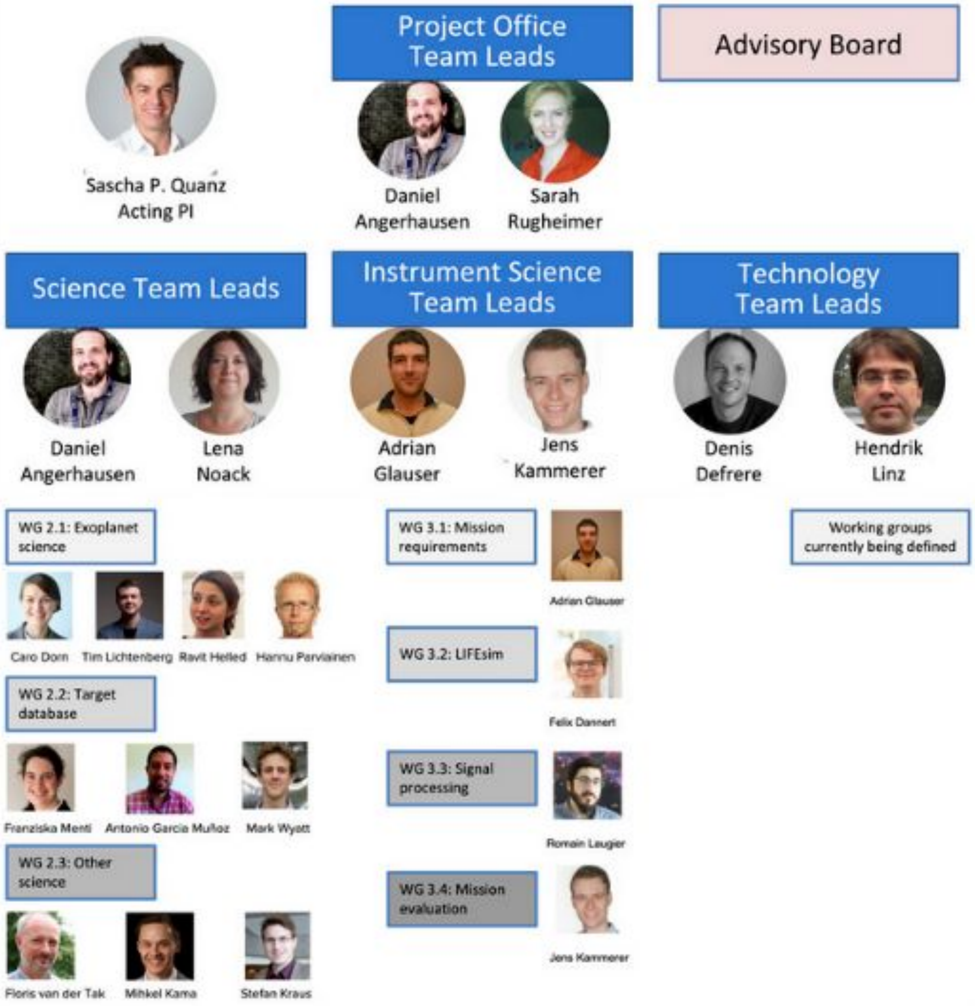
What is new is that we now **know exoplanet statistics much better**.

Status
2018 Kick-off
2020 Community building
2021 First study phase
-> Specialized Teams

Yield
At least 30 exoplanets with
-radius 0.5-1.5 R_{Earth}
-0.35-1.7 solar irradiation

Comprehensive Habitability statement
-> significant null result

Team



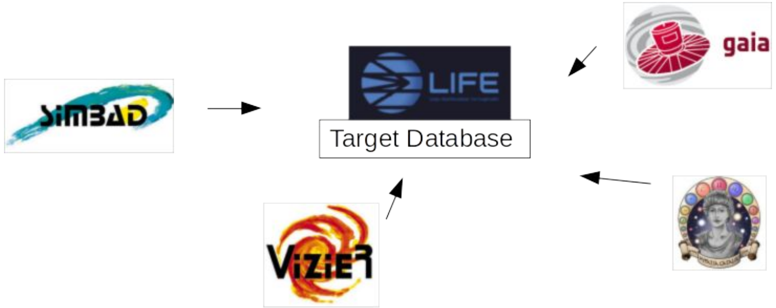
Project Office Team Leads
Advisory Board
Sascha P. Quanz
Acting PI
Daniel Angerhausen
Sarah Rugheimer
Science Team Leads
Instrument Science Team Leads
Technology Team Leads
Daniel Angerhausen
Lena Noack
Adrian Glauser
Jens Kammerer
Denis Defrere
Hendrik Linz
WG 2.1: Exoplanet science
Caro Dorn
Tim Lichtenberg
Ravit Helled
Hannu Parviainen
WG 2.2: Target database
Franziska Menti
Antonio Garcia Muñoz
Mark Wyatt
WG 2.3: Other science
Floris van der Tak
Mihkel Kama
Stefan Kraus
WG 3.1: Mission requirements
Adrian Glauser
WG 3.2: LIFEsim
Felix Dannert
WG 3.3: Signal processing
Romain Laugier
WG 3.4: Mission evaluation
Jens Kammerer
Working groups currently being defined

Target Database

Deliverables

Database

Database from multiple interconnected tables holding LIFE relevant data about stars, planets and disks.



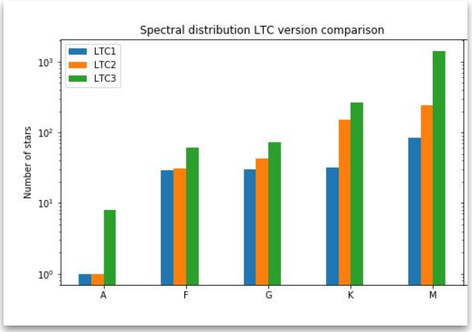
Catalog

Database query leading to scenario dependent target sample.
For yield estimation and observation (simulation)

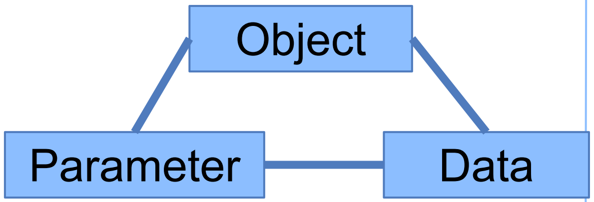
Star Name	Position
HD 4378A	...
* e Eri	...
...	...

State of the Database: Design

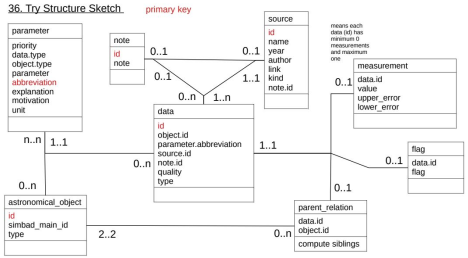
Functionality



Content



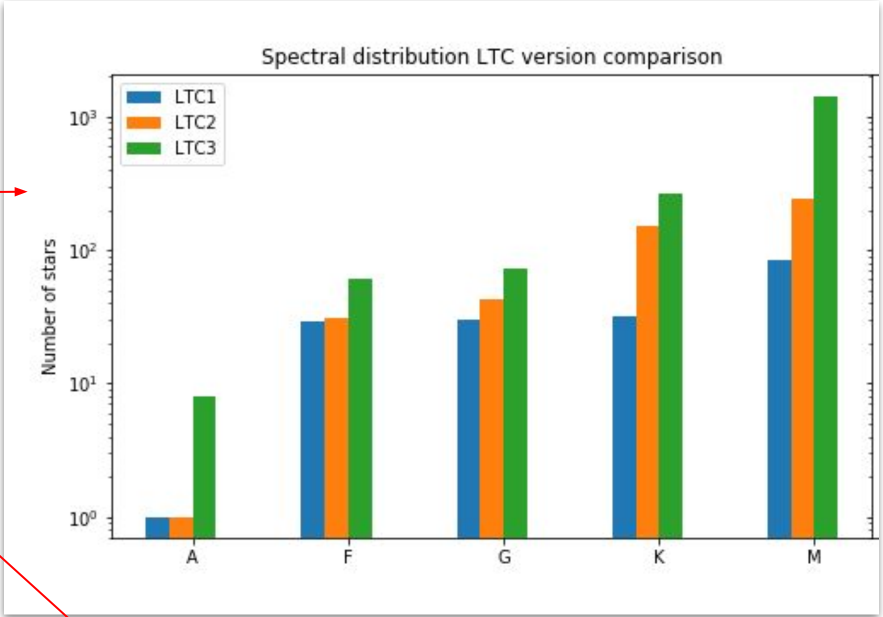
Structure



Functionality

User cases

- Maintenance
- Target sample
- Structured output
- VO compatible

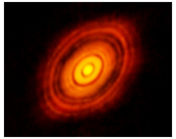


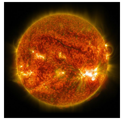
Find missing data

Content

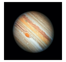
LIFE

- Objects
  - Stars, Planets, Disks, Systems
- Parameters
  - Measurables
- Data
  - Sources





e.g. Proxima centauri



Object

Parameter — Data

e.g. parallax

E.g. 768.5004 ± 0.2030 mas

Priority -> DR

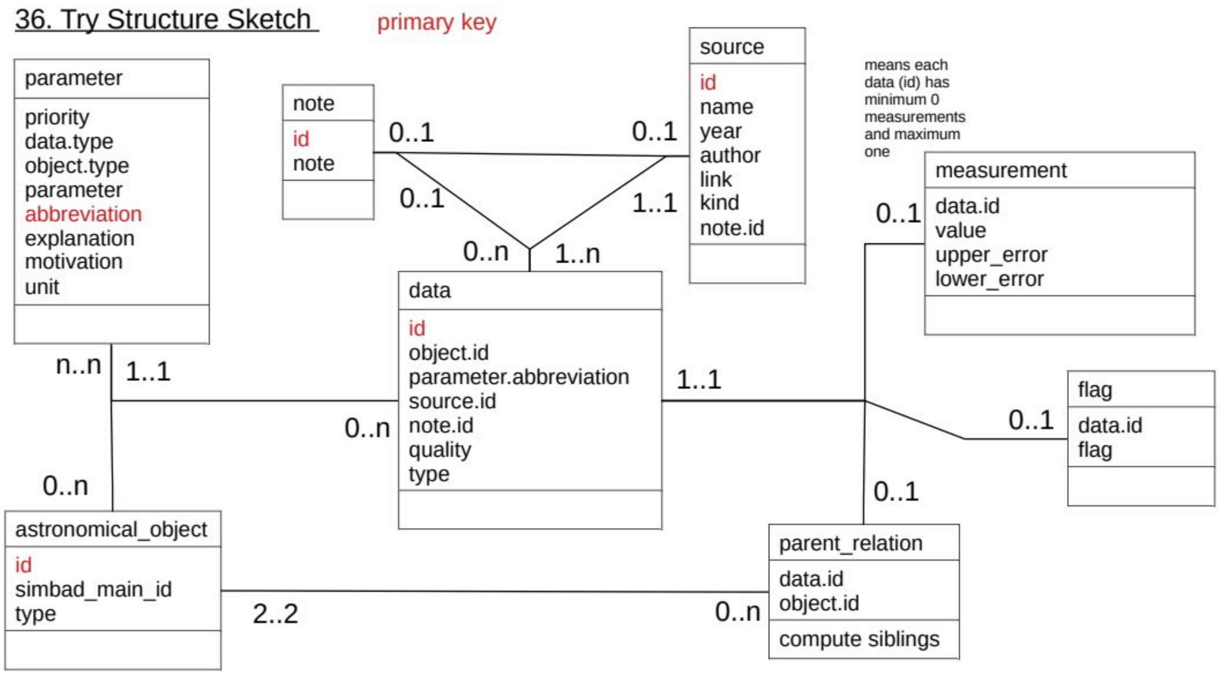
Sources

Image credits NASA

Structure

Data Model in UML

- Tables
- Relations
- Language



Participation Possibilities

How to Participate

- Check our webpage: **www.life-space-mission.com**
- Sign up for our newsletter: **life@phys.ethz.ch**
- Contribute to a work package →

1. Literature Comparison
2. Stellar Variability Parametrization
3. Parameter sources
4. Standardization
5. Database Implementation
6. Target Catalog extraction
7. Other science correspondence

credit thegoldguys.blogspot.com/

4. Standardization

Context
IVOA specifies standards in astronomy.

Deliverables
Document with

- IVOA standards important for us
- toolkits implementing those

Requirements
Knowledge of IVOA terminology or interest in reading up on it.

5. Database Implementation

Context
Transforming the data model into an actual working database.

Deliverables
Document with
- Software suggestions
- Solution for special cases

Database
- Implement structure
- Fill in data
- Test database

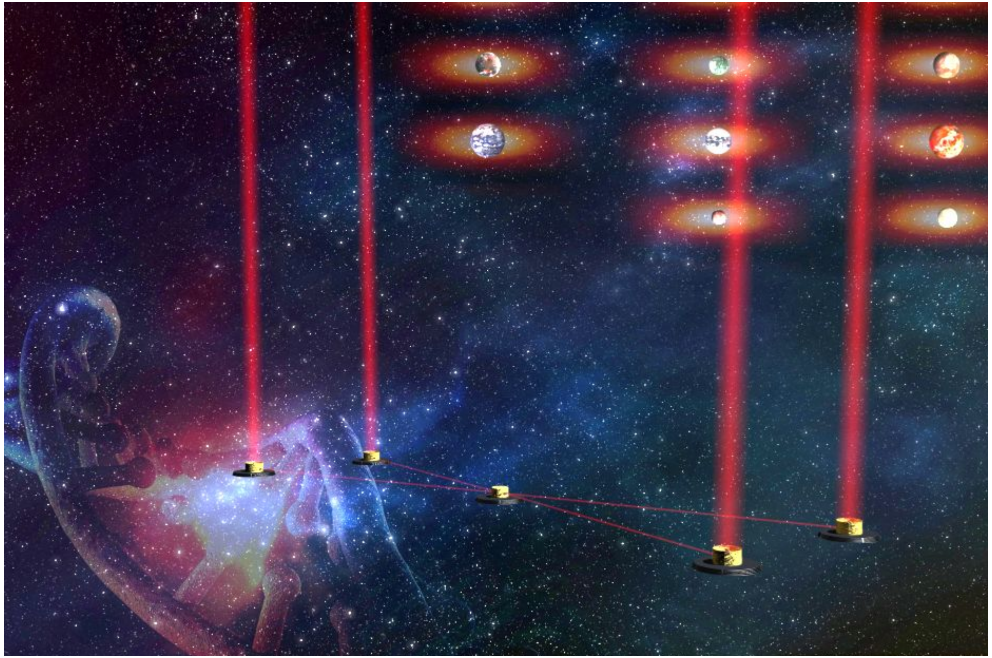
Requirements
Preferably experience in IT, data science and databases.

Questions and Feedback

Challenges with IVOA standards

- Newcomers introduction / Where do I start reading?
- Understanding complex terminology
- Understanding complex diagrams e.g. data models
- Wishing for more concrete examples

LIFE Target Database



Franziska Menti
ETH Zürich, fmenti@ethz.ch
27.05.21

Image credit LIFE initiative

Additional Material

LIFE in a nutshell

Mission

- Mid-Infrared
- Free flying
- Nulling interferometer
- Space mission

Science

- Thermal emission spectra
- Requirement 30, goal 50 extrasolar planets
- Diversity, habitability and search for biomarkers

Numbers

- 4 Telescopes
- 600 m baseline
- Wavelength: ~4-18 micron (tbc)
- Spectral Resolution: 35-50 (tbc)
- Mission Lifetime: ~6yr
  - Detect hundreds of planets
  - Characterize dozens of them

Database Creation Process

1. Requirements
   e.g. user cases

2. Database Design
   e.g. data model
3. Build the application
   e.g. user interface

Did this answer your question?

Feeding of database

Order of obtaining data:

1. From databases
2. From papers
3. Calculating ourselves

Feeding process should be as automated as possible

Did this answer your question?

Database type

Relational Database
= multiple tables linked to each other by relations

Did this answer your question?

Object table

id	simbad_main_id	type
1	* alf Cen	system
4	* alf Cen A	star
6	NAME V645 Cen b	planet
9	* eps Eri	disk

Parameter table

id	object.id	parameter.abbreviation	source.id	note.id	quality	type
1	4	plx	1		B	measurement

Data table

data.id	value	upper_error	lower_error
1	743	1.3	1.3

Database Input Example

Parameter

priority	parameter	abbreviation	explanation	motivation	unit
1	parallax	plx	Angular difference in position of target when observed half a year later.	Limit of distance inclusion of stars into the database as well as difficulty of observation since a star's apparent magnitude decreases with distance to observer. Planets of a given mass and age are brighter the nearer to us they are.	mas

Roadmap

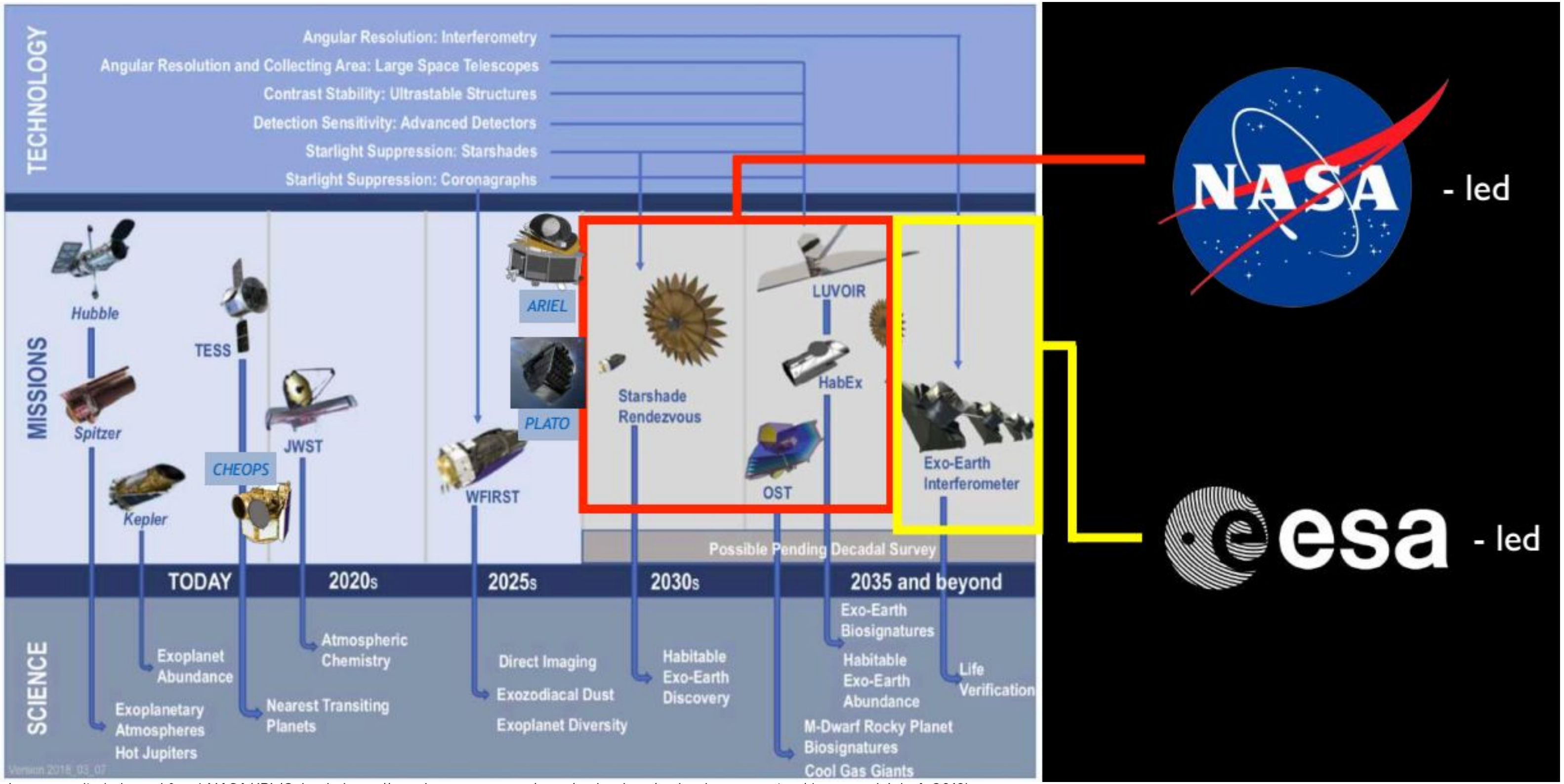
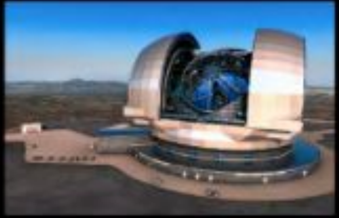


Image credit: (adapted from) NASA/JPL/Caltech; https://exoplanets.nasa.gov/exep/technology/technology-overview/ (accessed July 4, 2019)

Supplementary Science

What to expect in the coming 10-30 years?

	Thermal emission	Reflected light
M-stars	LIFE 	 ELT/PCS
Sun-like stars	ELT/METIS  LIFE 	 HabEx 

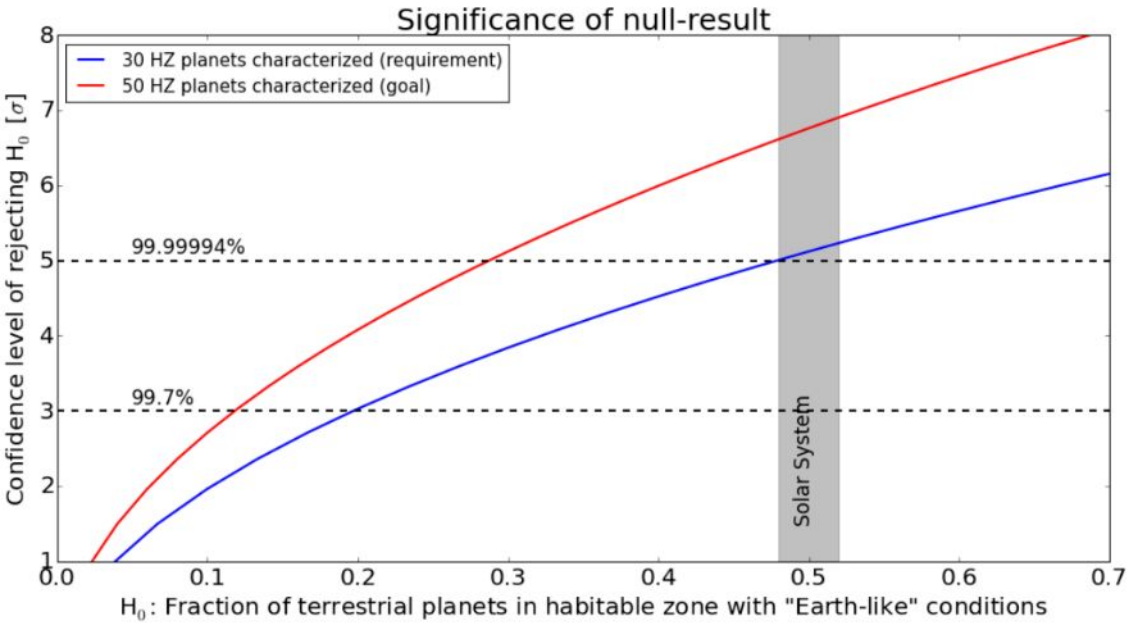


Figure 4: The statistical power of a null-result: in case 30 (blue curve) or 50 (red curve) exoplanets with radii between 0.5 and 1.5 $R_\oplus$ and receiving between 0.35 and 1.7 times the insolation of the Earth are investigated with high-quality thermal emission spectra and not a single one is found to support conditions that allow for the existence of liquid water, then the null-hypothesis – shown on the x-axis – can be rejected with the significance shown on the y-axis. In the Solar System, one out of two planets within the empirical habitable zone provides (surface) conditions for liquid water to exist; hence, $H_0 = 50\%$ for the Solar System.

Quanz et al. 2019