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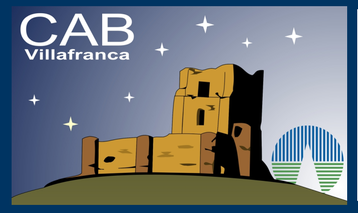
Synergies between

ESA space missions

and the

Remote Worlds Lab



CENTRO DE ASTROBIOLOGÍA · CAB
ASOCIADO AL NASA ASTROBIOLOGY PROGRAM
CSIC INTA

Jorge Lillo-Box
Junior Leader Fellow —> RyC
Centro de Astrobiología (CAB)

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The team

Jorge Lillo-Box

Junior Leader Fellow
Ramón y Cajal (from 2023)

Olga Balsalobre-Ruza

PhD co-supervised
with Nuria Huélamo

Amadeo Castro-González

PhD co-supervised
with David Barrado

Asier Abreu

PhD co-supervised
with Ana Pérez García

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Projects

TROY

the KOBE experiment

PiGs

MAISHA enterprise

exoAI

see talk by
Olga Balsalobre-Ruza

TROY the hunt for the first exotrojan planets

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KOBE

K-dwarfs
Orbited
By habitable
Exoplanets

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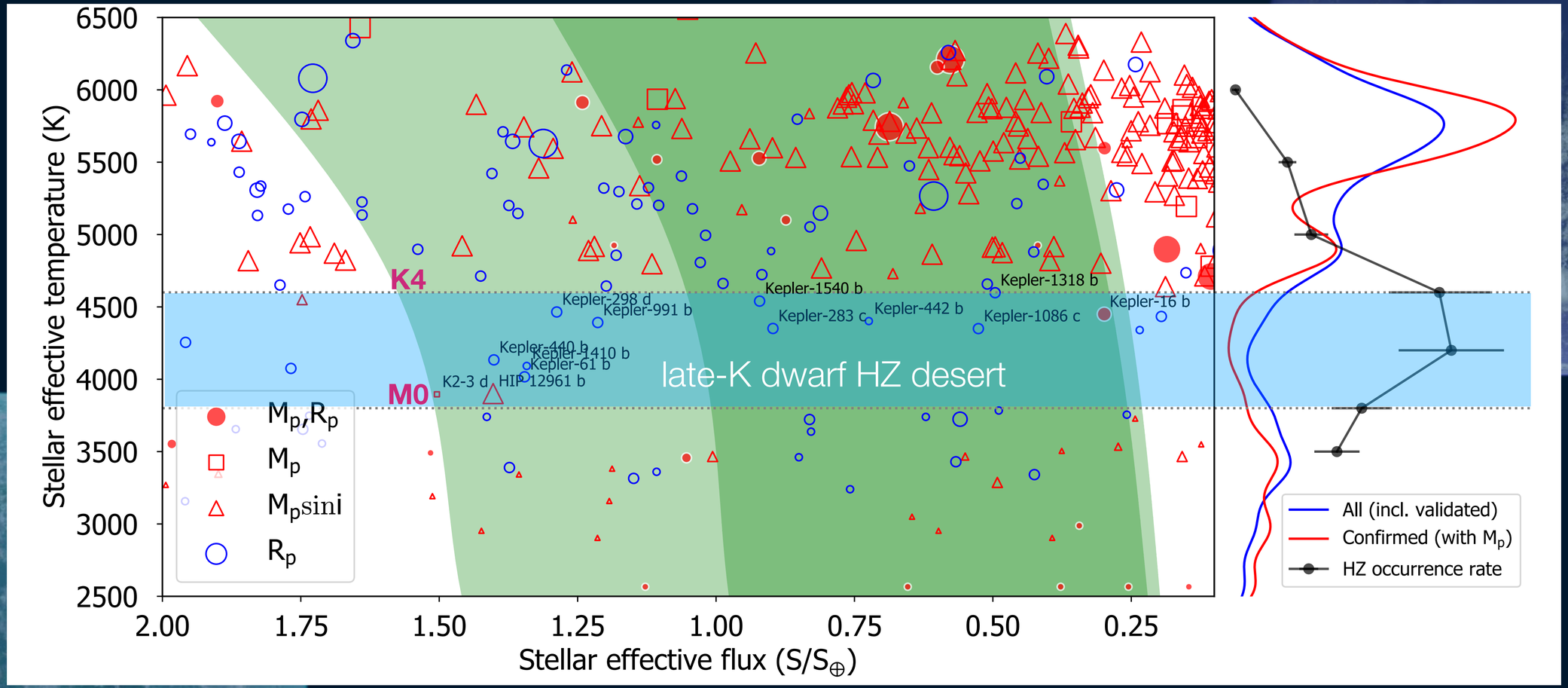

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5-semesters legacy program at Calar Alto Observatory

175 nights (35 nights/semester)

CARMENES instrument for precise radial velocity monitoring of 50 late-K dwarfs to look for habitable-zone planets.

Observations started in 2021 and ill finish in 2024 (including extension)

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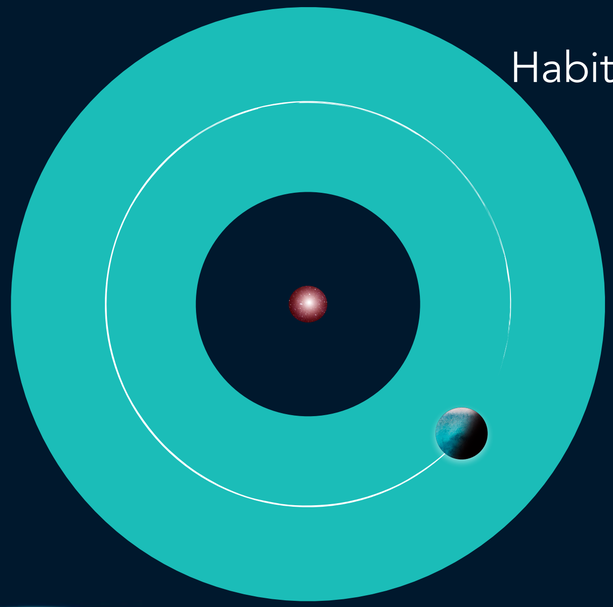

Habitable Zone

Synnergies with ESA missions

esa gaia

Gaia: Key in the target selection for the KOBE experiment, based on Gaia derived stellar parameters

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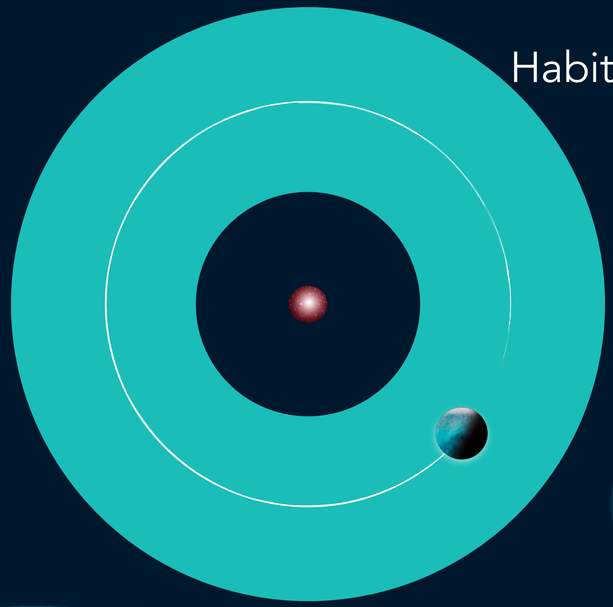

esa plato

Synnergies with ESA missions

PLATO: KOBE planets might transit. detecting them transiting would be key to understand their properties and trigger astrobiological studies (atmospheric characterization, etc.)

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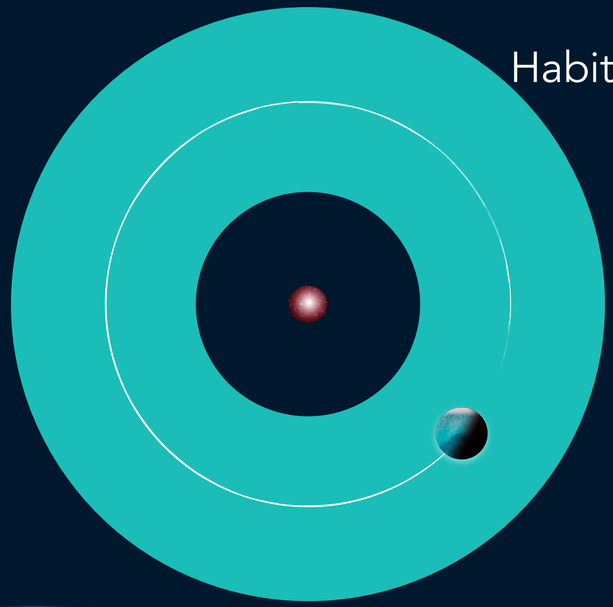

Synnergies with ESA missions

LIFE: the HZ of KOBE stars is located at typical separations of 5-37 mili-arcsec at the KOBE stars (distances between 15-40 pc). They will then be detectable by missions like LIFE. This will enable atmospheric studies of this prime astrobiological targets.

LIFE
LARGE INTERFEROMETER FOR EXOPLANETS

PiGs

Planets in Giant stars

(in collaboration with E. Pallé & R. Luque)

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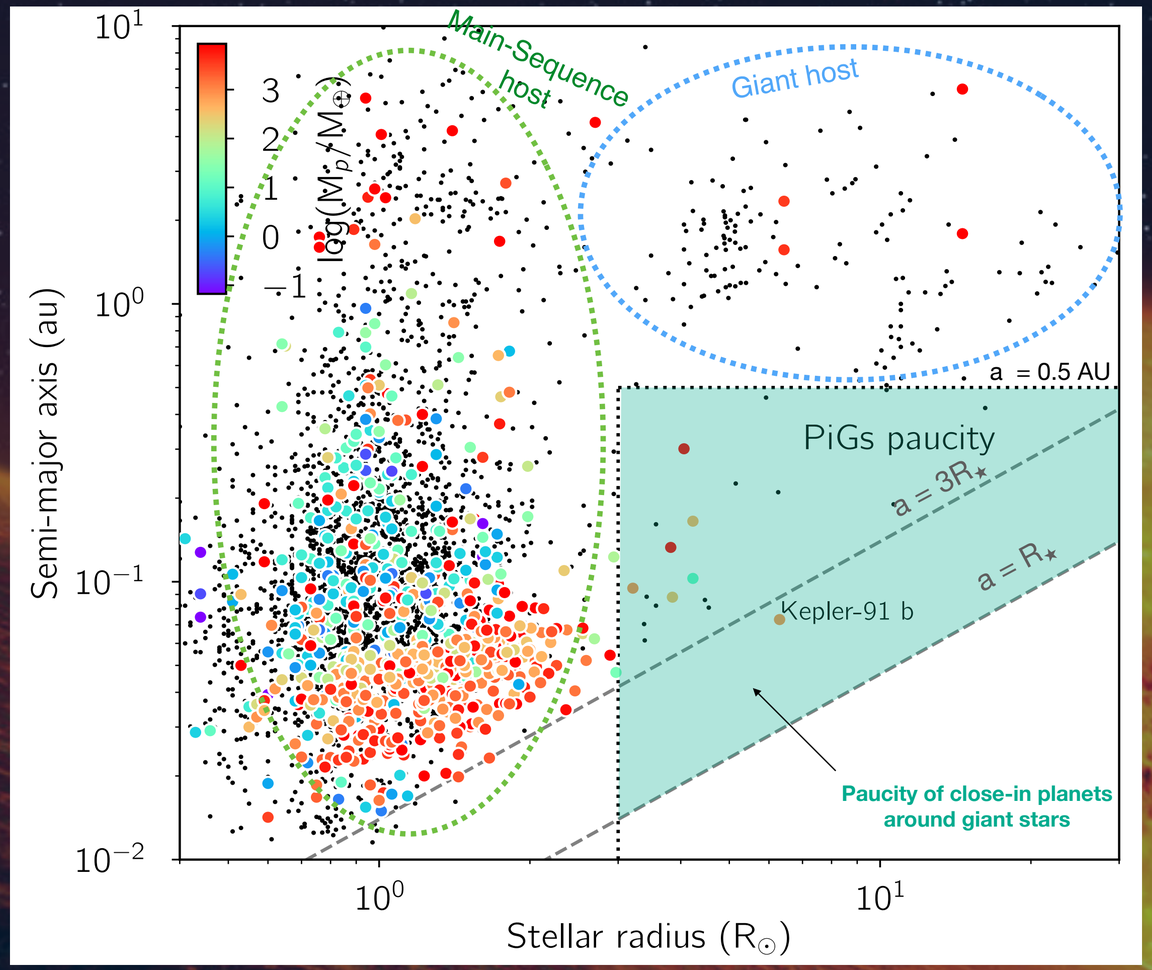
Lillo-Box et al., 2014a, A&A, 562, 109
Lillo-Box et al., 2014c, A&A, 568, 1



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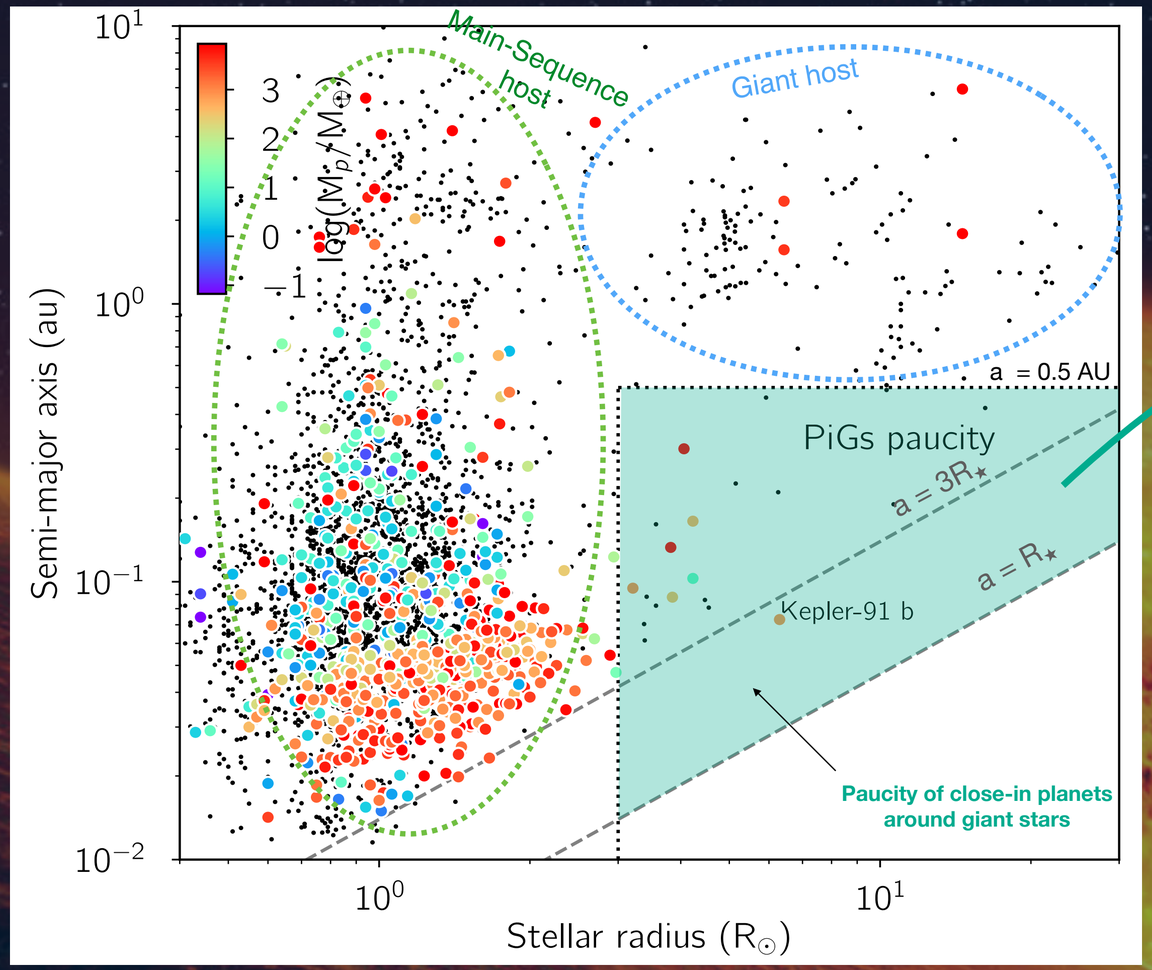
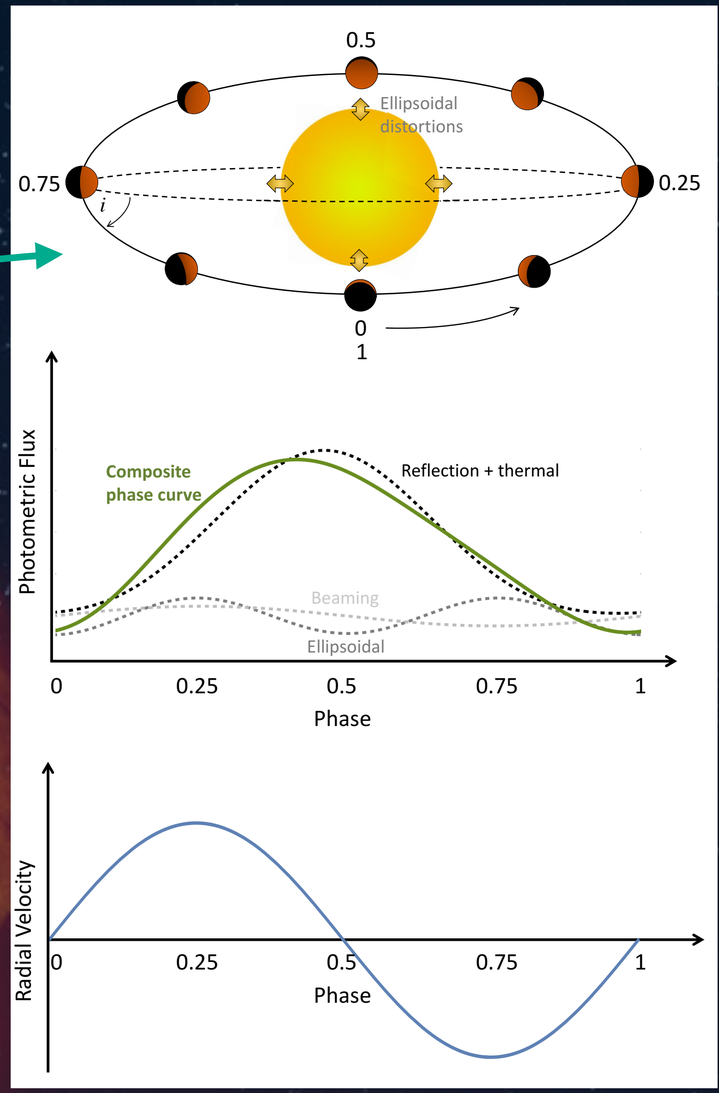


Reflexion

Ellipsoidal

Beaming



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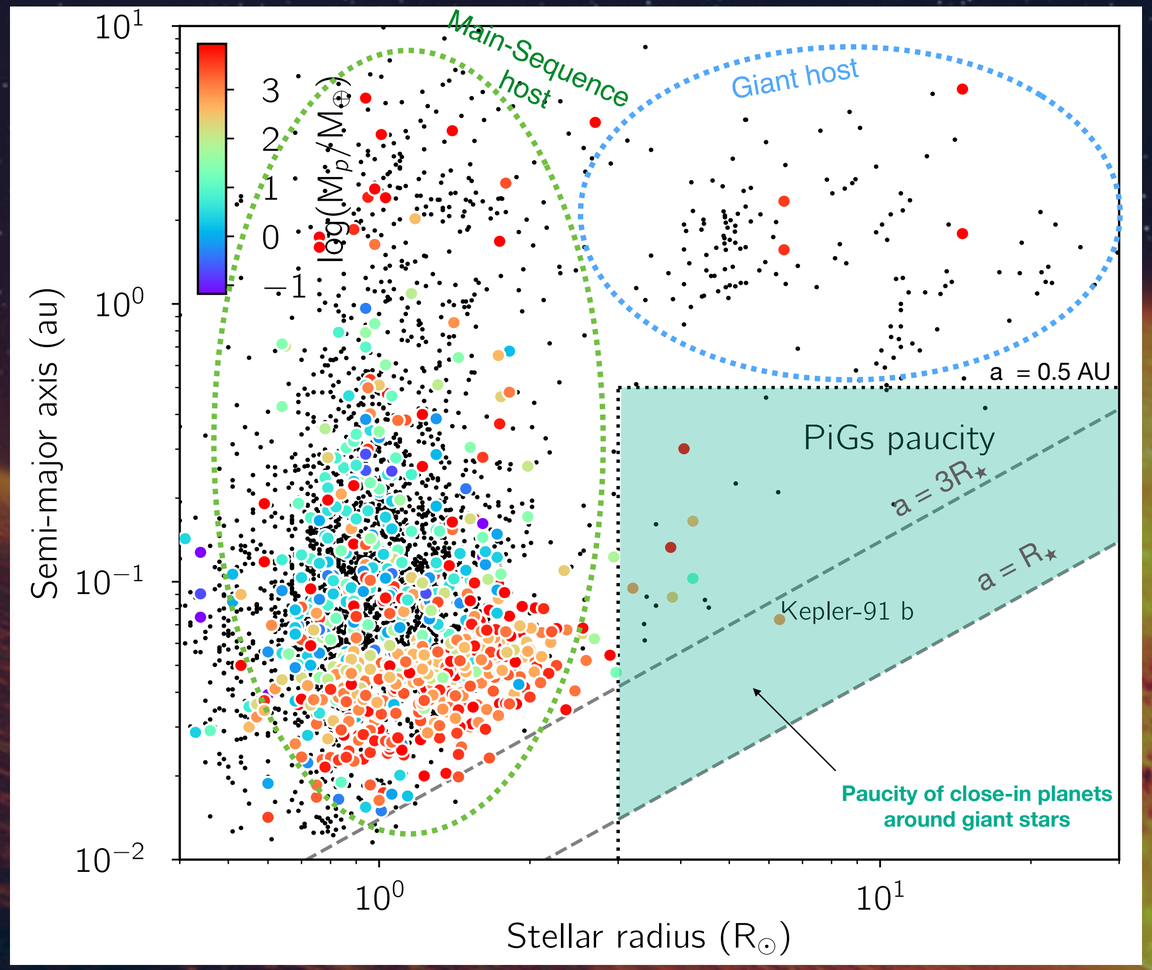
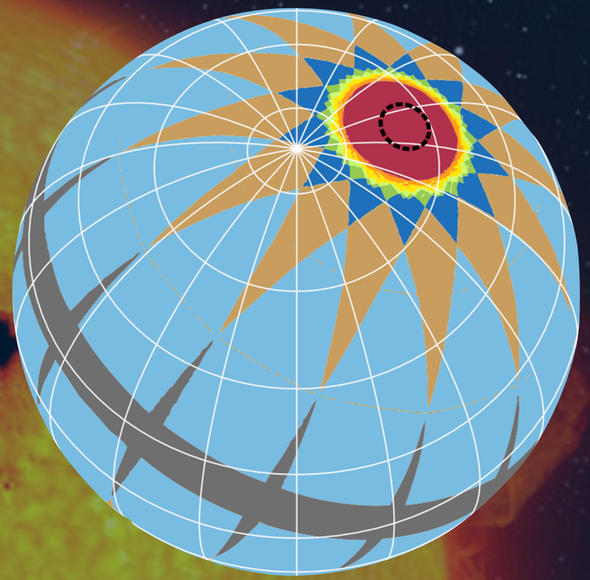
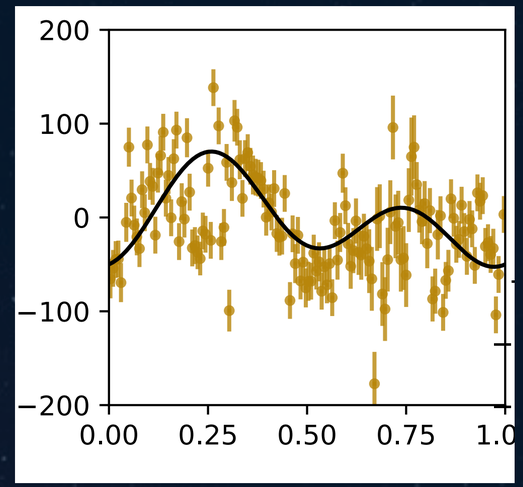


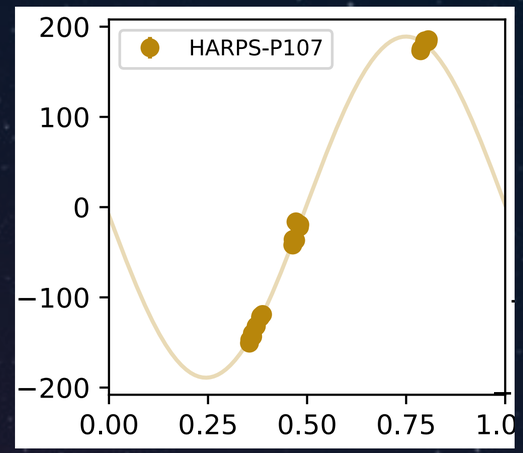
Search and characterization of close-in planets around giant stars using the **REBs** technique

TESS mission





Orbital phase



Orbital phase

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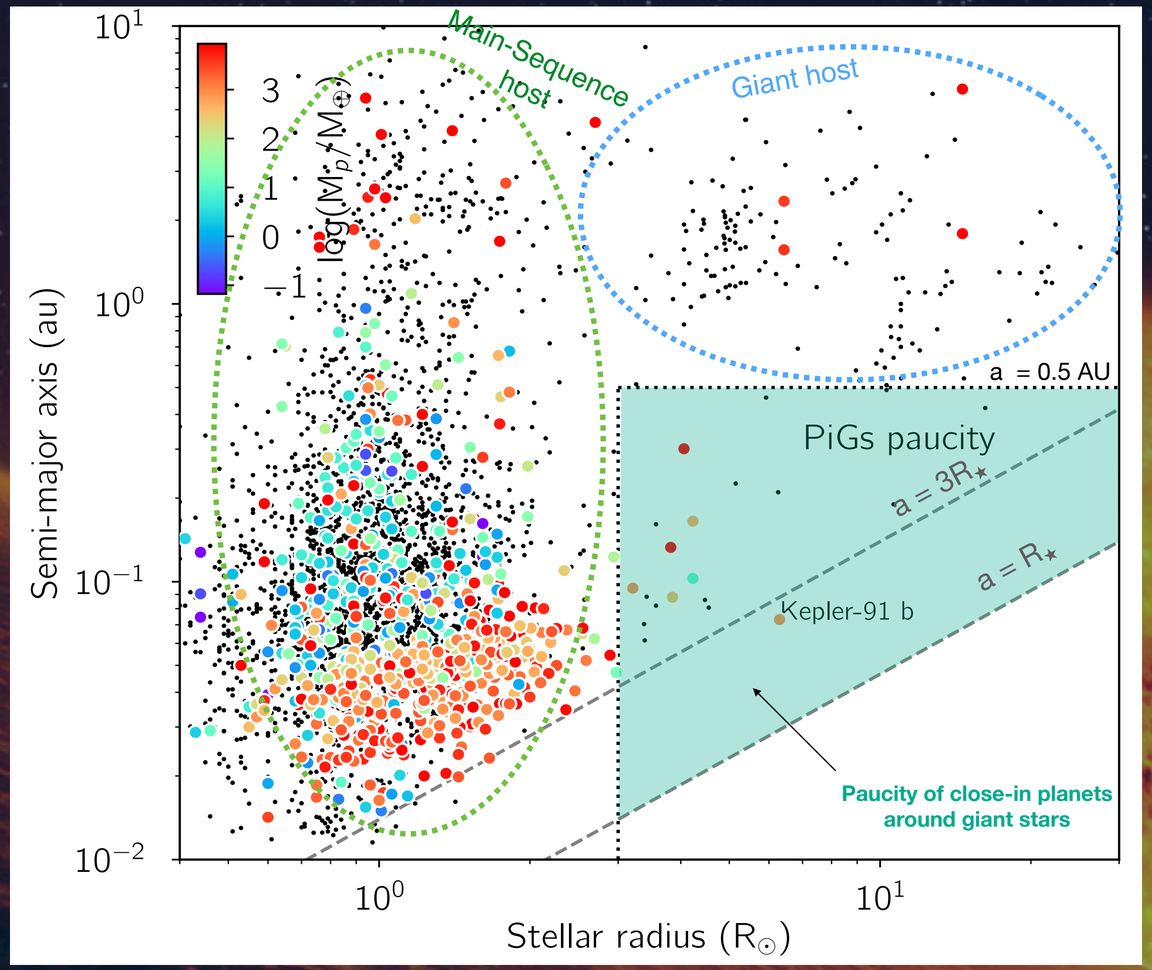
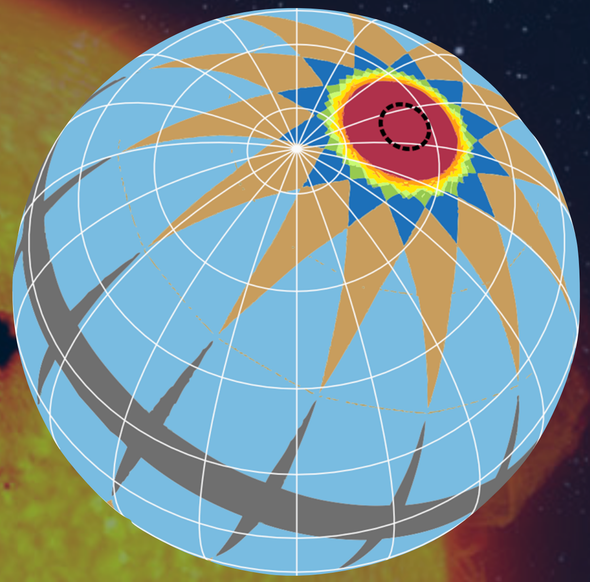


Search and characterization of close-in planets around giant stars using the **REBs** technique

TESS mission → PLATO mission



Synnergies with ESA missions

esa plato

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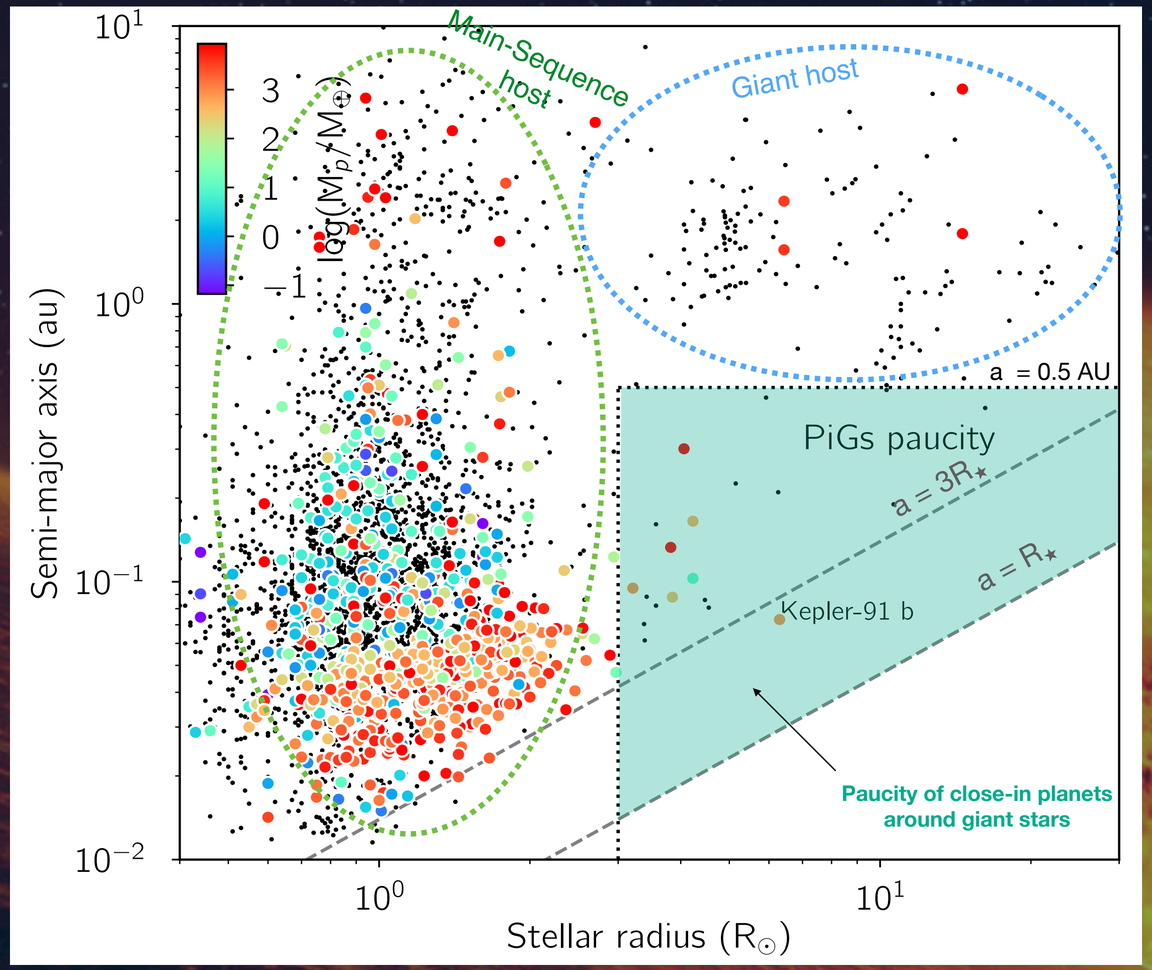
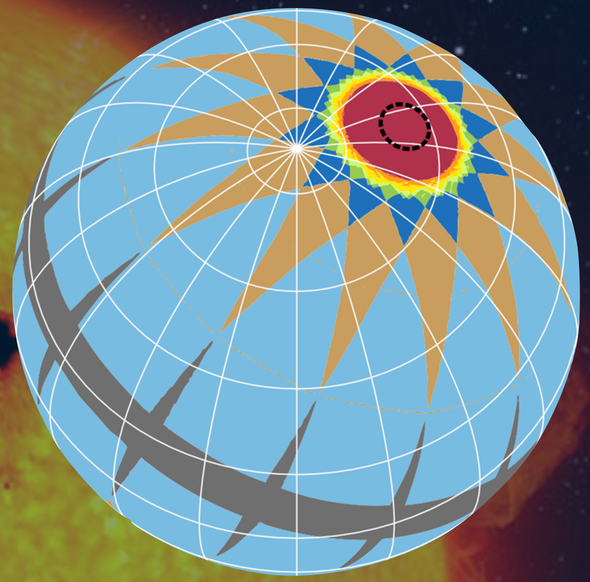


Search and characterization of close-in planets around giant stars using the **REBs** technique

Synnergies with ESA missions

TESS mission → ARIEL mission



Ariel

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PiGs

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exoAI

Would any terrestrial organism survive on a given exoplanet?

Which ones would?
What would be their
dominant biosignatures?

the MAISHA enterprise

(in collaboration with P. Cruz, A. Álvarez-Saavedra, C. Escudero, D. Ruano, M. Moreno)

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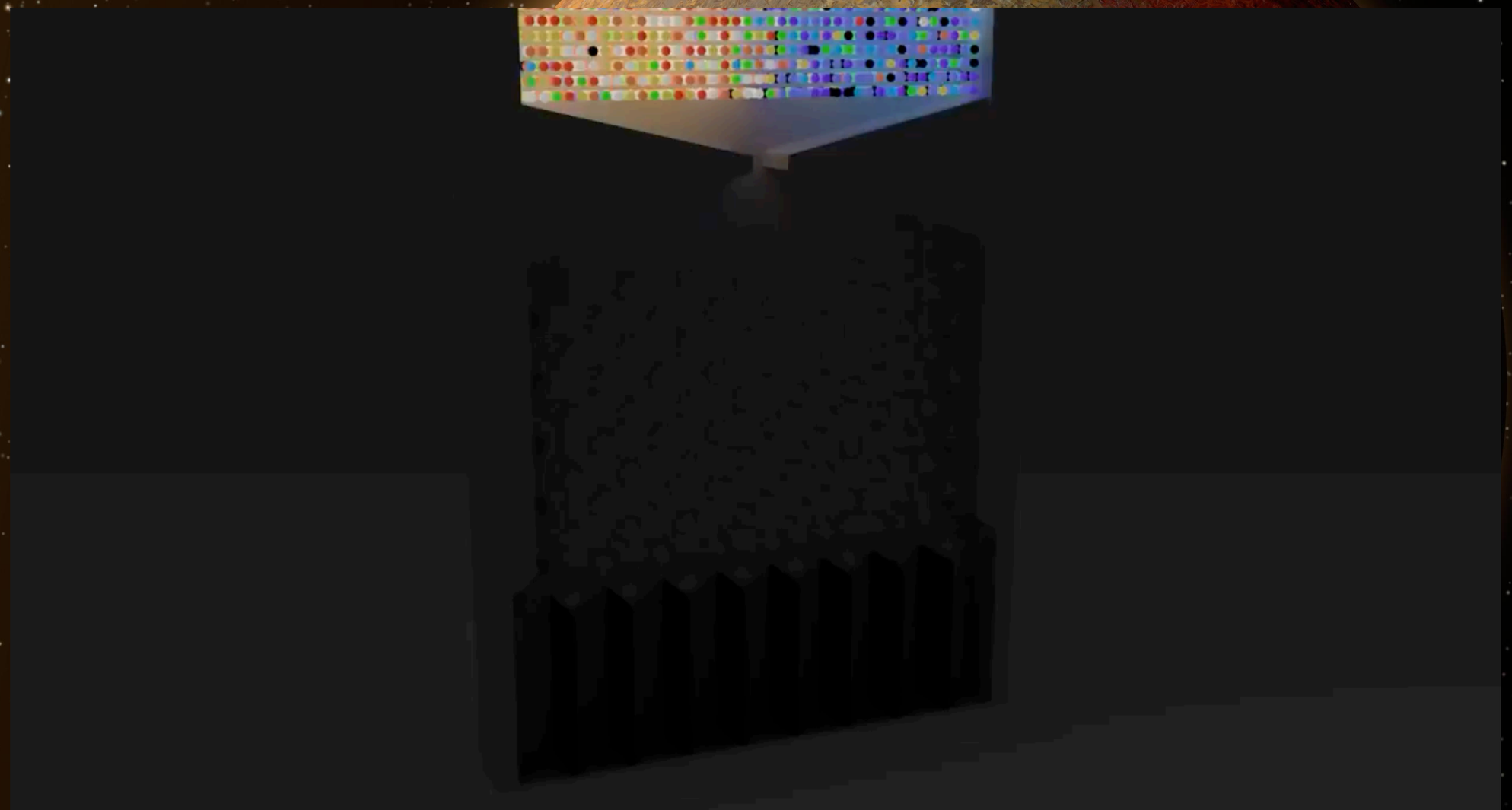

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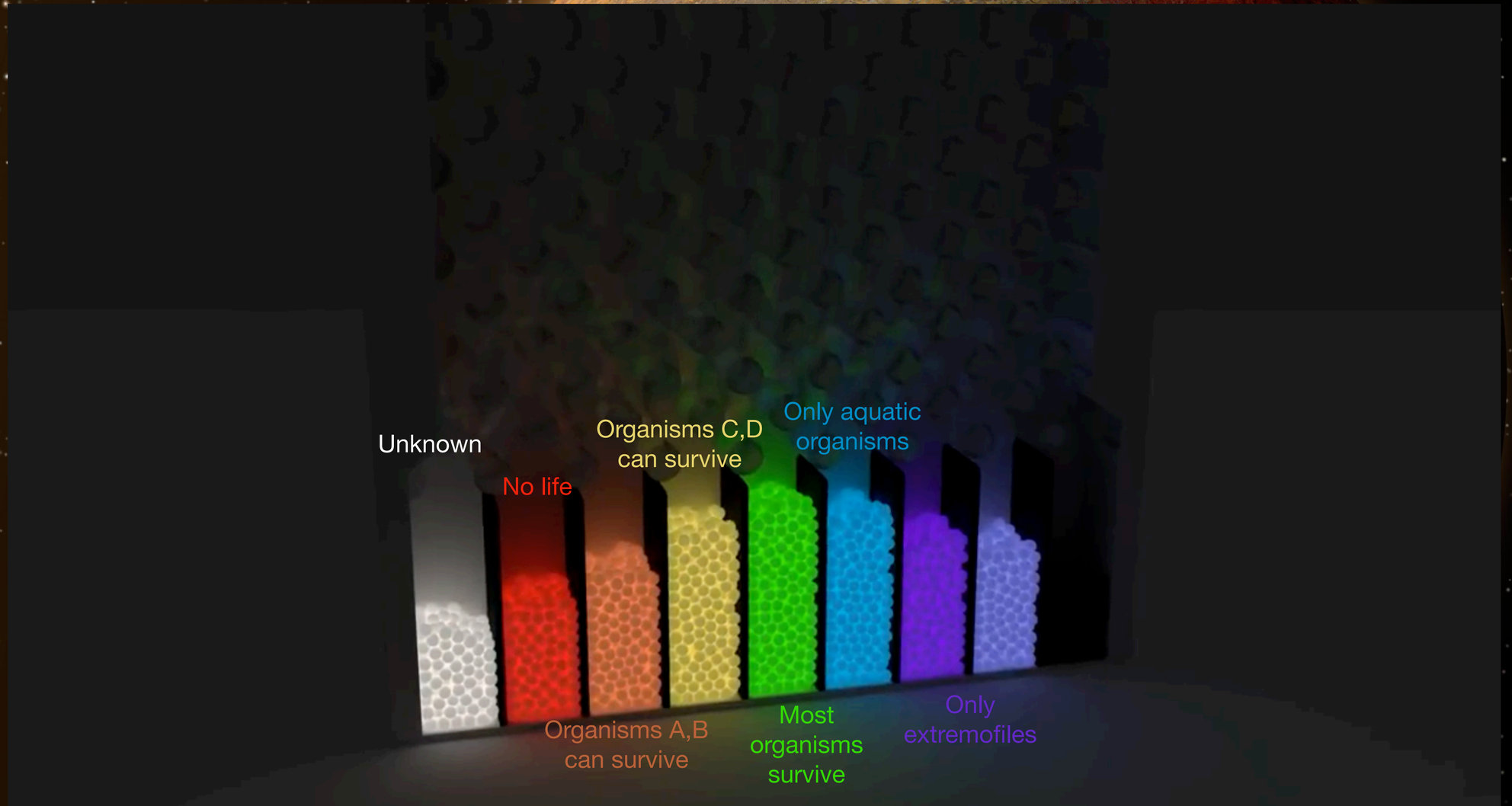

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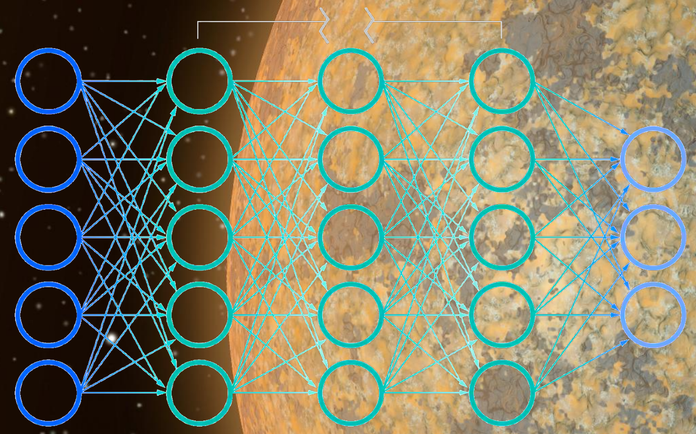
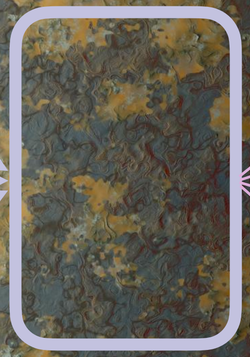
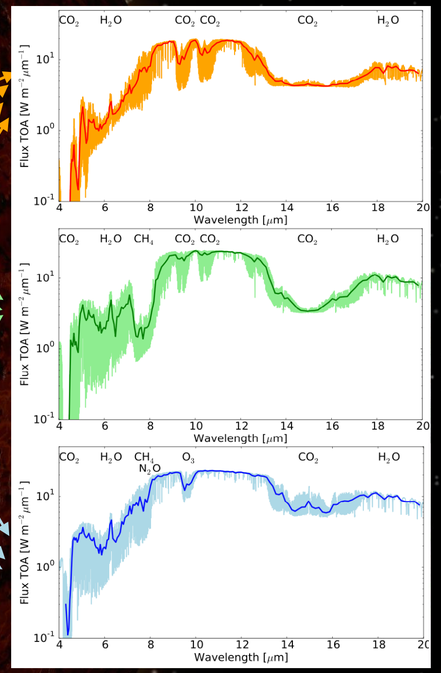
PHASE 1

PHASE 2

PHASE 3







Inhabitability Decision Tree

Determination of the key parameters involved in the development and survival of life

Artificial Neural Network

Inference of the probability of survival of earth's organisms based on input parameters defining a specific environment

Ecosystem to biomarkers

Use of bioinformatics to create an ecosystem based on the living organisms predicted by the ANN to survive in the given conditions and provide the expected biosignatures detectable in the exoplanet's atmosphere

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Life
Tolerability
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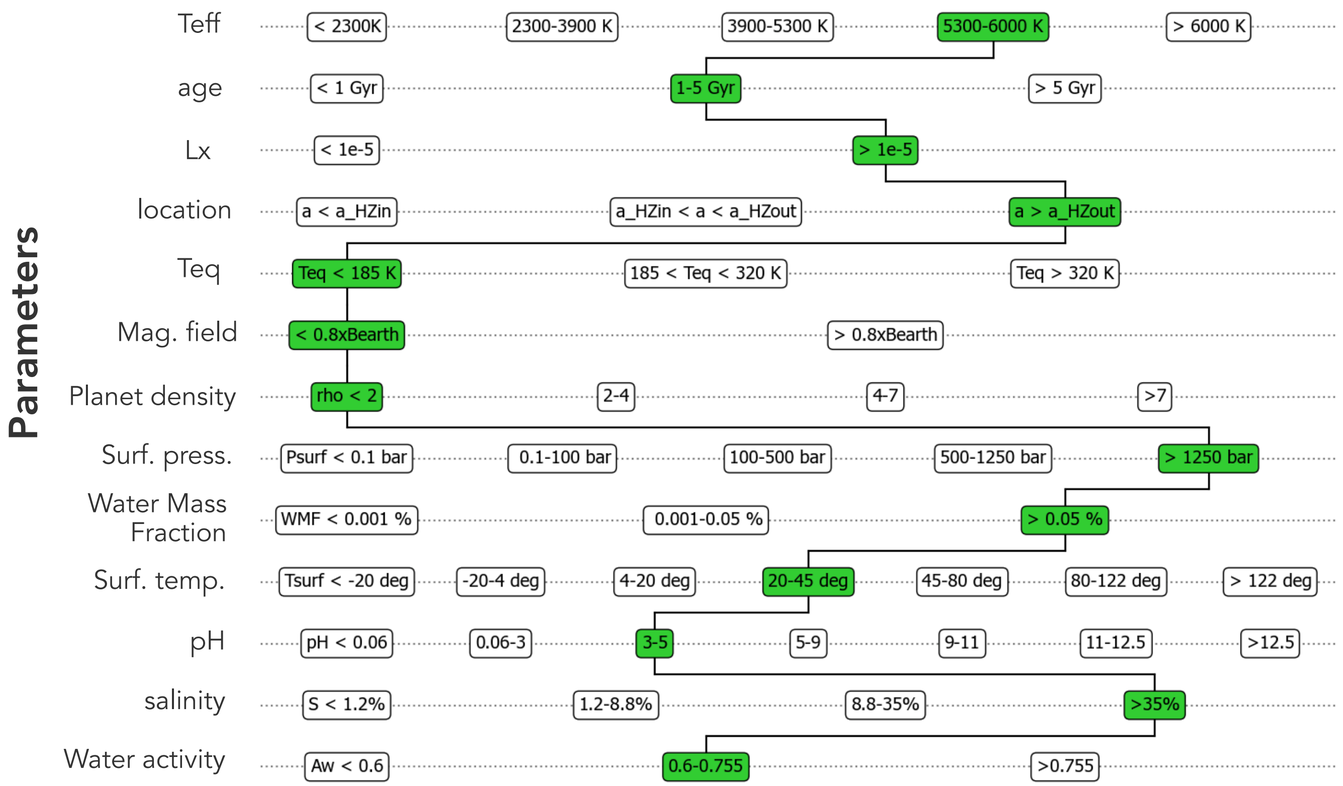

life = yes life = no

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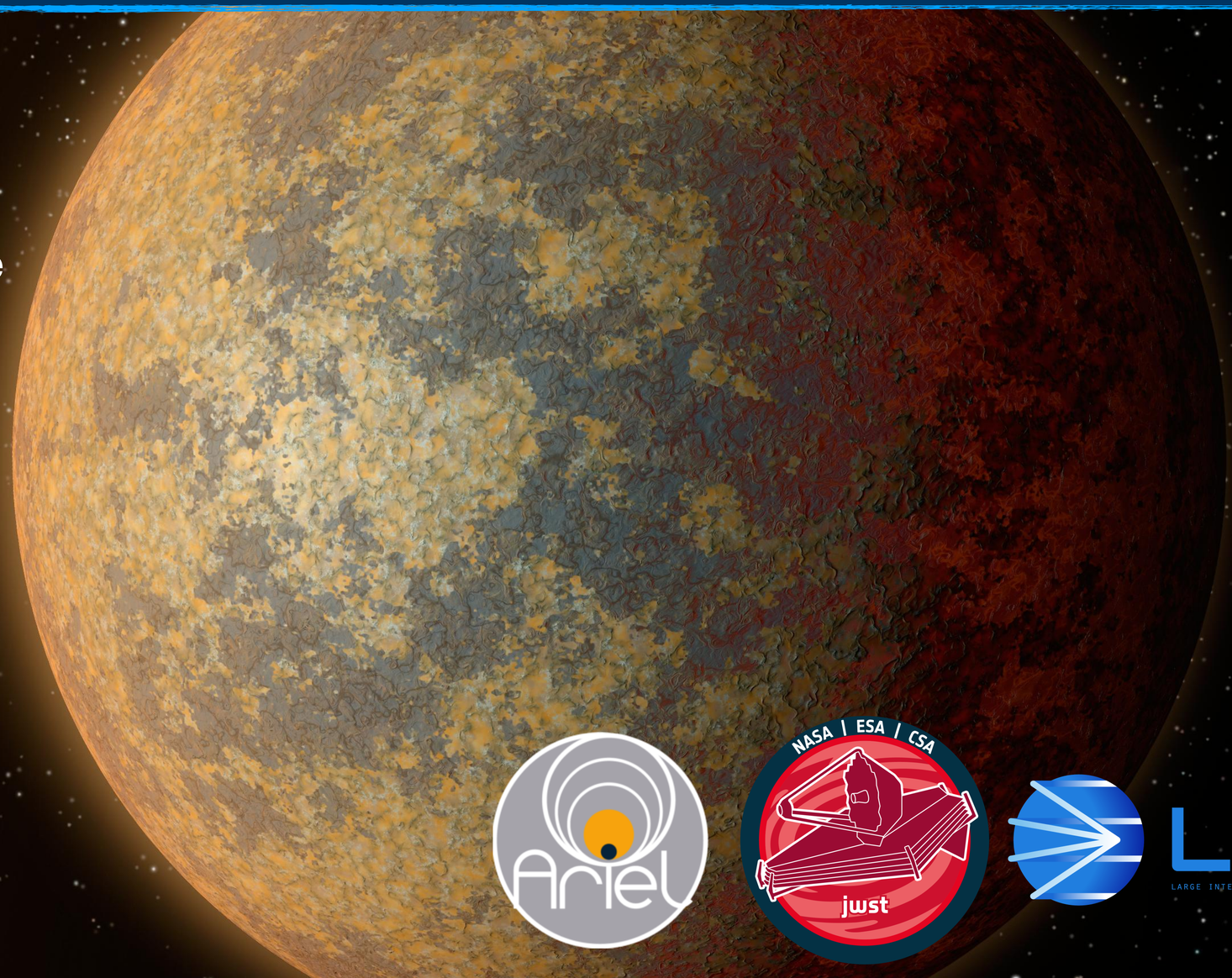
Synnergies with ESA missions

- Rank known extrasolar planets by their ability to sustain Earth-like life
- **Prioritise** known exoplanets for astrobiological observations with ESA missions (e.g., atmospheric characterization with **ARIEL**, target selection for **LIFE**, etc.)
- **Infer predominant life/ genomics** population and consequently unveil the most prominent biomarkers to search for (LIFE, Ariel, JWST).



Ariel

NASA | ESA | CSA
jwst

LIFE
LARGE INTERFEROMETER FOR EXOPLANETS

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(PhD by Asier Abreu, co-supervised by Ana Pérez-García and J. Lillo-Box)

exoplanet

Artificial **I**ntelligence

detection

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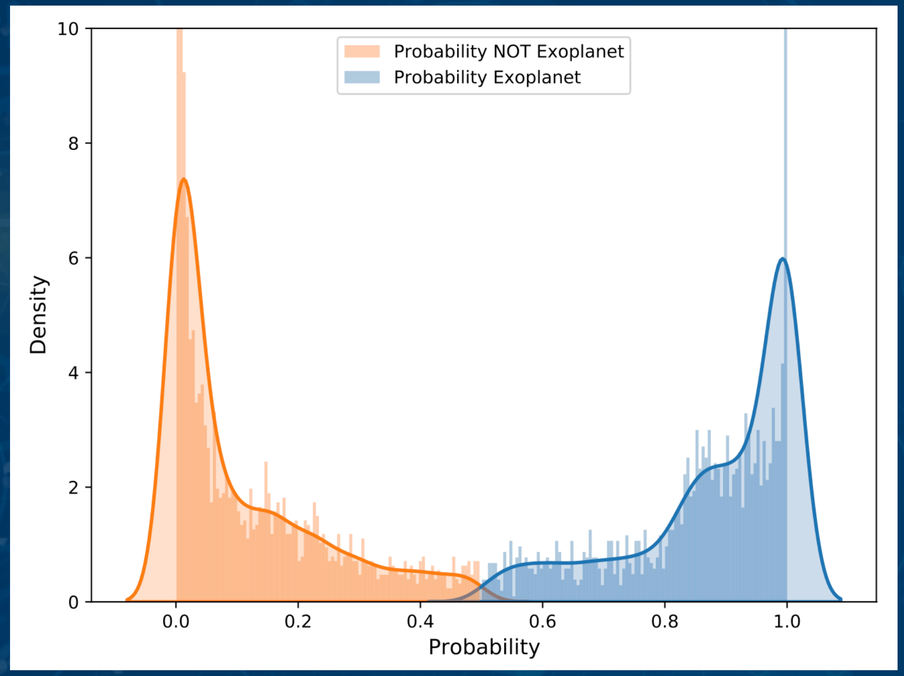
What is the probability of a given star to host a planetary system?

How can we take profit of all observational information to answer that question?



Asier Abreu's Master Thesis, 2021

We are testing different AI methodologies using infromation from Gaia and other surveys

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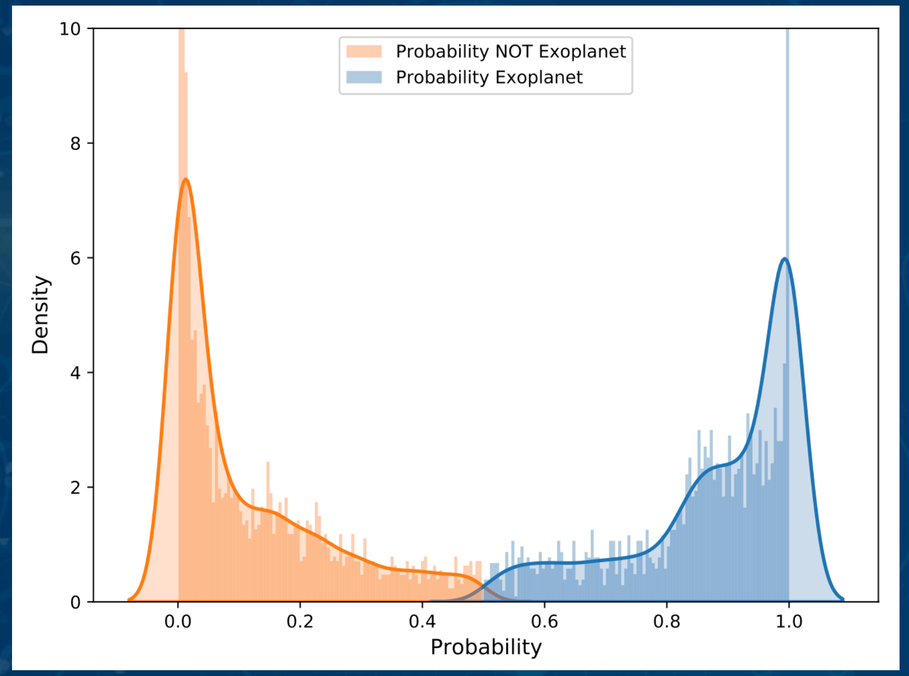
Synnergies with ESA missions

- Efficient selection of targets for planet hunting missions (e.g., PLATO)
- Use of space-based mission catalogs (e.g., Gaia, Kepler, TESS, PLATO) to train AI techniques
- Classification of stars according to their probability to host a given type of planet. Key for missions like LIFE.



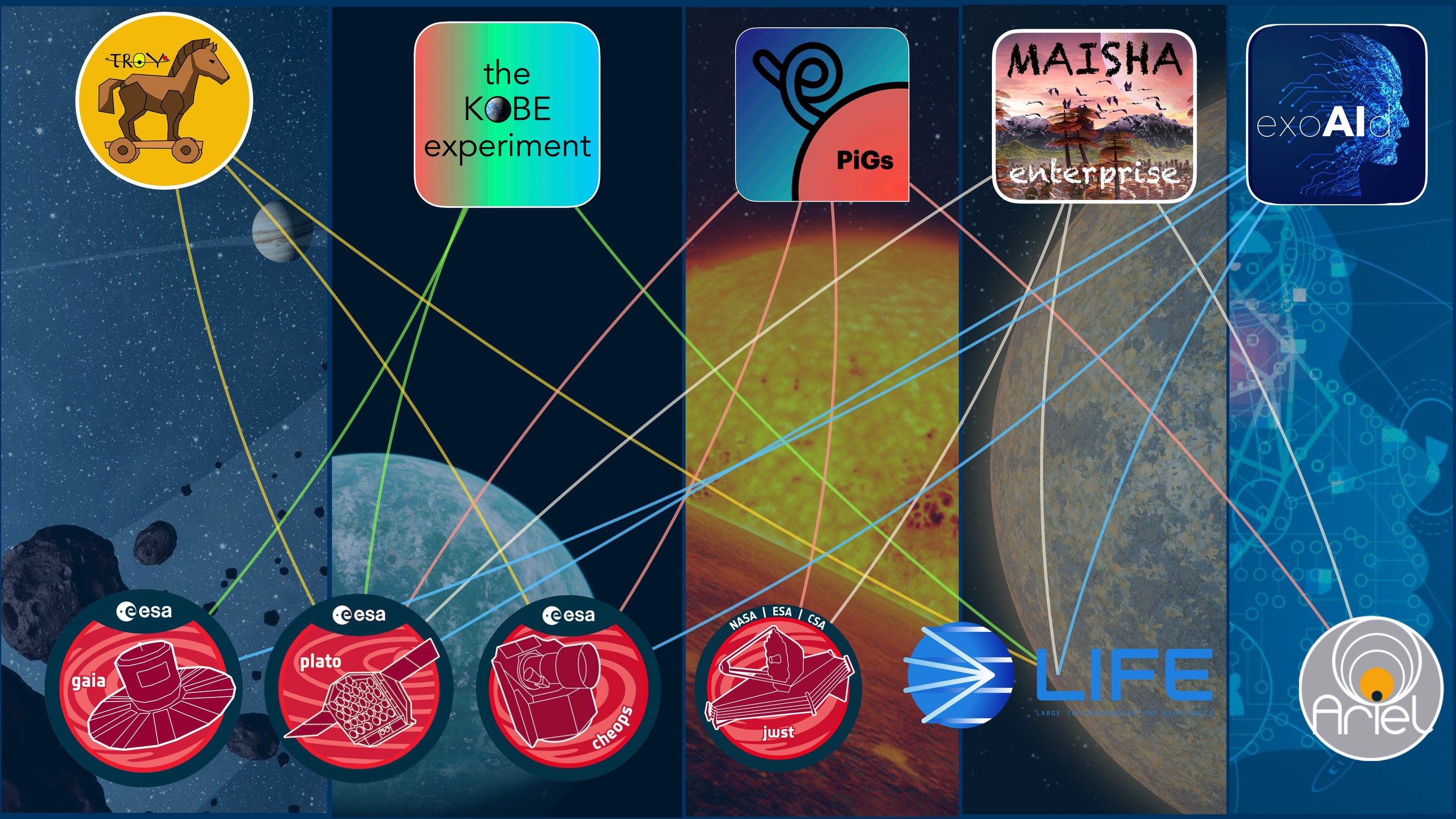
Asier Abreu's Master Thesis, 2021

esa gaia

esa plato

esa cheops

LIFE
LARGE INTERFEROMETER FOR EXOPLANETS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cheops
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Thanks!