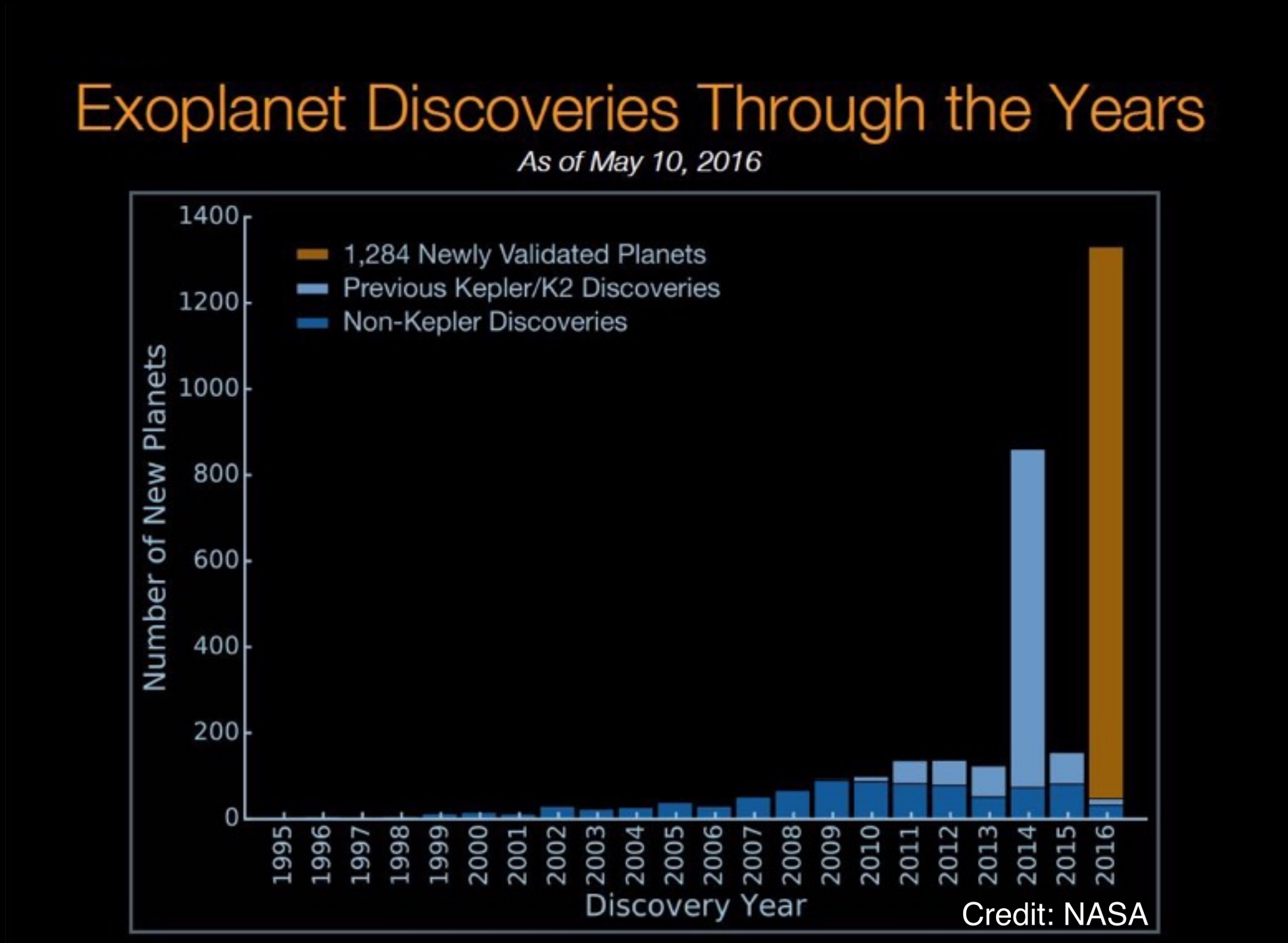
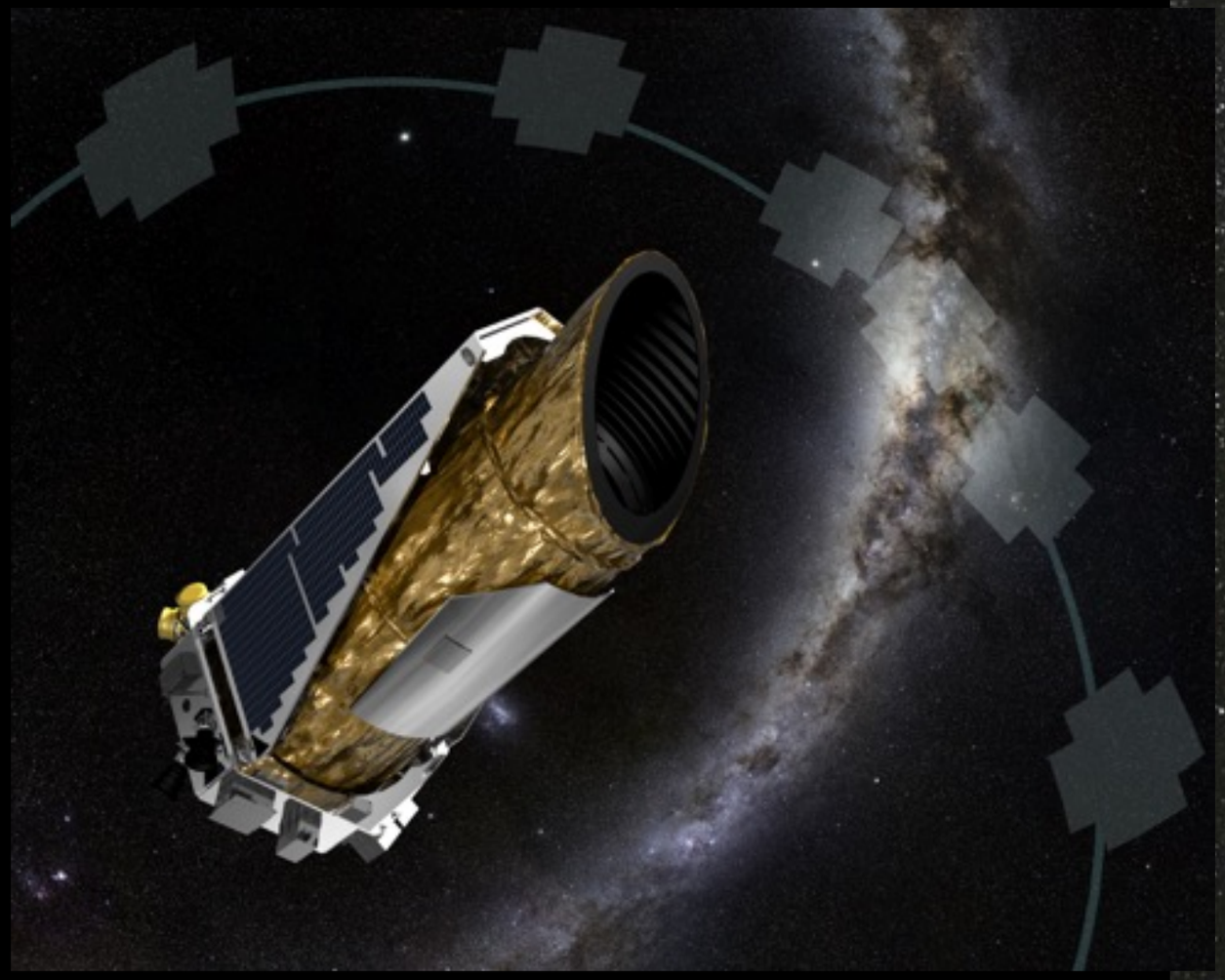
Exoplanets and the Search for Life around Low-mass Stars

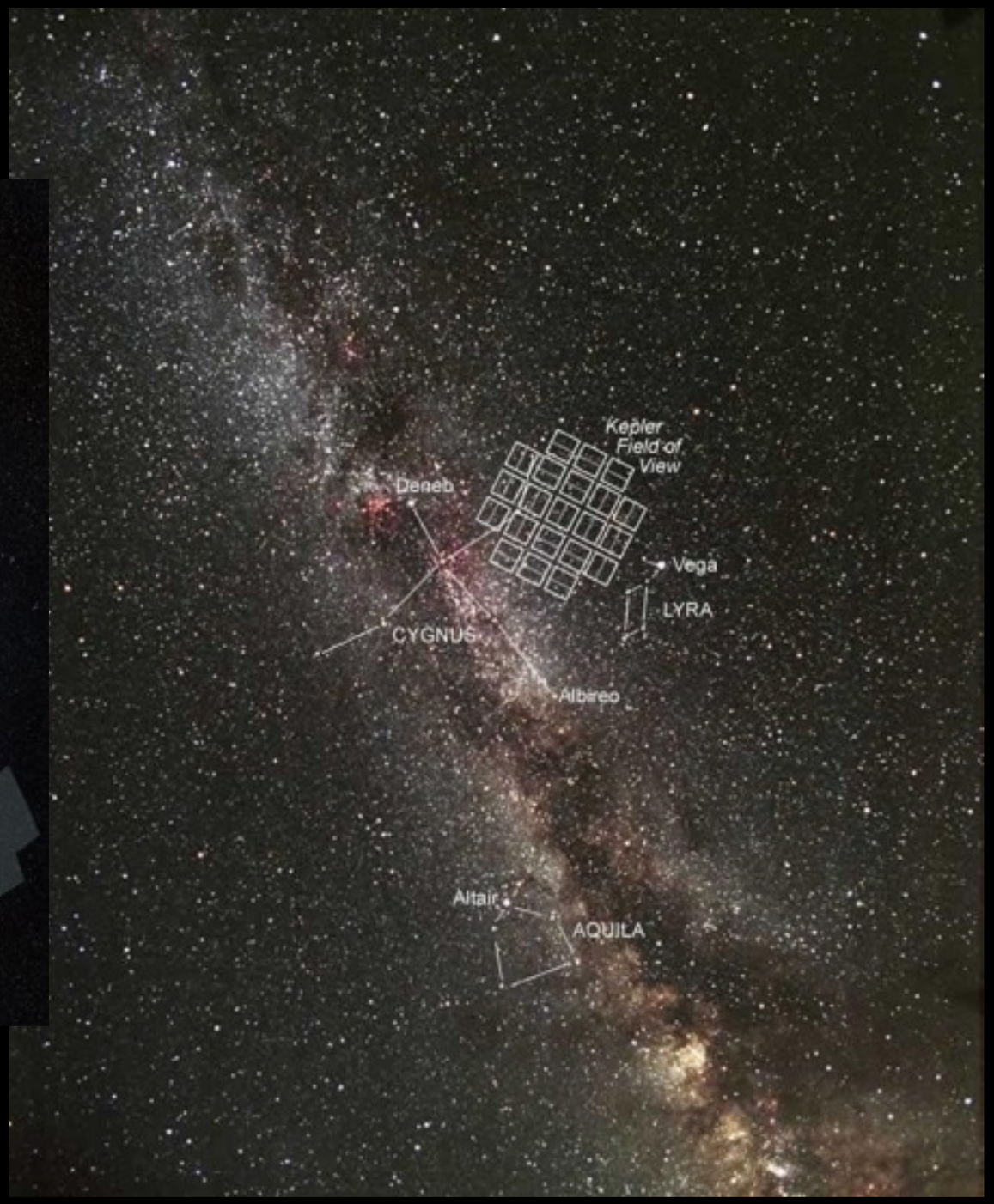
Christopher Theissen

How many exoplanets do we know about?



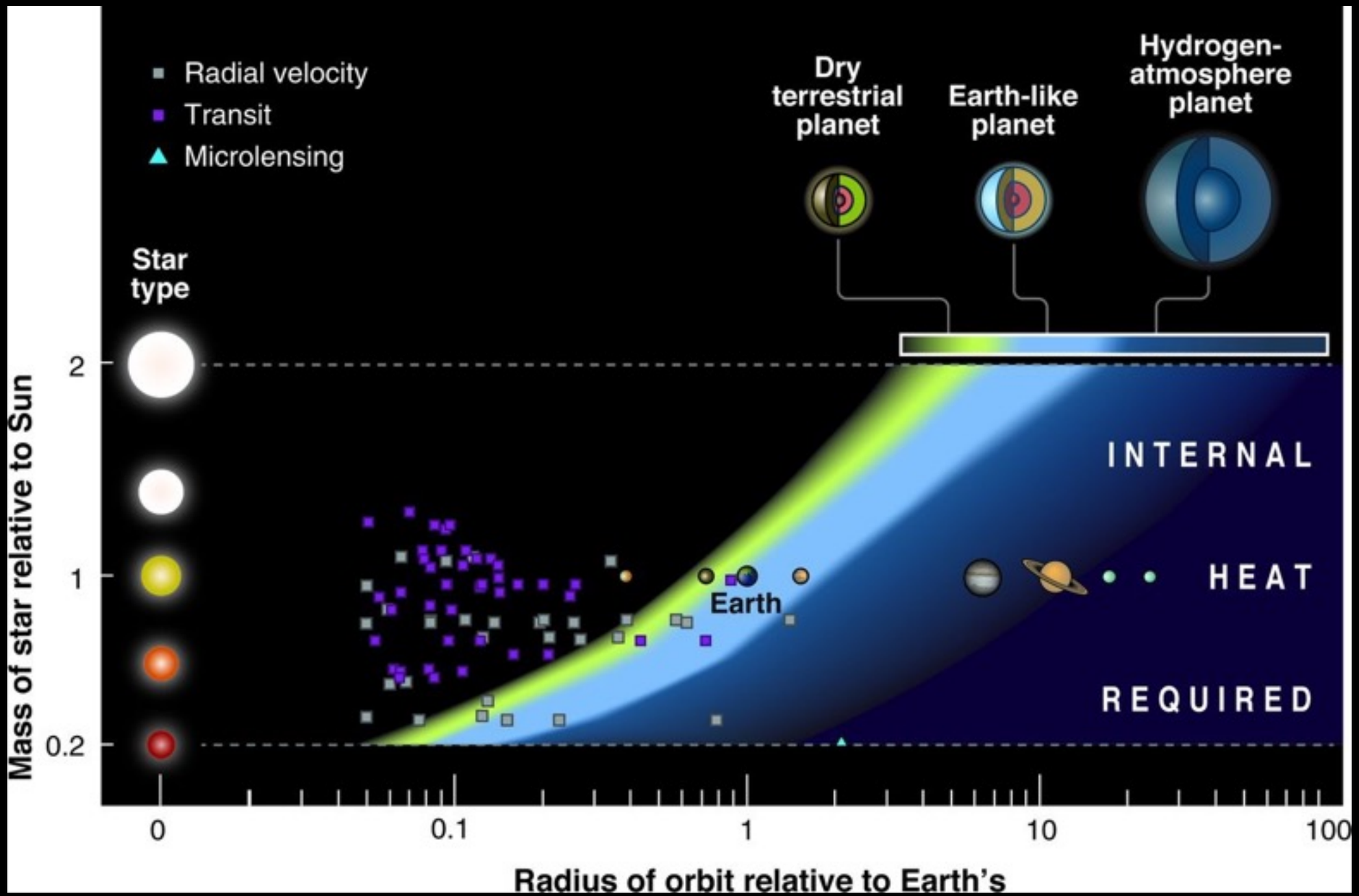
Kepler Space Telescope





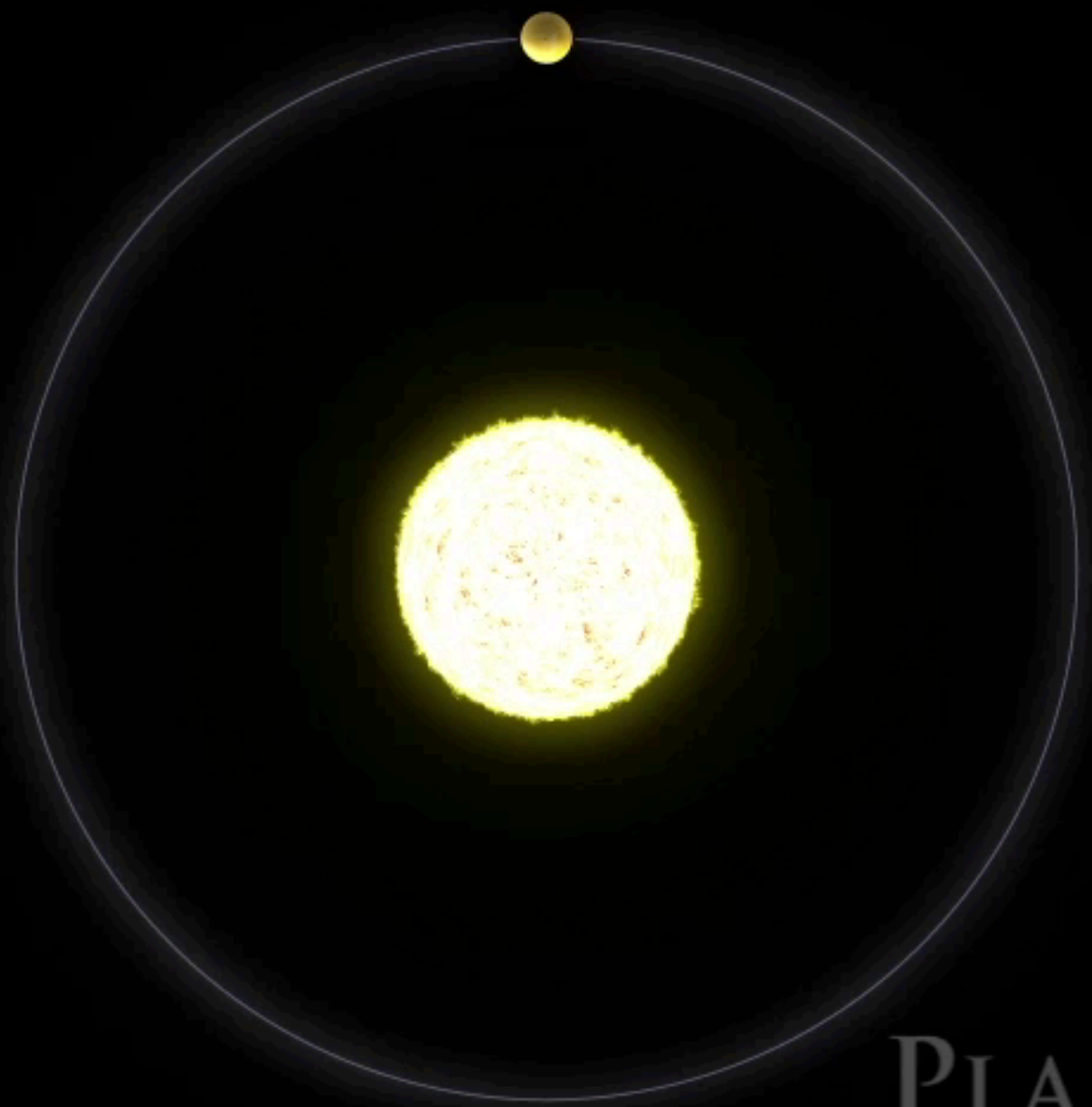
Credit: NASA

The “Habitable” Zone



Credit: Seager (2013)

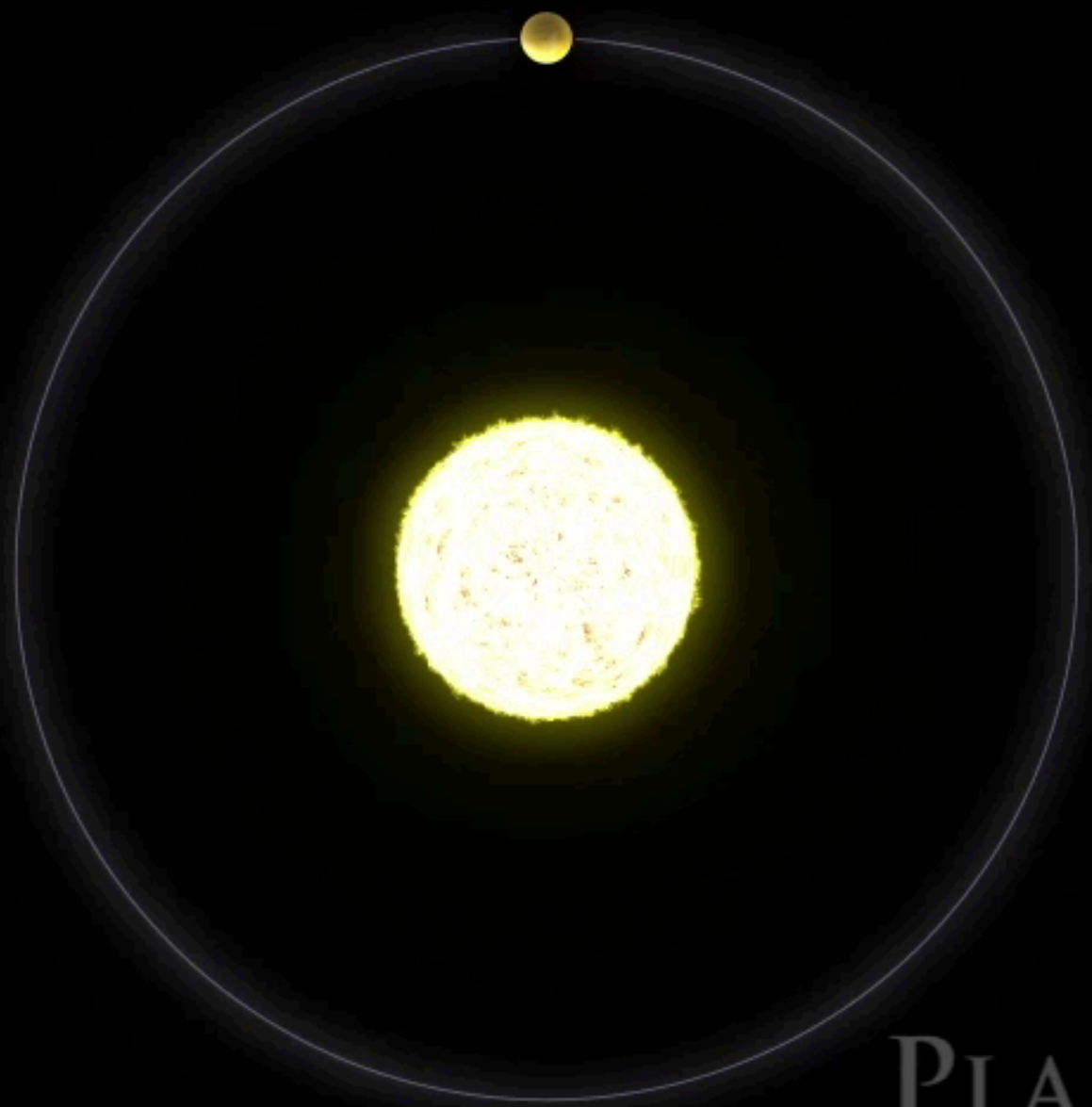
Finding Exoplanets: The Transit Method



PLANET QUEST
THE SEARCH FOR ANOTHER EARTH

Credit: NASA

Finding Exoplanets: The Transit Method



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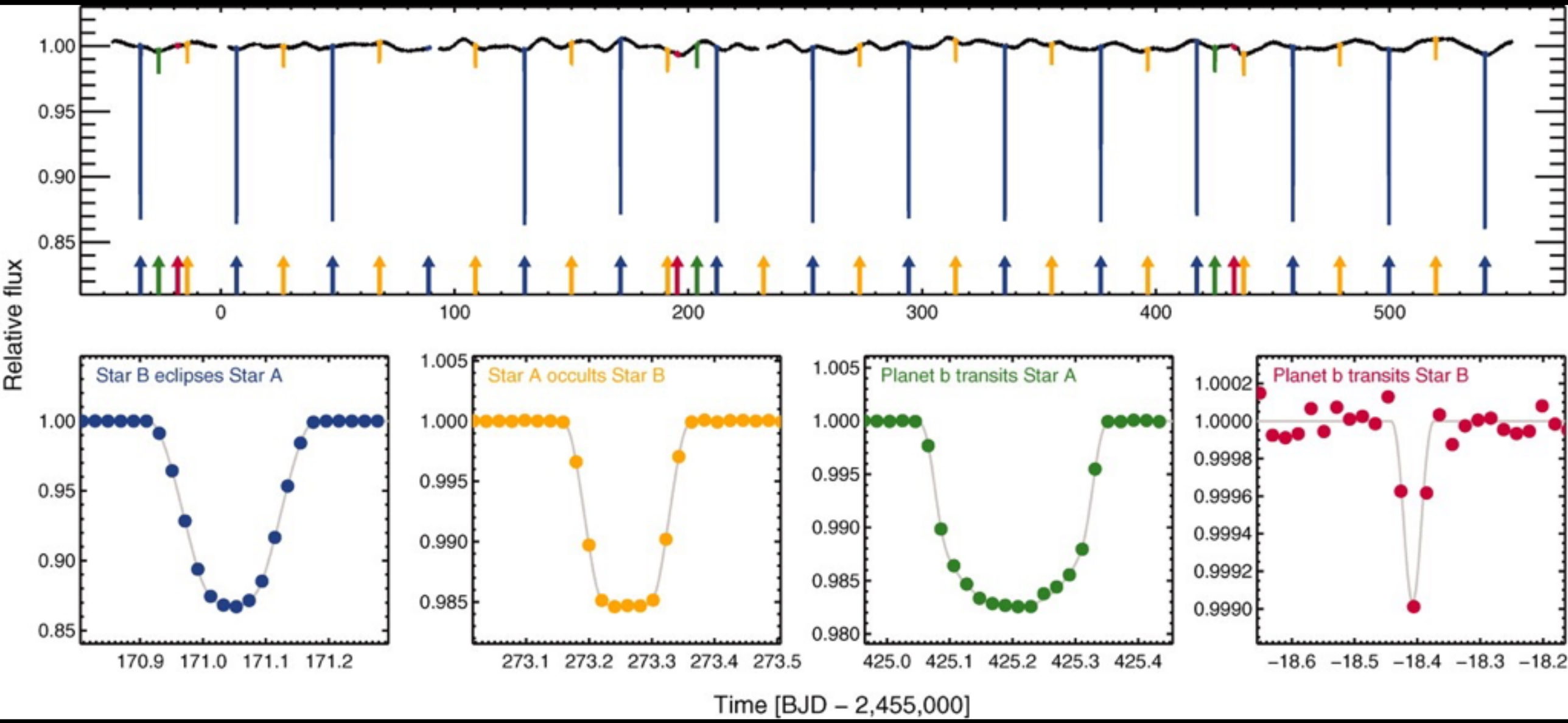
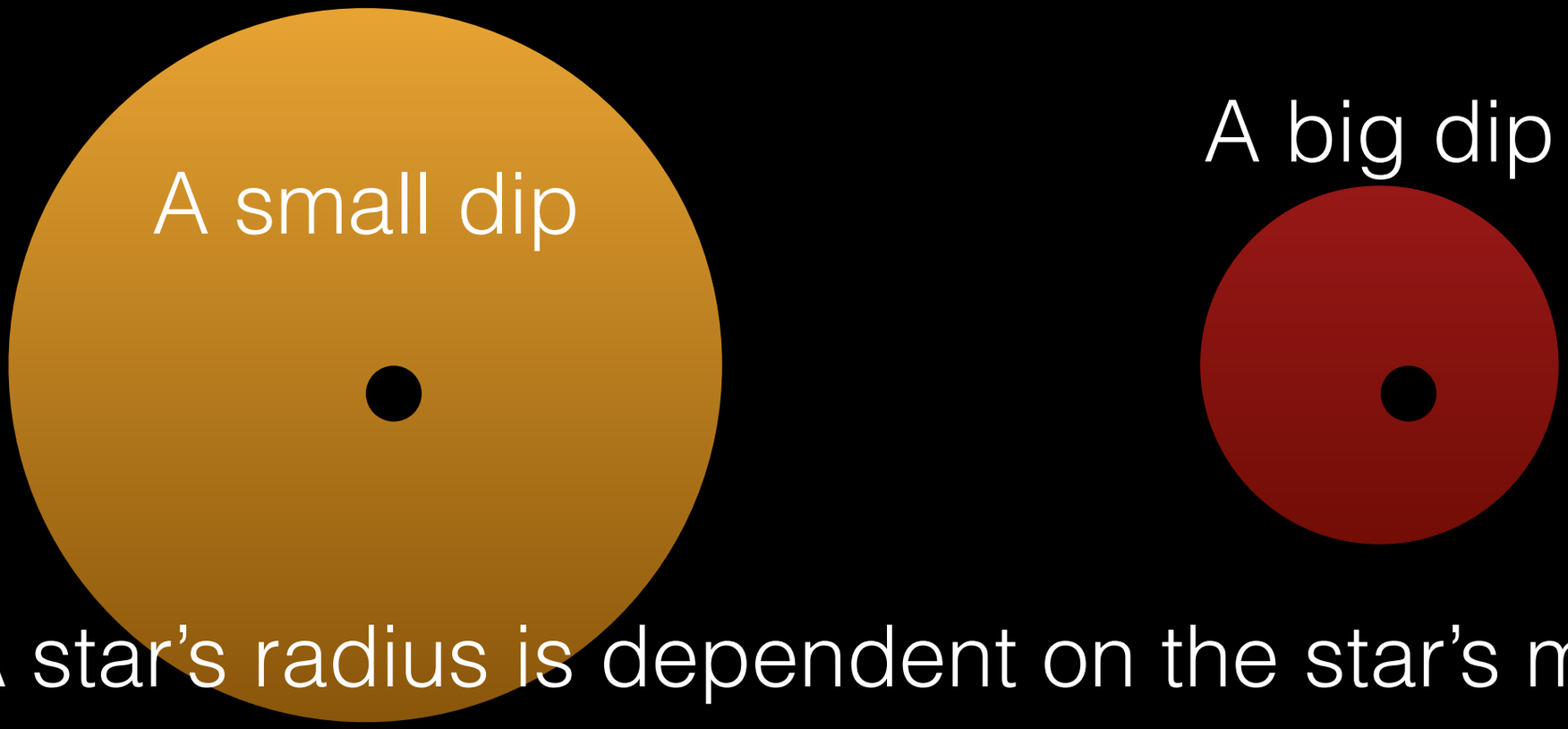
Kepler-16



Credit: Doyle et al. (2011)

Finding Exoplanets: The Transit Method

Planet finding sensitivity depends on the radius of the star and planet.



A star’s radius is dependent on the star’s mass

Finding Exoplanets: Measuring Radial Velocities

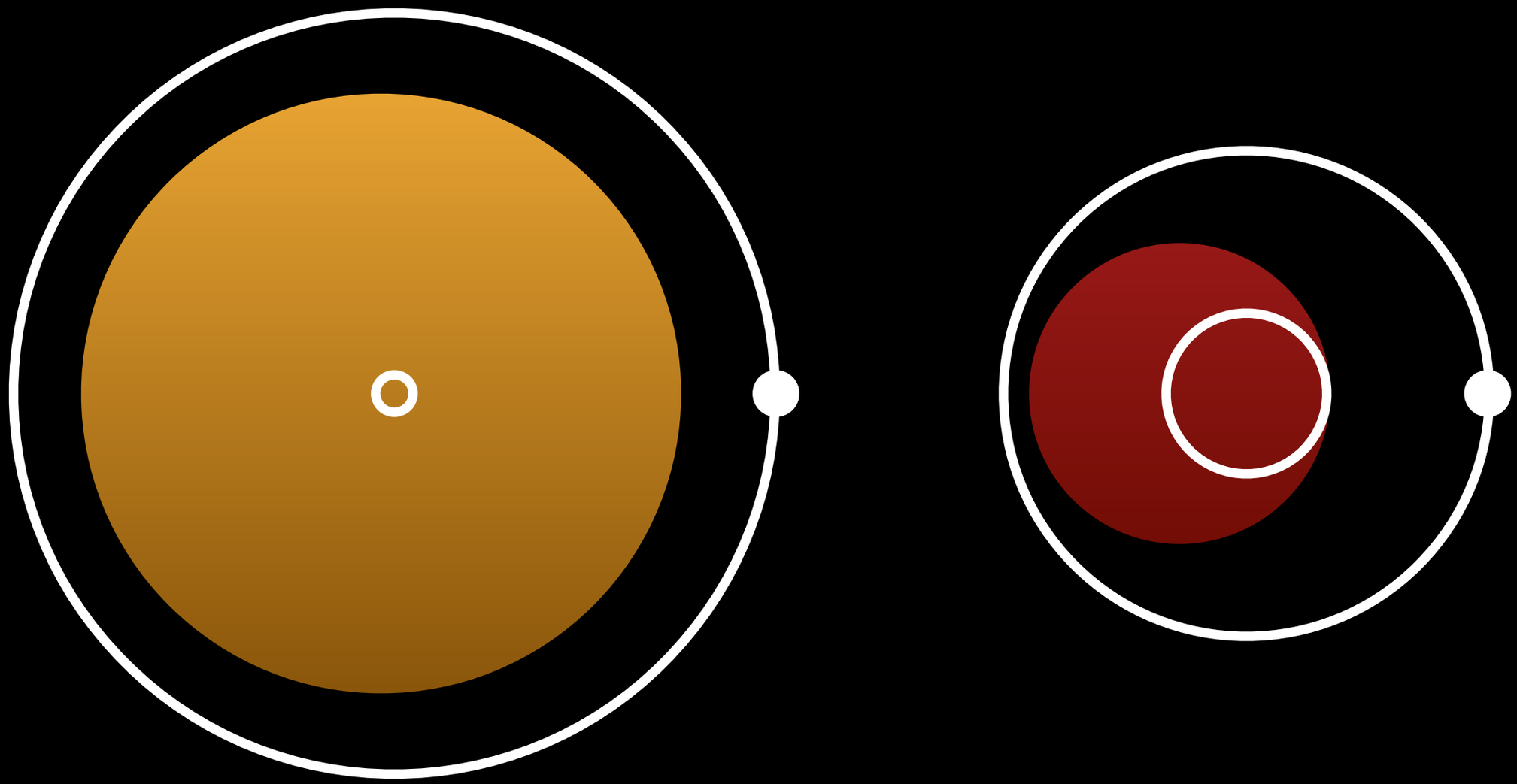
Credit: NASA

Finding Exoplanets: Measuring Radial Velocities

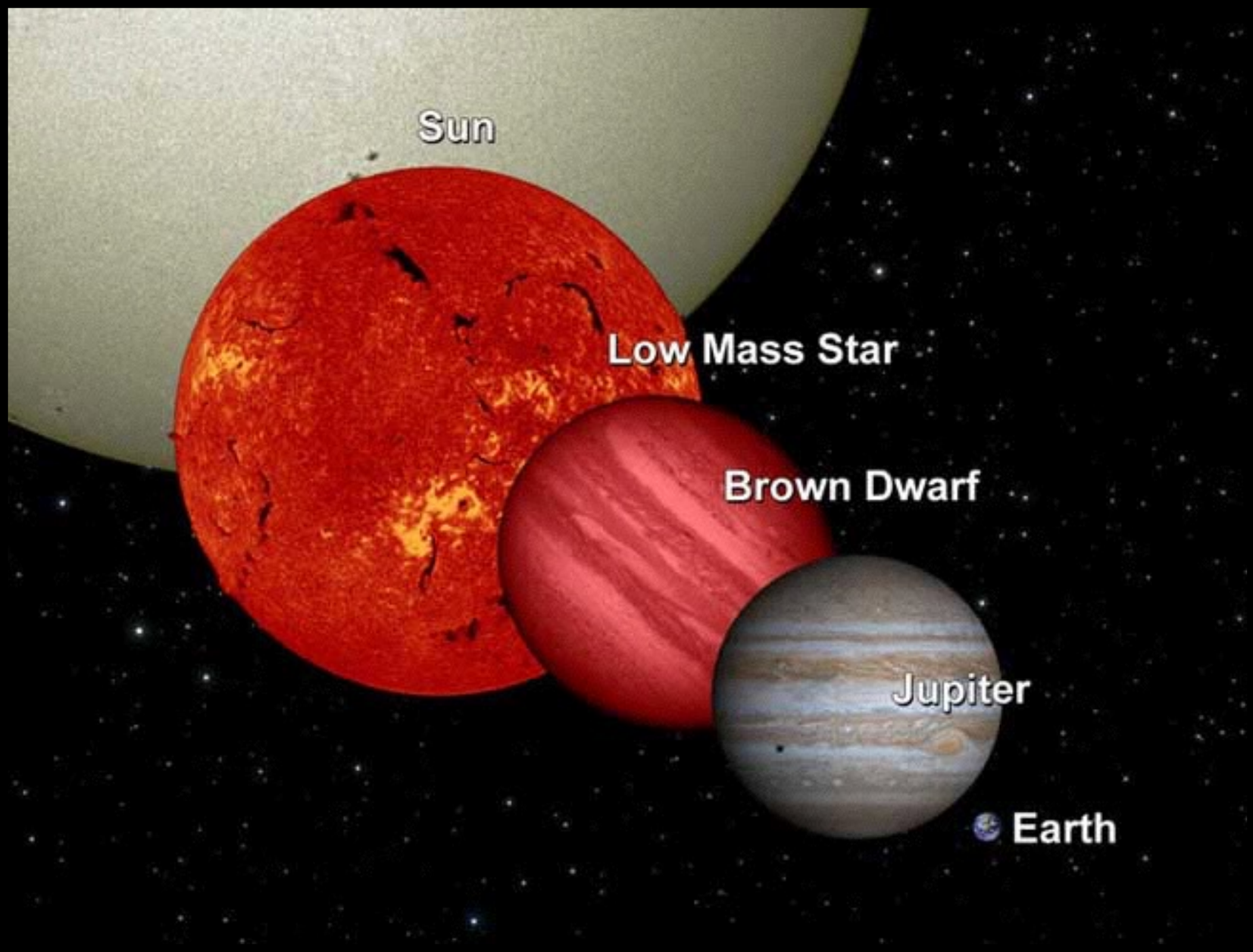
Credit: NASA

Finding Exoplanets: Measuring Radial Velocities

The magnitude of the wobble depends on the mass of the star



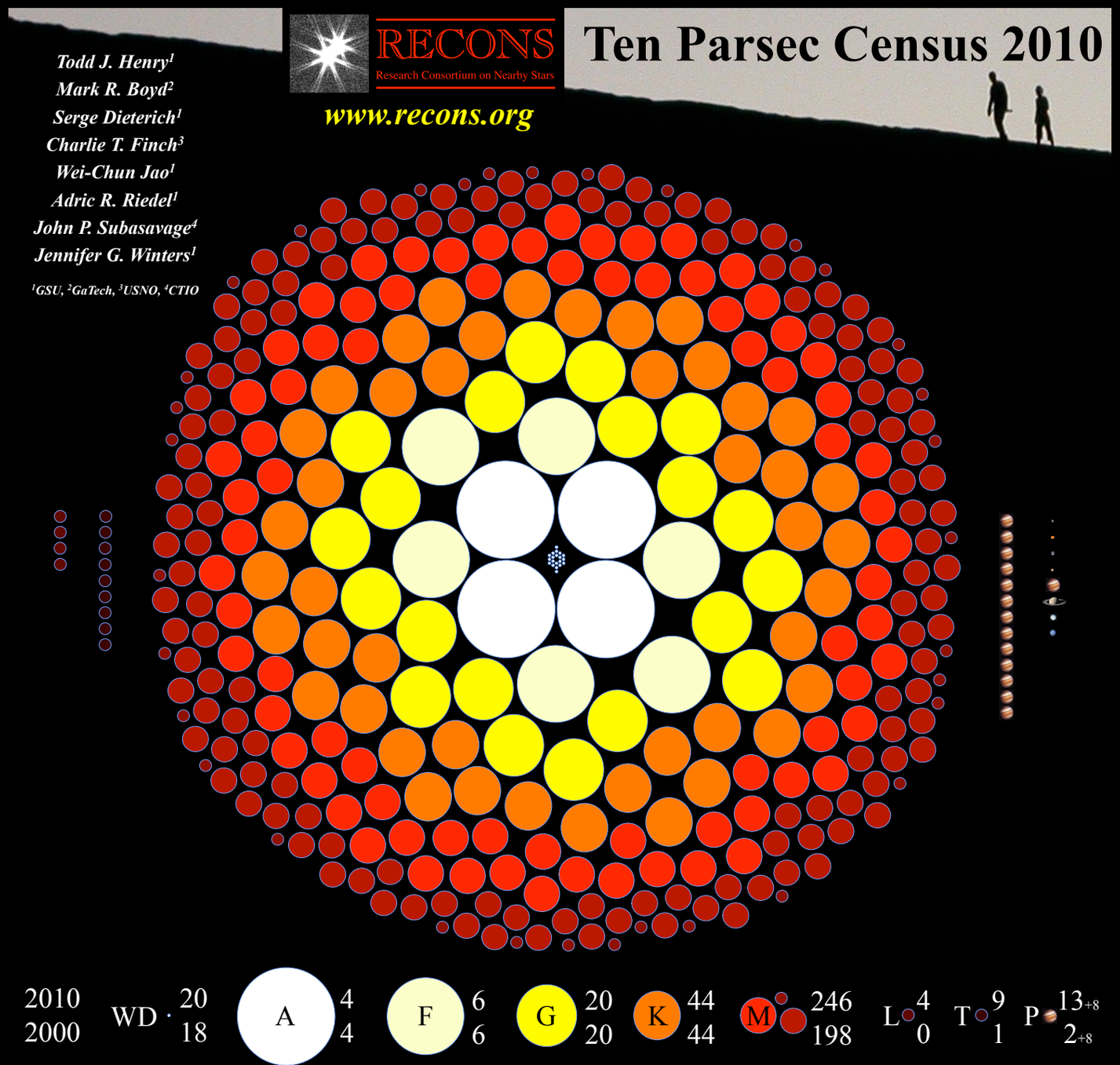
Low-mass Stars: A Primer



Credit: NASA

- Less than 60% the mass of the Sun
- Cool stars (Temperatures < 4600 K)
- Red dwarfs
- M dwarfs

Low-mass Stars are Everywhere



~70% of all stars
are low-mass stars

Credit: RECONS

Low-mass Stars are Everywhere (with Earth-sized Planets!)

Todd J. Henry[1]
Mark R. Boyd[2]
Serge Dieterich[1]
Charlie T. Finch[3]
Wei-Chun Jao[1]
Adric R. Riedel[1]
John P. Subasavage[4]

RECONS
Research Consortium on Nearby Stars
www.recons.org

Ten Parsec Census 2010

THE *KEPLER* DICHOTOMY AMONG THE M DWARFS: HALF OF SYSTEMS CONTAIN FIVE OR MORE COPLANAR PLANETS

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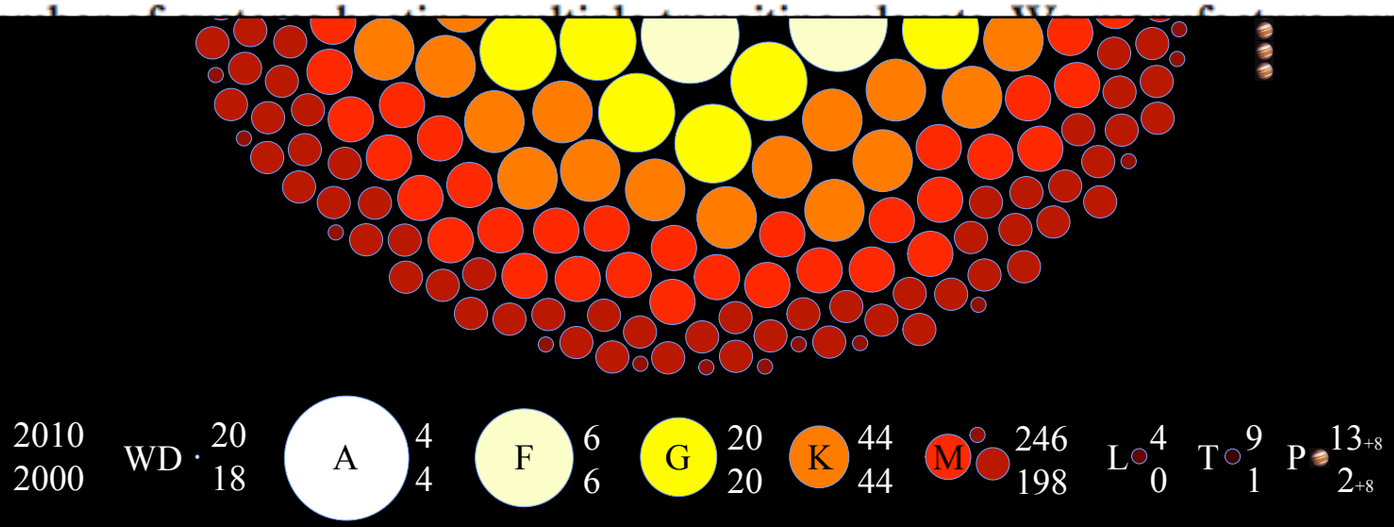
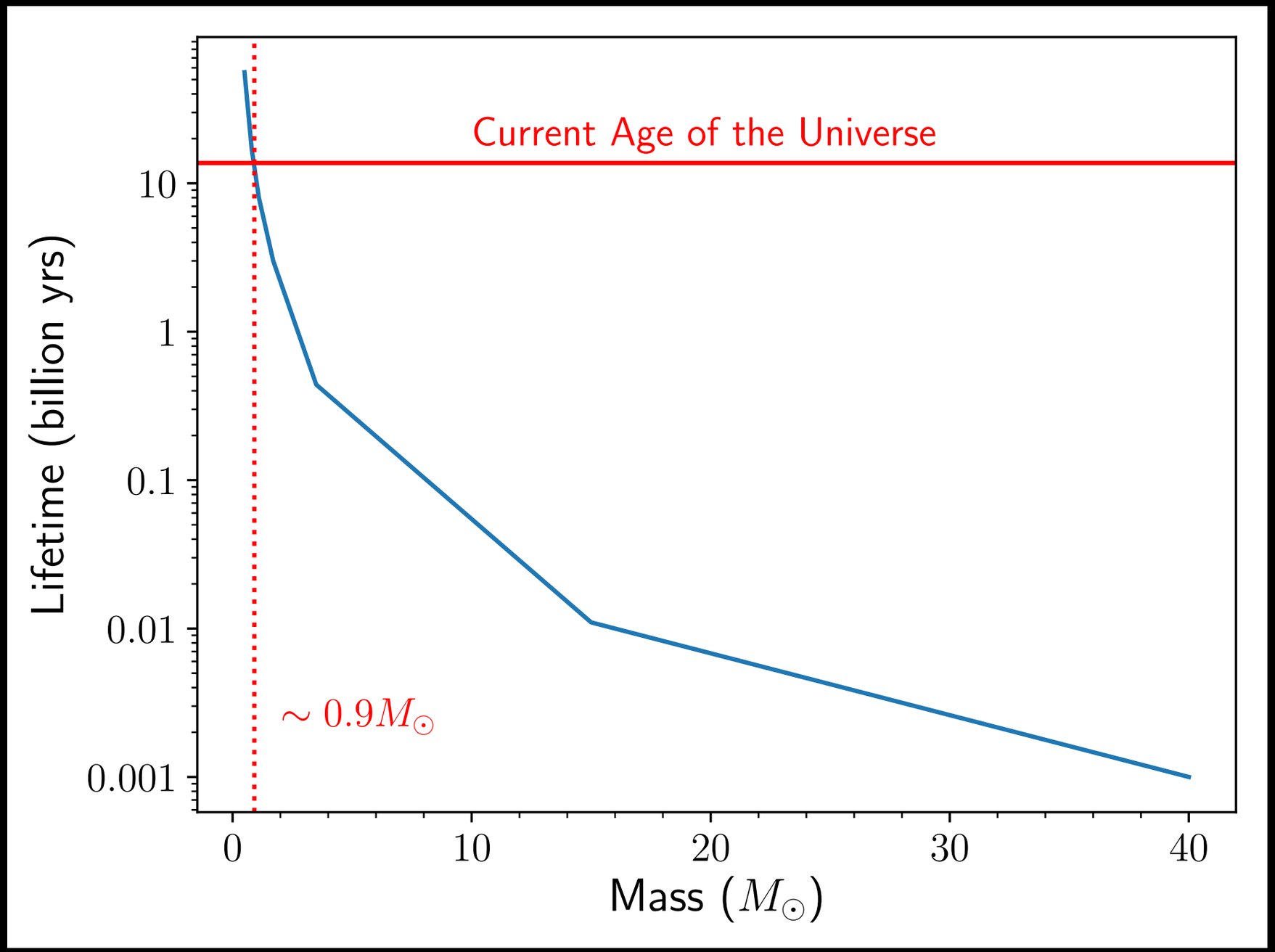
ABSTRACT

We present a statistical analysis of the *Kepler* M dwarf planet hosts, with a particular focus on the fractional



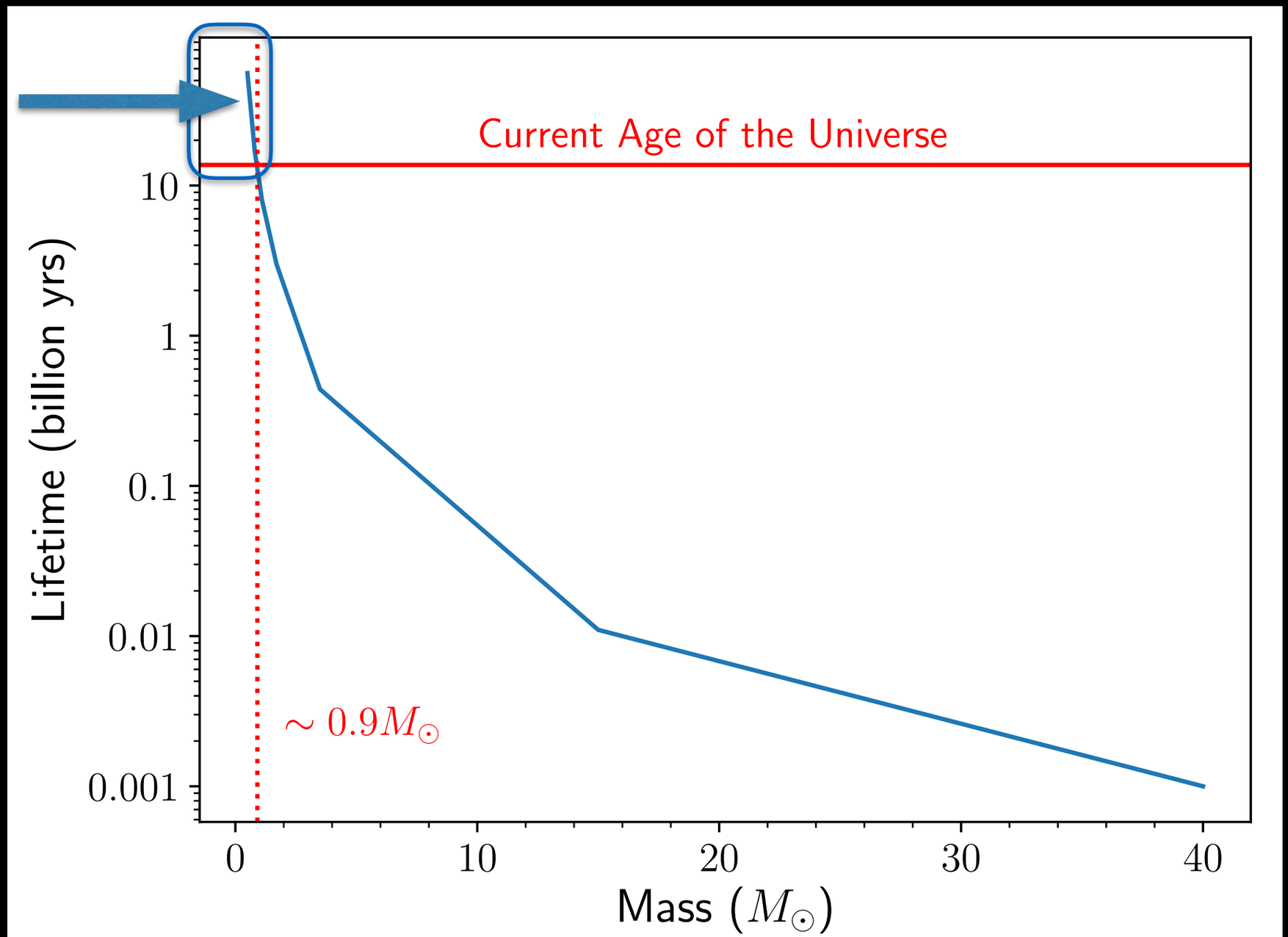
Credit: RECONS

They have incredibly long (hydrogen burning) lifetimes

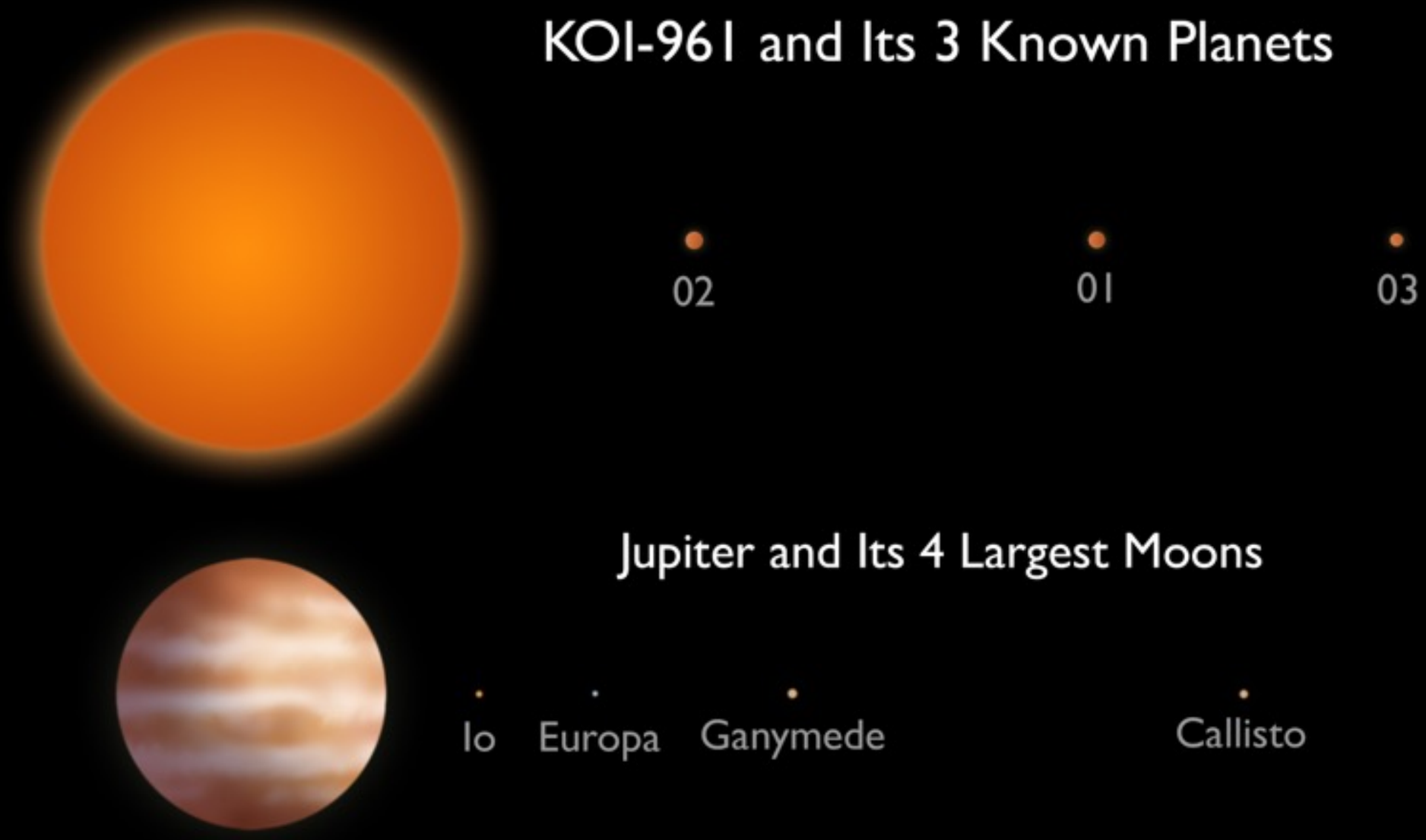


They have incredibly long (hydrogen burning) lifetimes

Low-mass stars live here

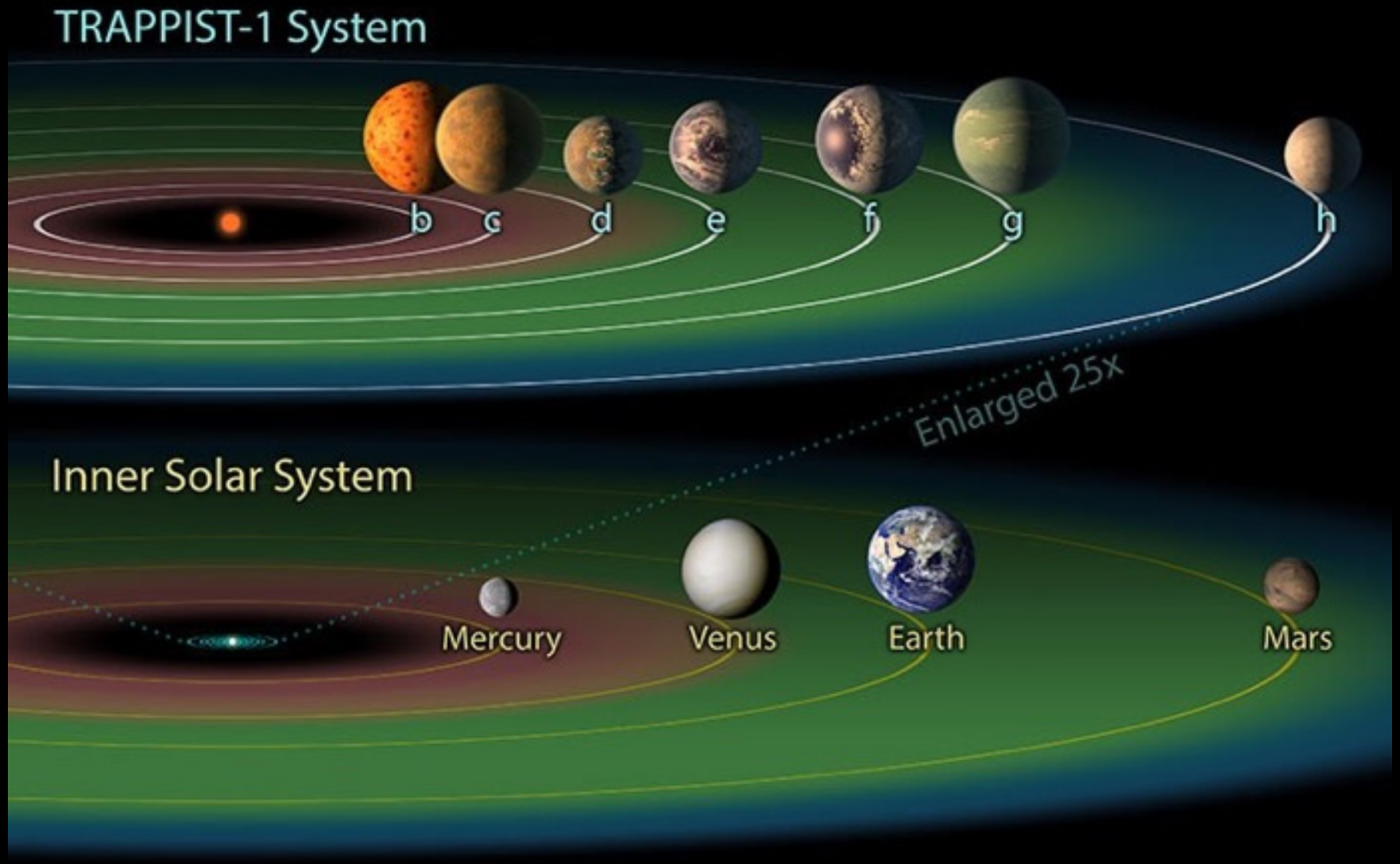


Planets orbit close-in



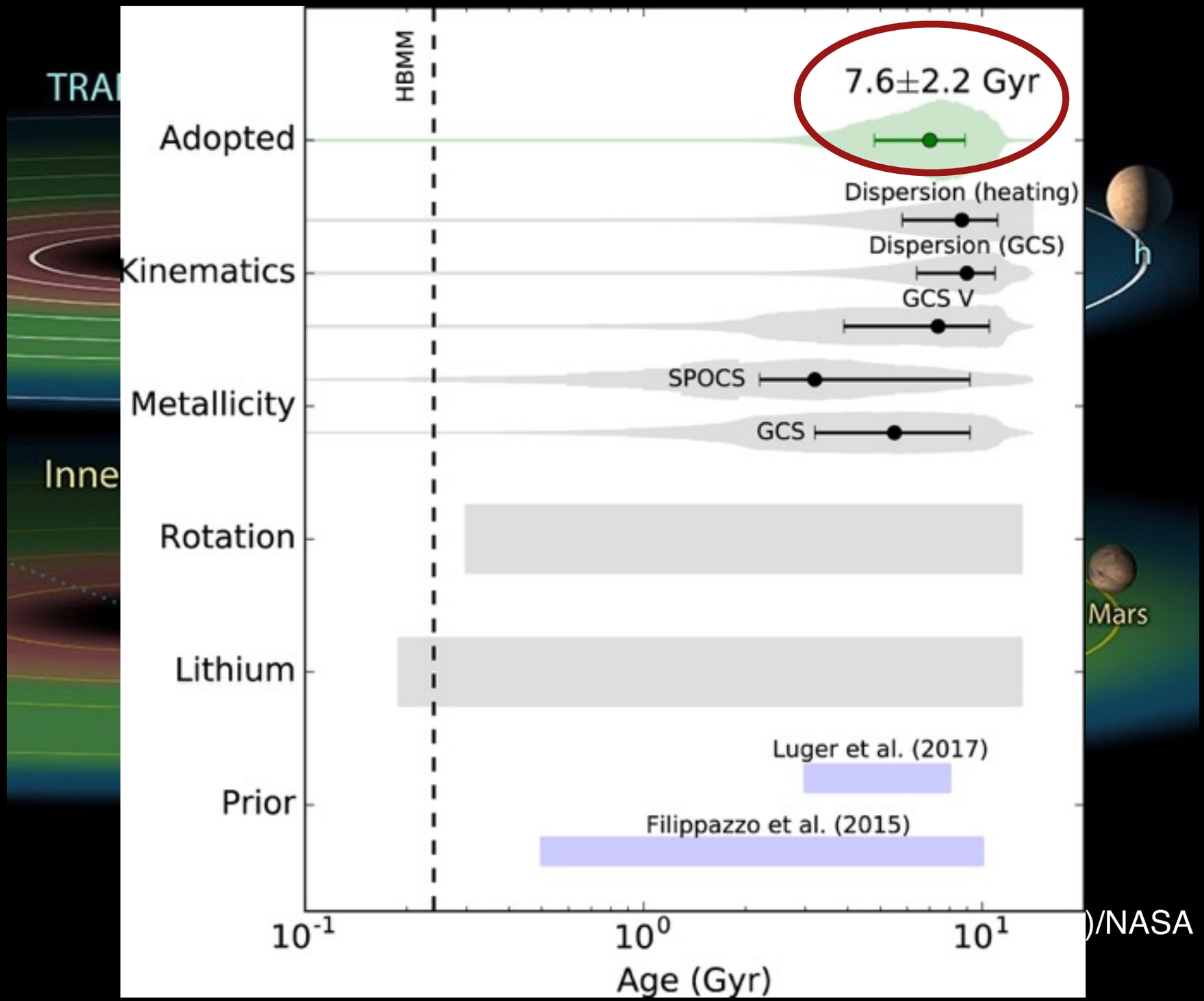
Credit: Muirhead et al. (2012)/NASA

Planets orbit close-in



Credit: Gillon et al. (2016, 2017)/NASA

Planets orbit close-in



Credit: Burgasser & Mamajek (2017)

Let’s run the numbers

~300,000,000,000 M dwarfs in the Galaxy

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~2.5 planets per star (many in the habitable zone)

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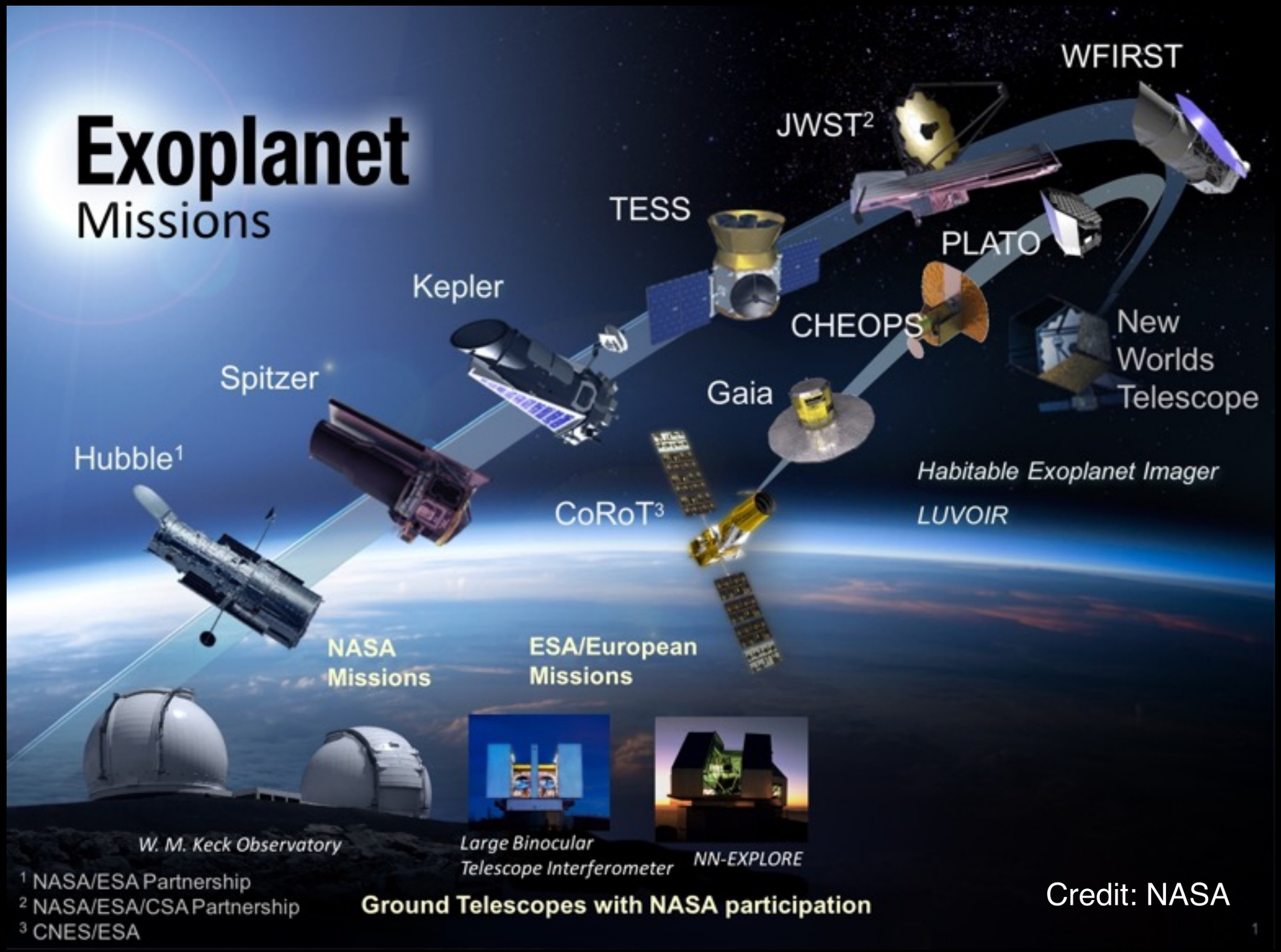
~2.5 planets per star (many in the habitable zone)

~ 750 billion (750,000,000,000)
potentially Earth-like planets in our Galaxy!

Just around low-mass stars!

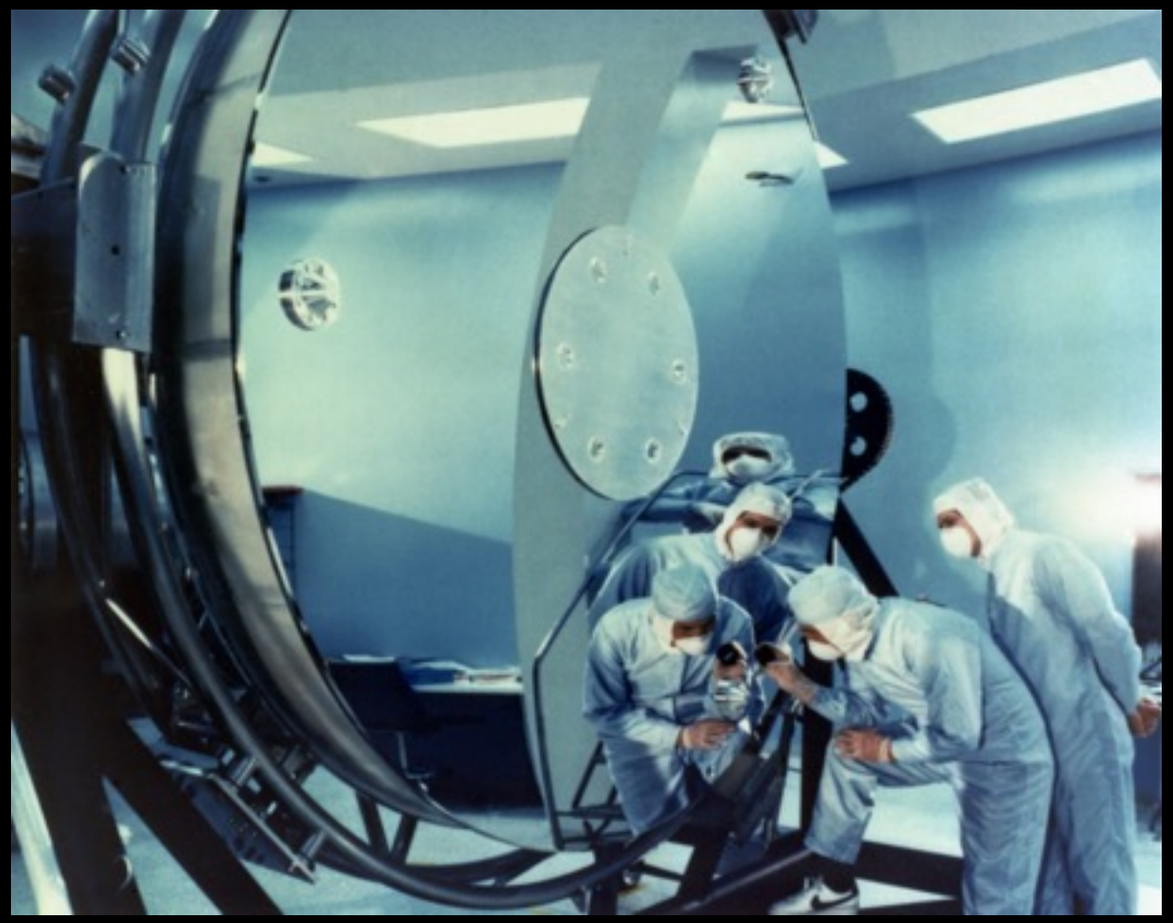
Looking to the future



Credit: NASA

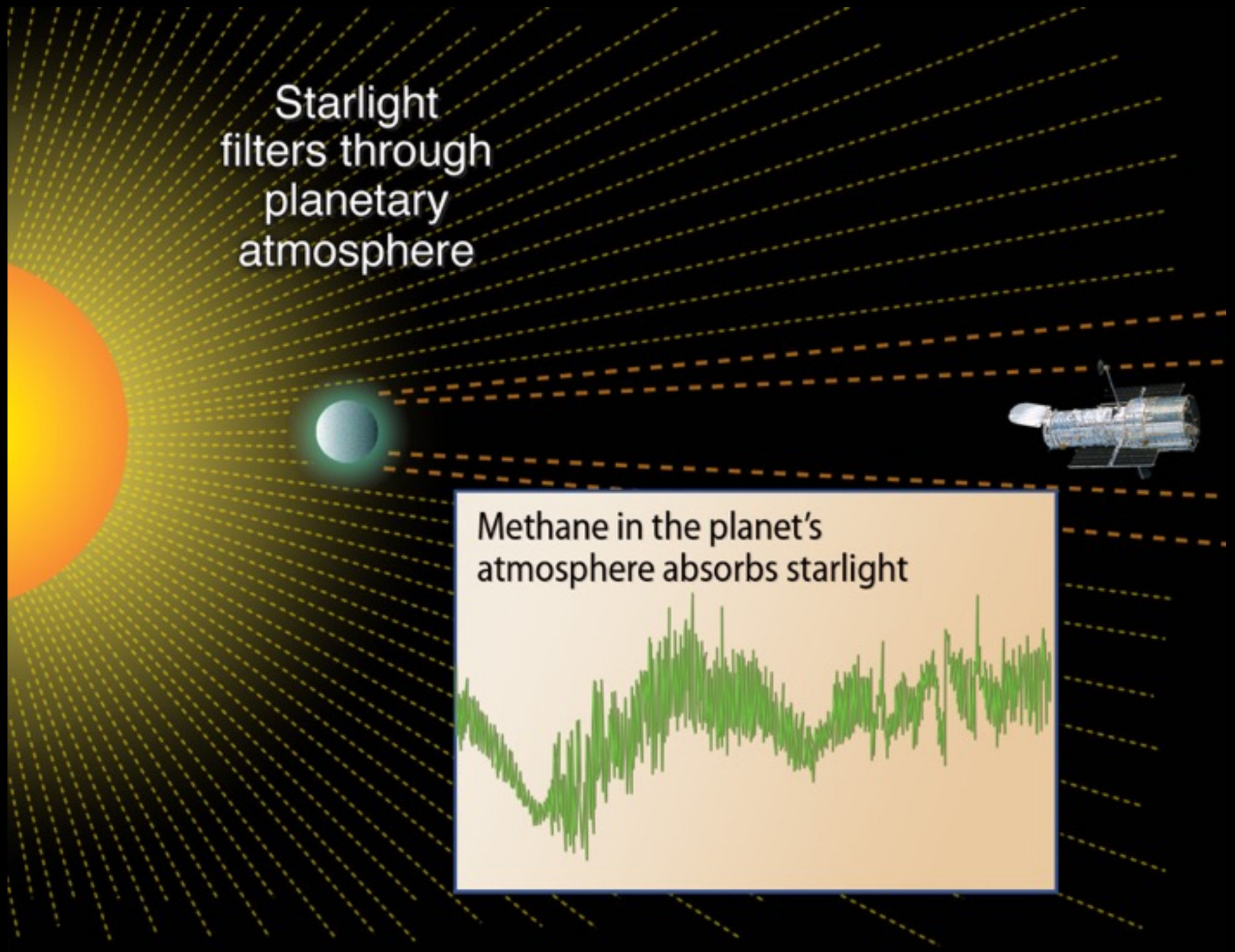
JWST

Hubble mirror



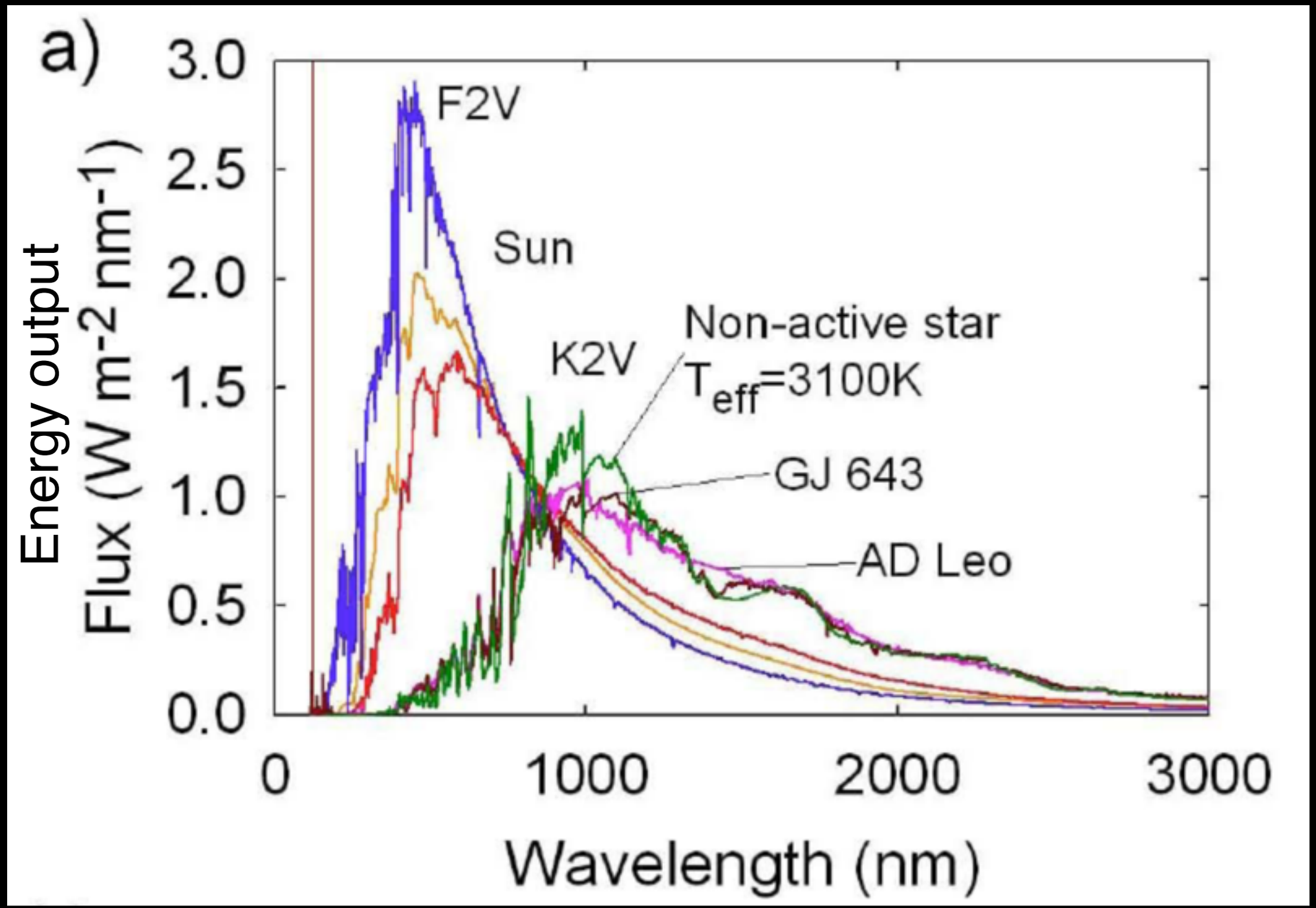
Credit: NASA

Biosignatures



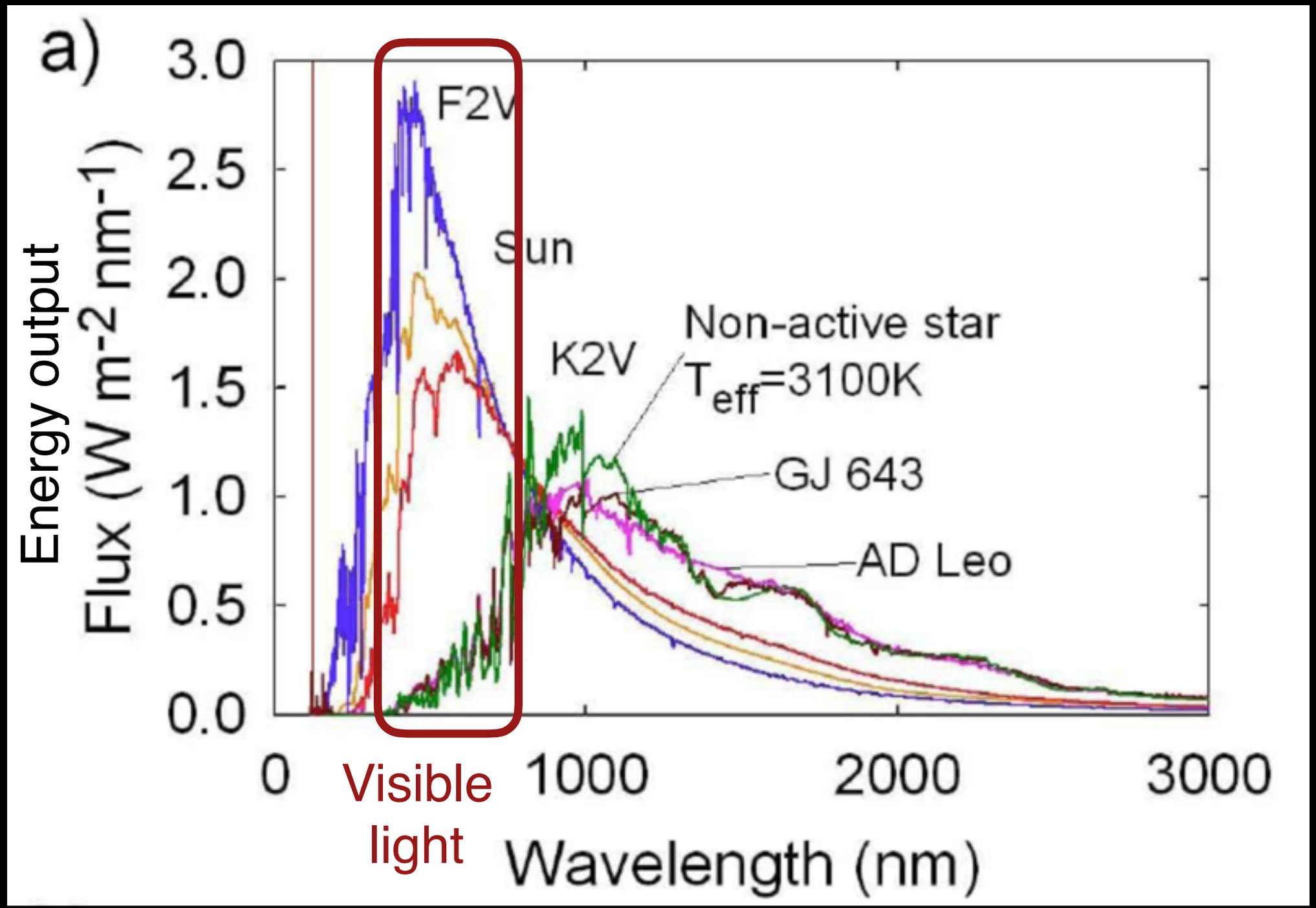
Credit: NASA/ESA

Complications: Energy Output



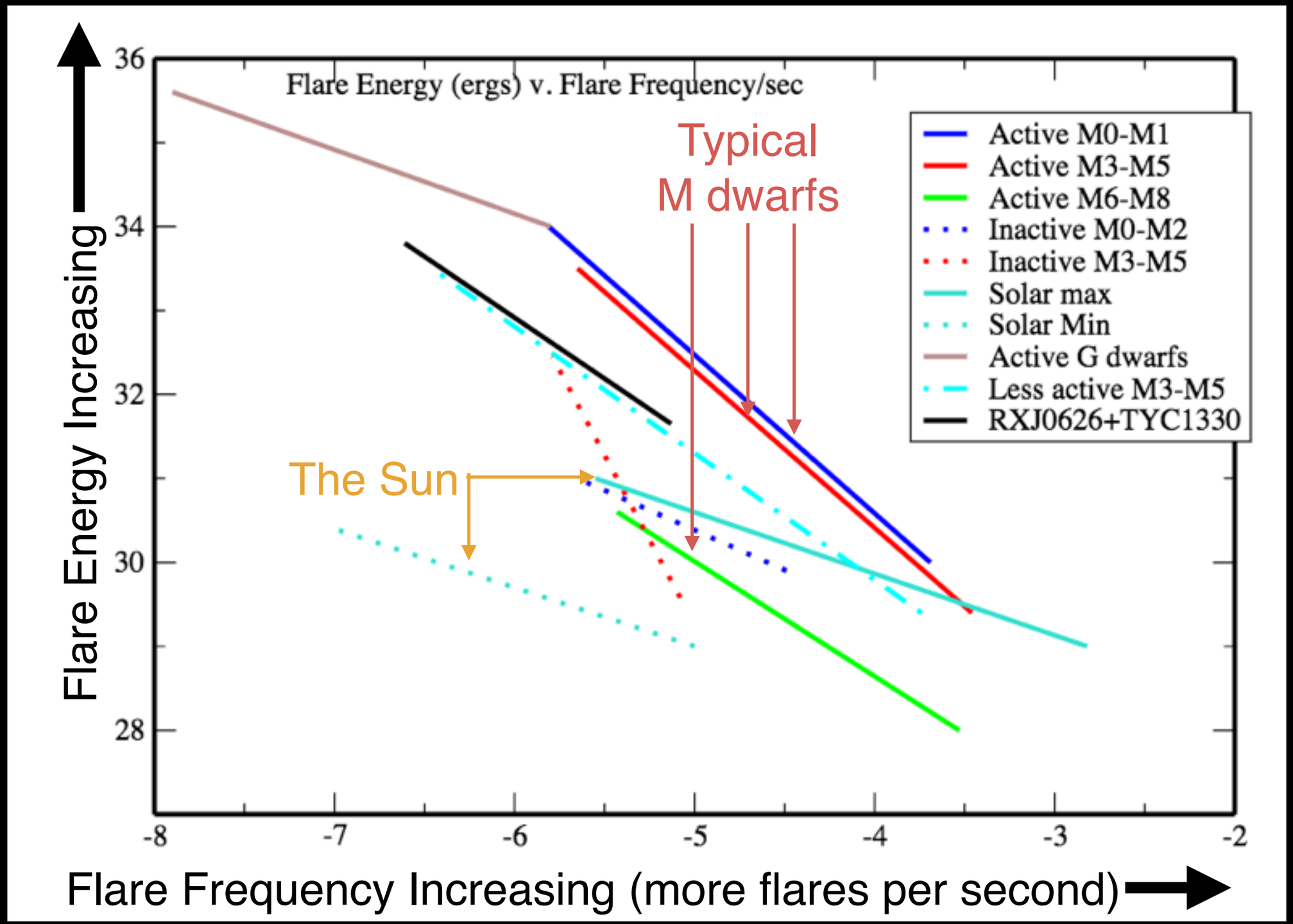
Credit: Segura et al. (2016)

Complications: Energy Output



Credit: Segura et al. (2016)

Complications: Flares



Credit: Drake et al. (2016)

Complications: Planetary Collisions

Collisions of Terrestrial Worlds: The Occurrence of Extreme Mid-infrared Excesses around Low-mass Field Stars

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Abstract

We present the results of an investigation into the occurrence and properties (stellar age and mass trends) of low-mass field stars exhibiting extreme mid-infrared (MIR) excesses ($L_{IR}/L_* \geq 0.01$). Stars for the analysis were

Credit: Theissen & West (2016)

Similar to the Moon forming event

Let’s not stop looking for life around low-mass stars just yet.

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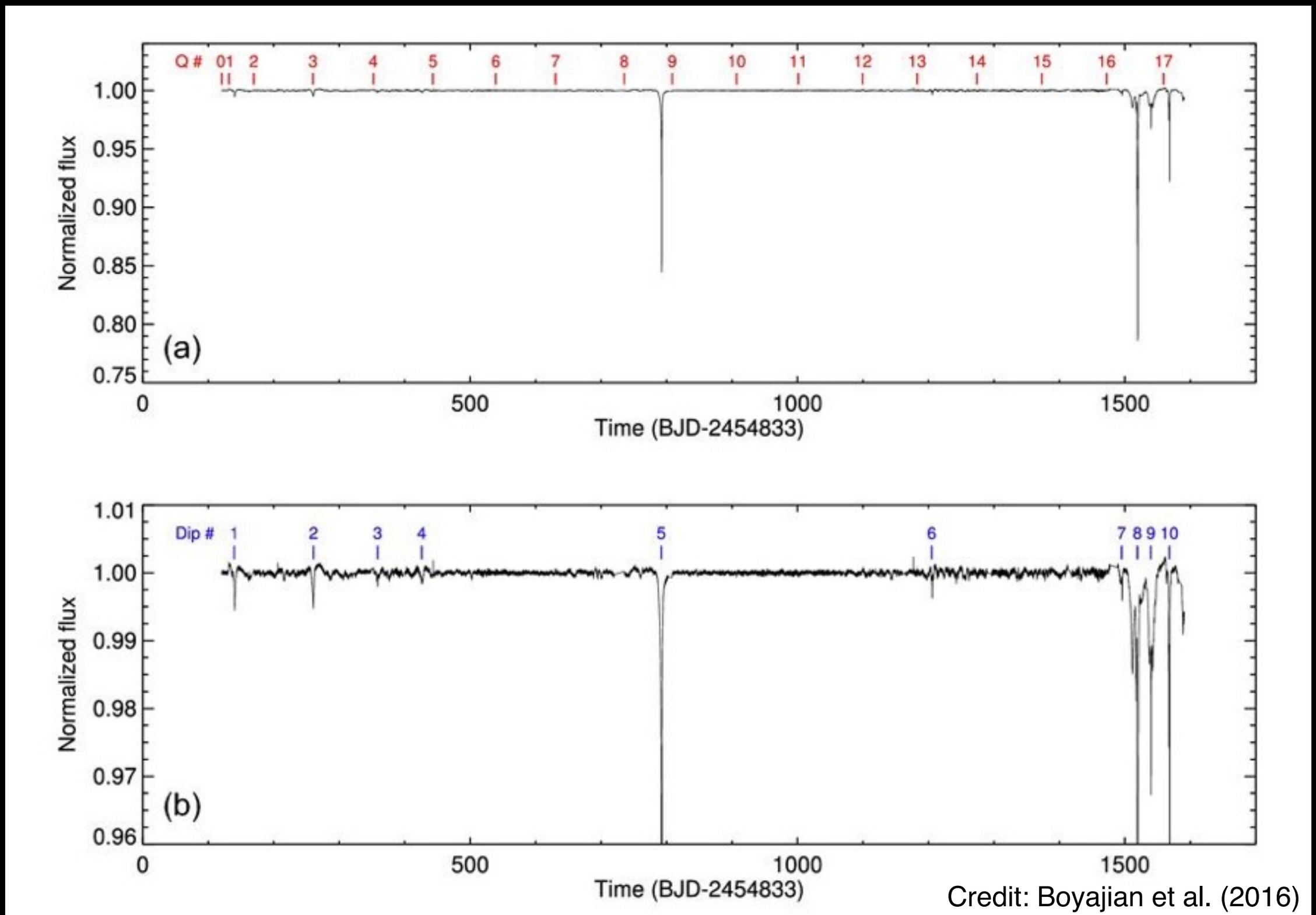
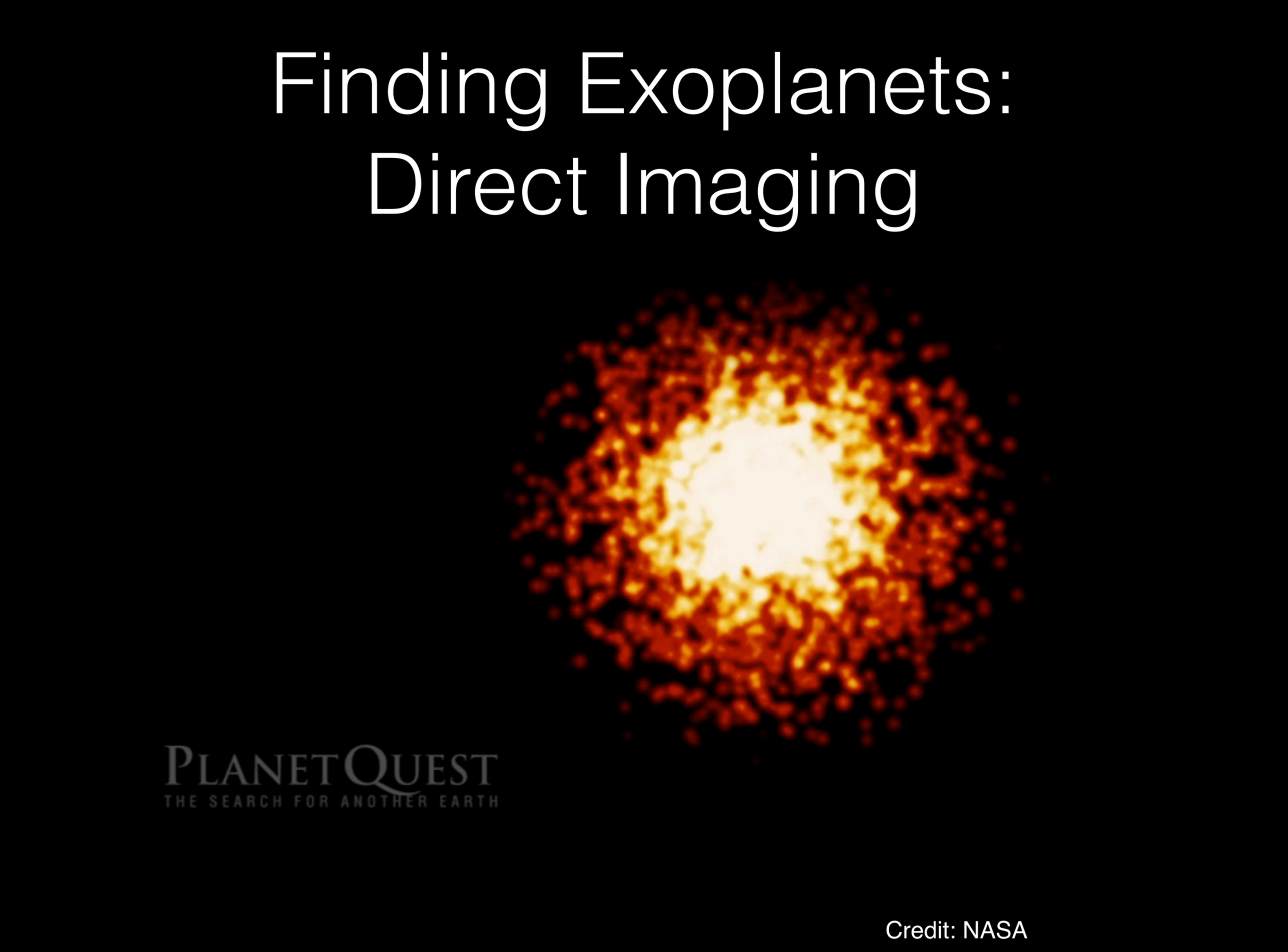
Thanks

Tabby's Star



Credit: Boyajian et al. (2016)

Finding Exoplanets: Direct Imaging



Credit: NASA

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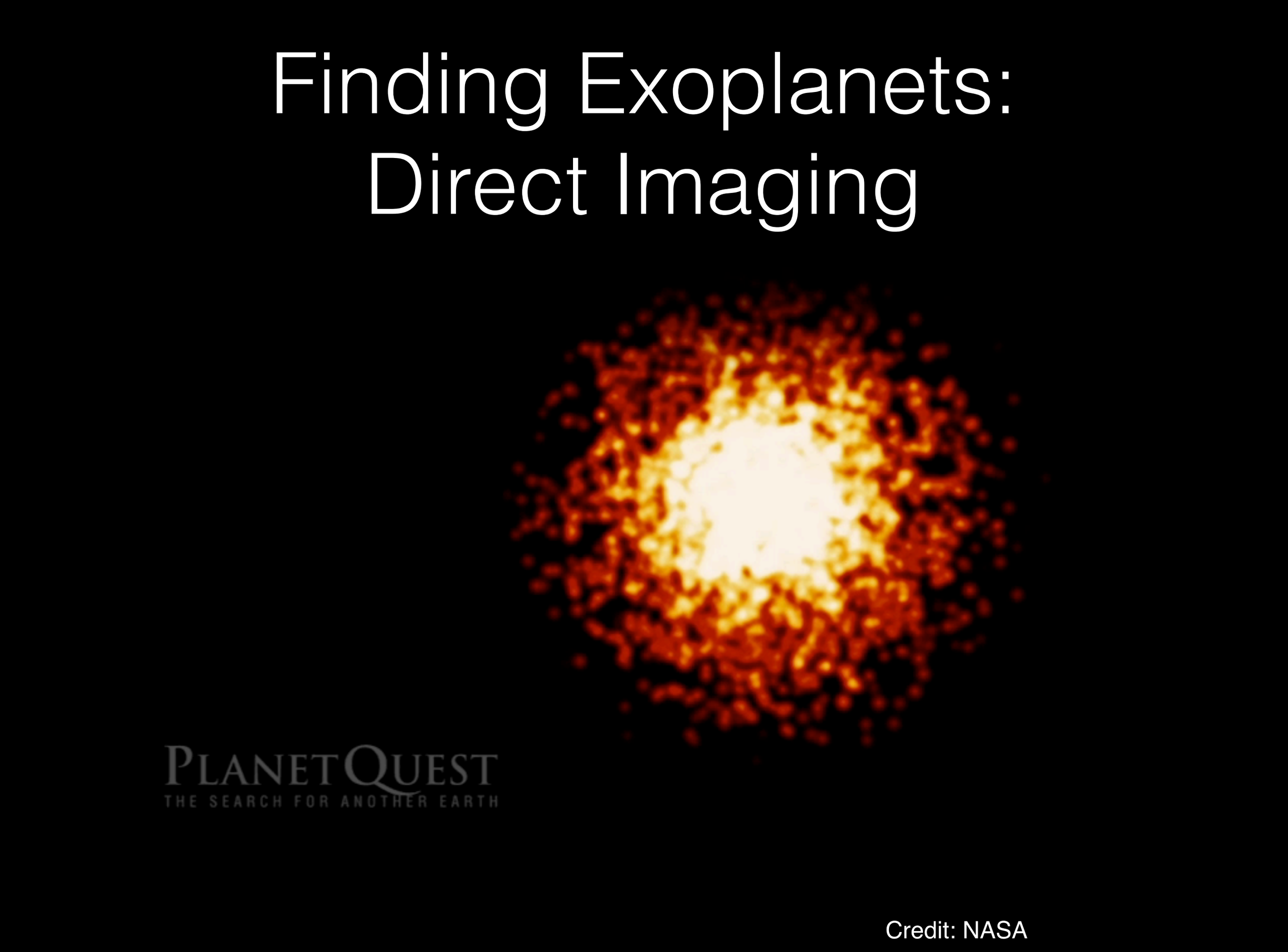
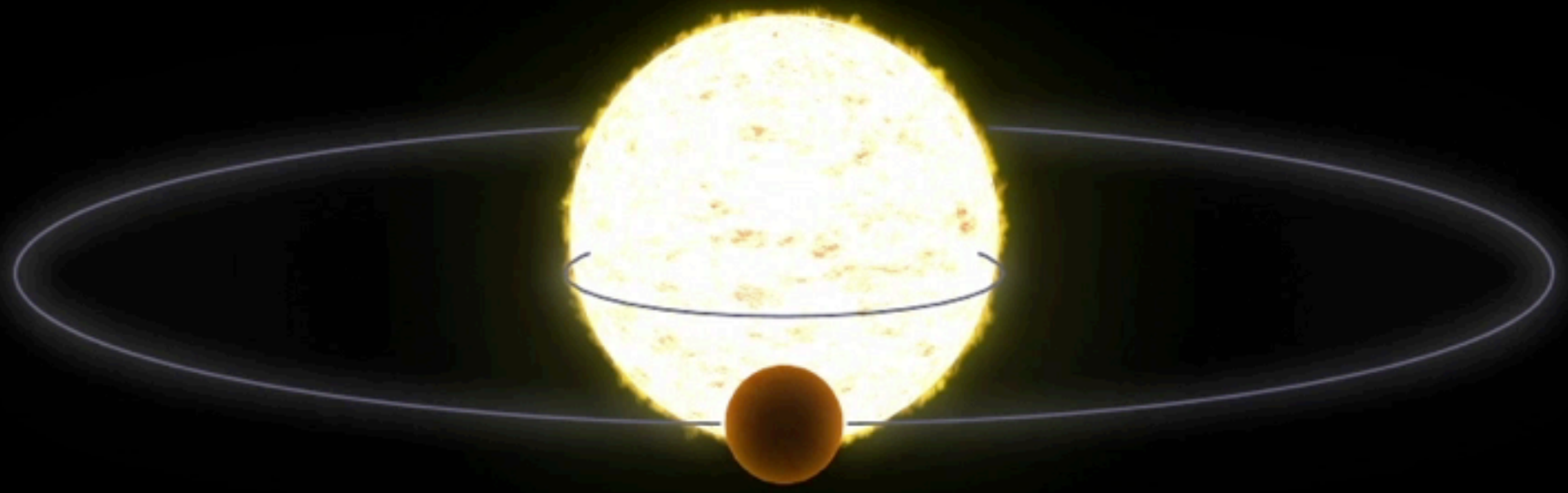


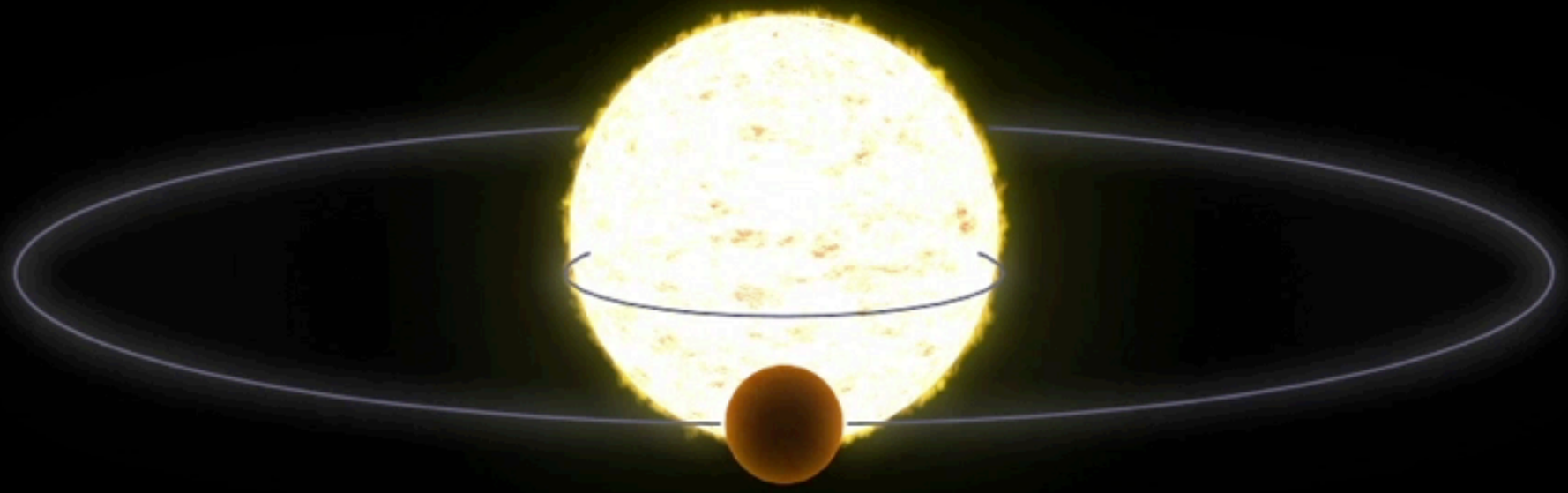
Credit: NASA

Finding Exoplanets: Astrometry



Credit: NASA

Finding Exoplanets: Astrometry



Credit: NASA

Finding Exoplanets: Microlensing

PLANET QUEST
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Finding Exoplanets: Microlensing

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Credit: NASA

Transit Timing Variations

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