Hunting for habitable worlds

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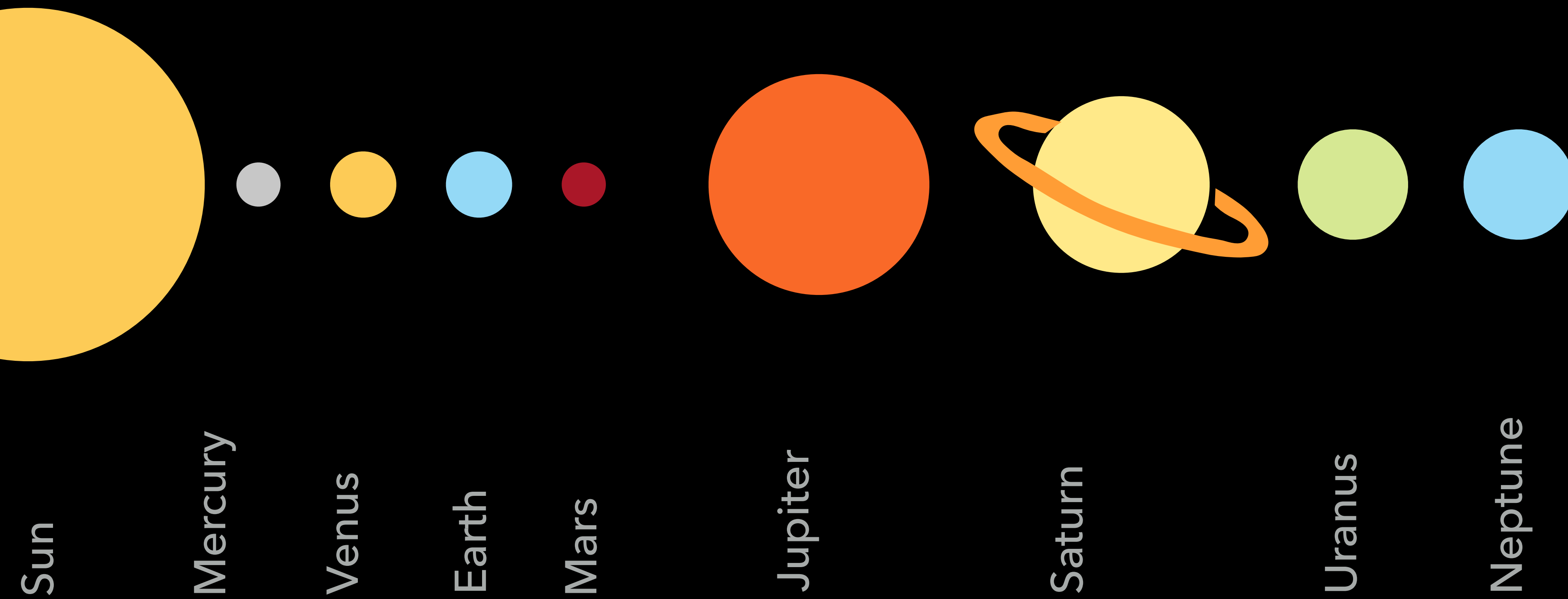
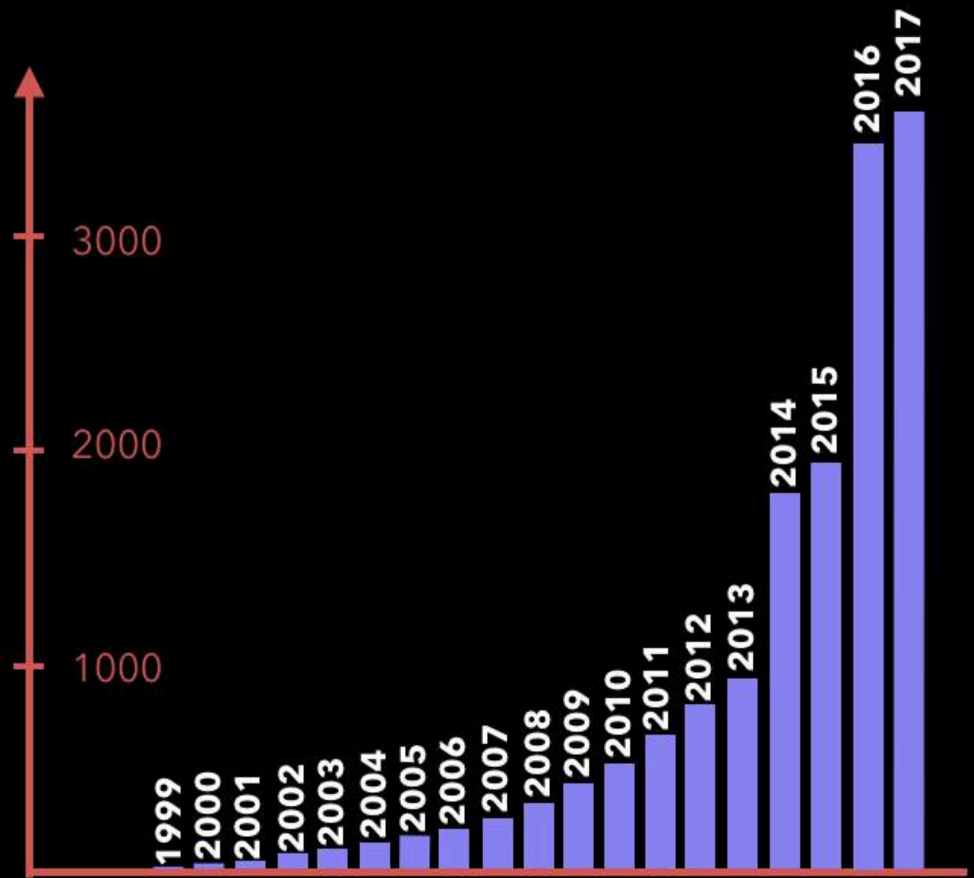


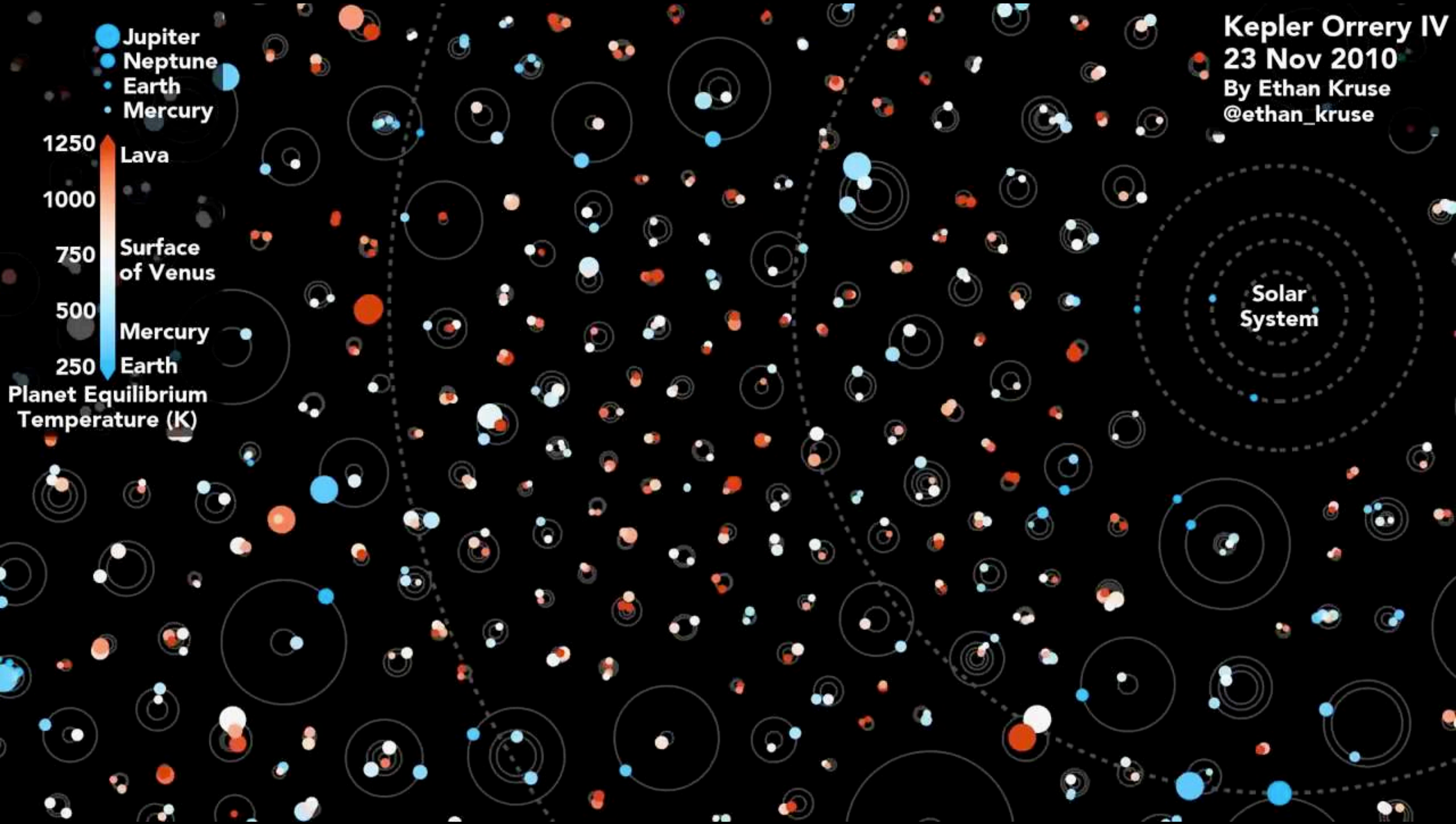
Sun
Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune



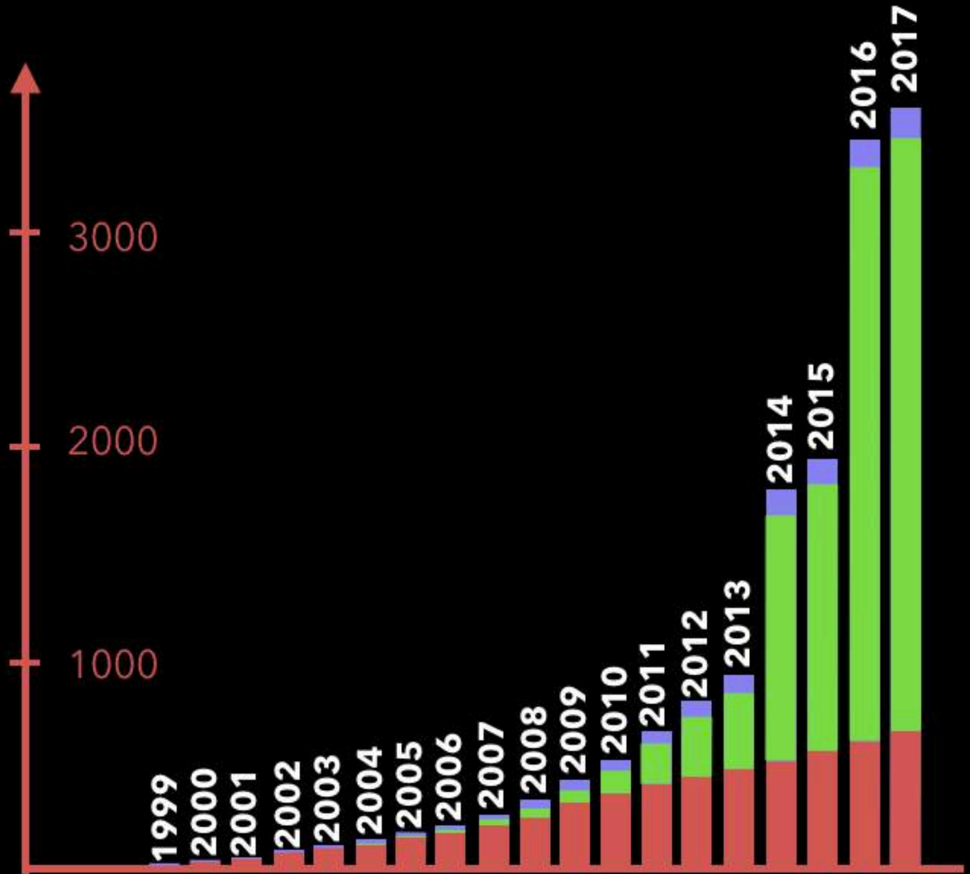
https://exoplanetarchive.ipac.caltech.edu

We now know of thousands of exoplanets:

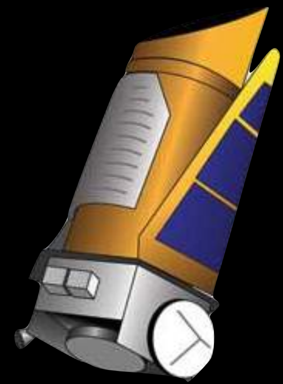
Planets that orbit stars beyond the Sun.



Could any of these new worlds be habitable?



https://exoplanetarchive.ipac.caltech.edu



Kepler

(Transit)

ESO La Silla Observatory

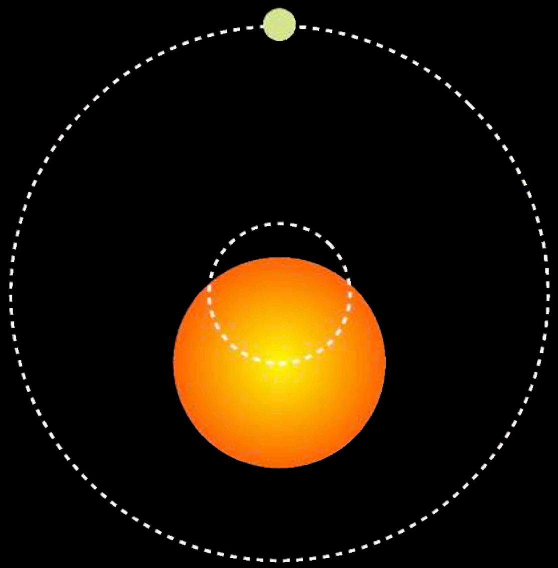
(Radial velocity)

96% exoplanets found by either the radial velocity or transit technique

Transit

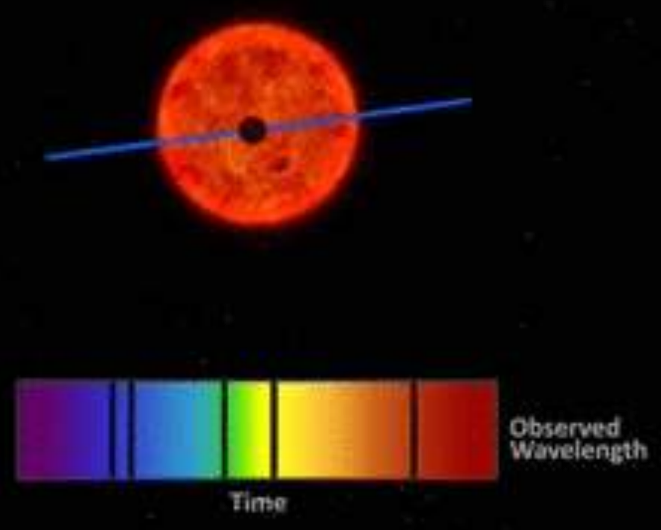
Radial velocity

Other



Radial velocity or
Doppler wobble

Orbit with planet causes the star to wobble, creating a periodic shift in wavelength



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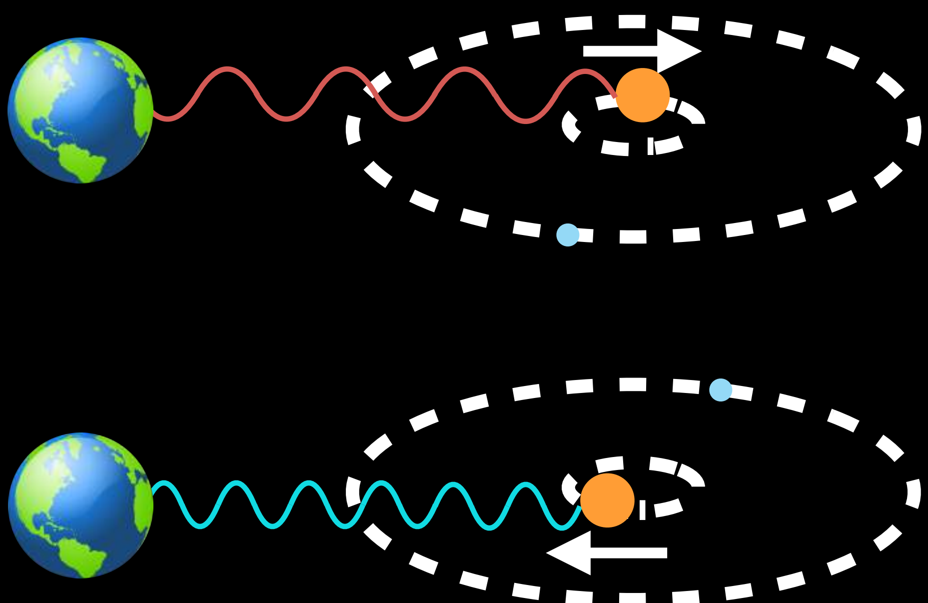

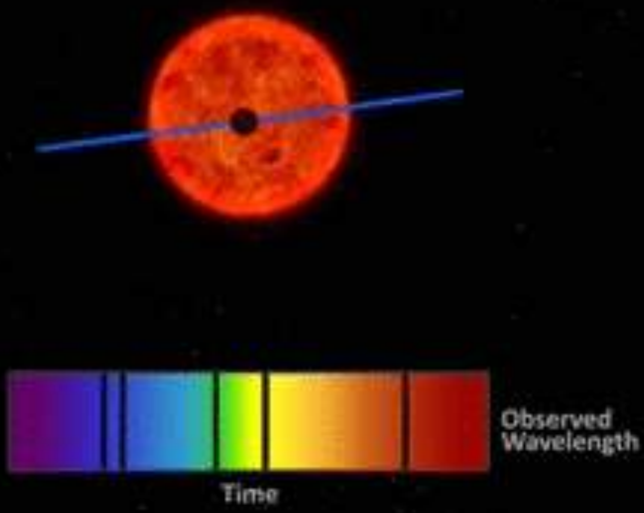

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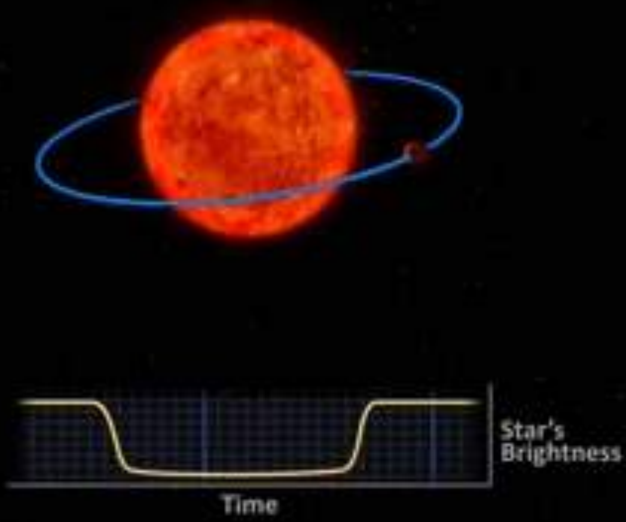
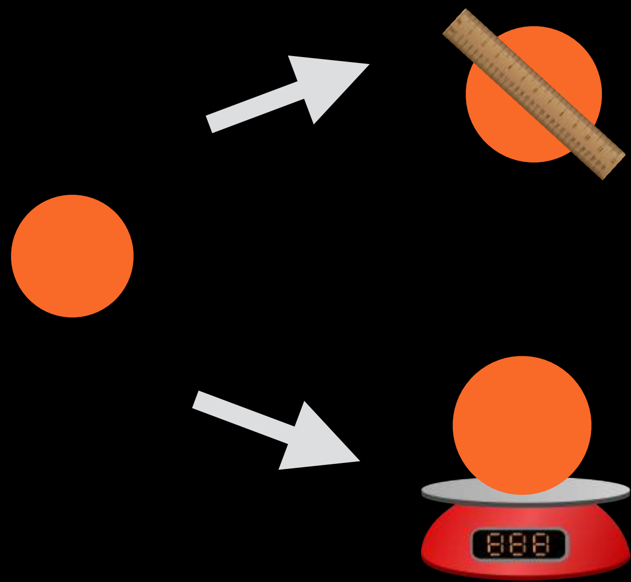


Transit

Dip in light as planet crosses our line of sight to the star

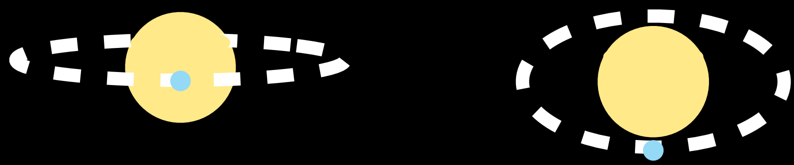
Hubble Space Telescope YouTube

Typically, < 2 planet properties:



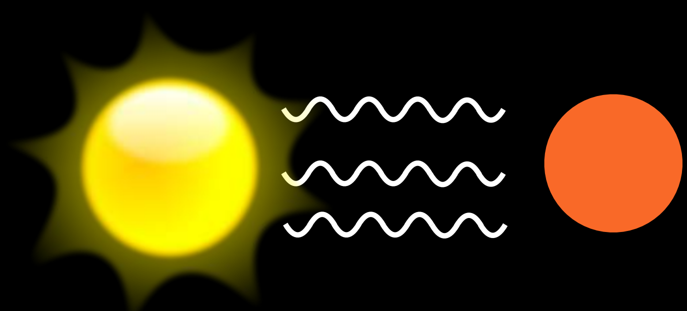
Planet radius

Planet (minimum) mass

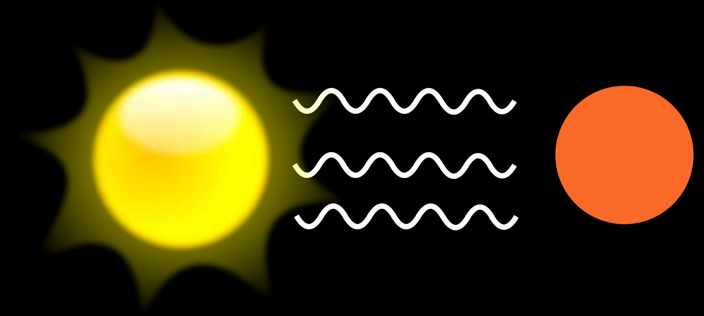


m sin (i) = mass

m sin (i) << mass

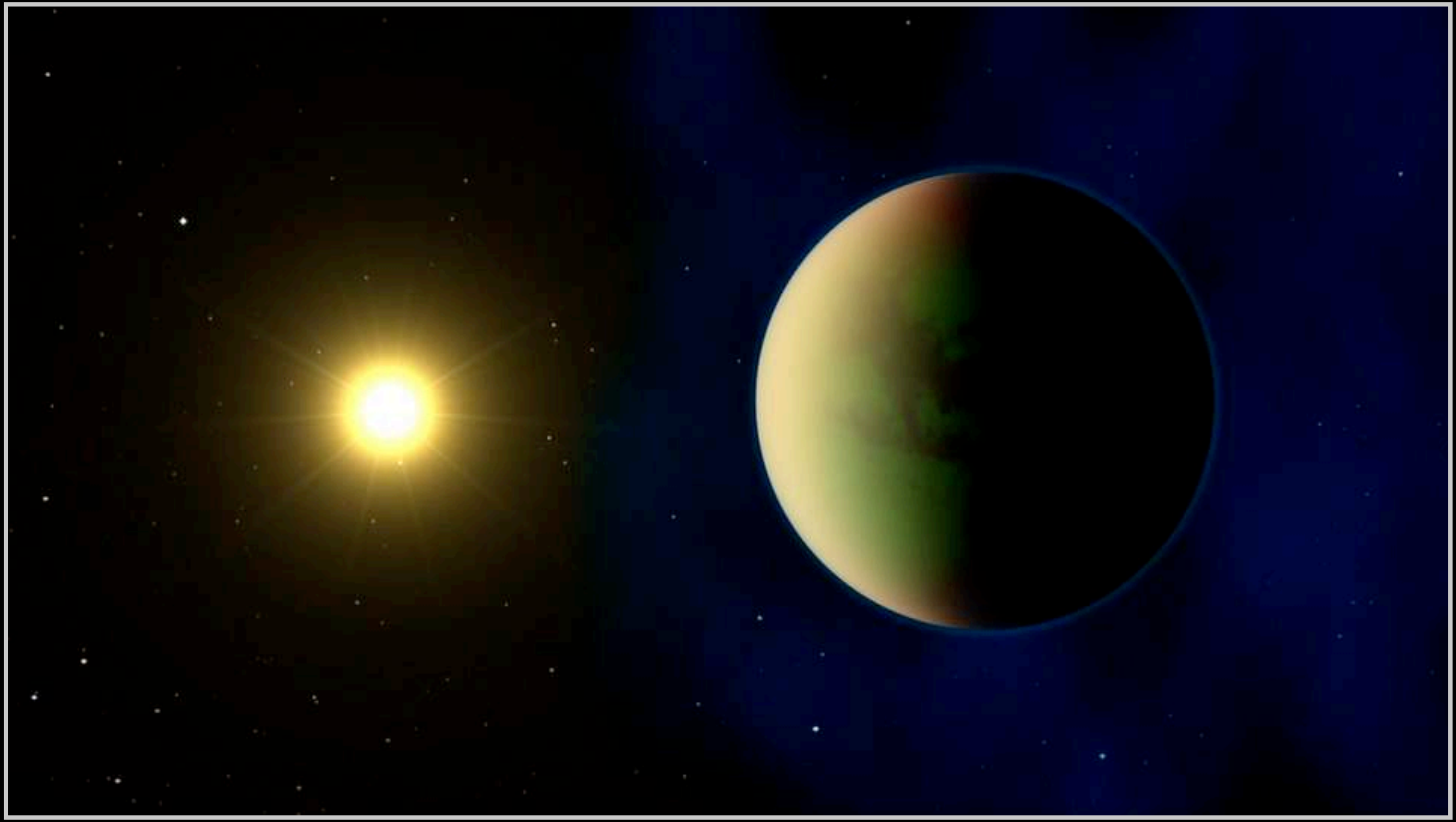


Amount of radiation from star

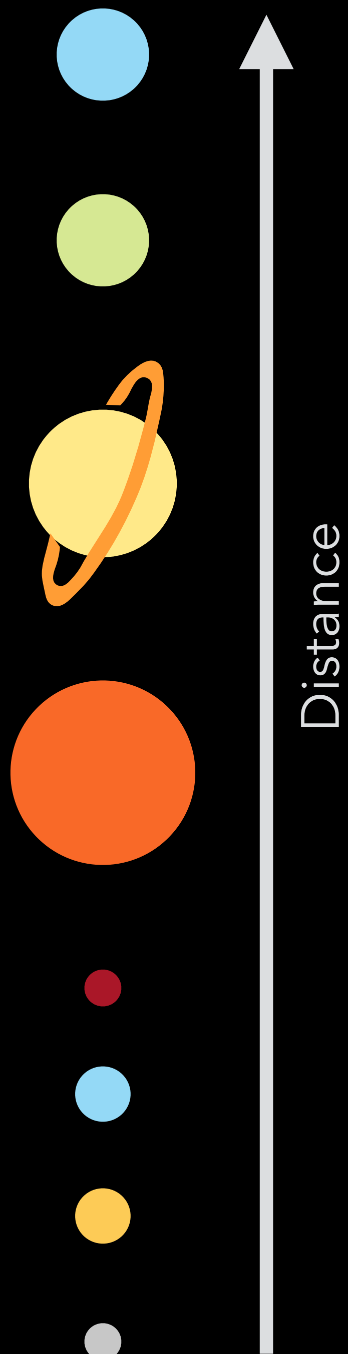


None of these measurable properties directly relate to surface conditions

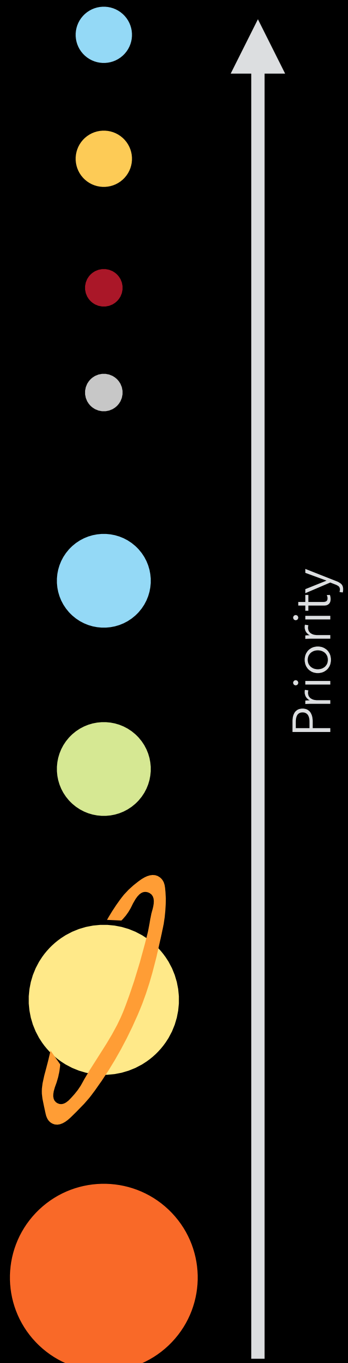
NASA GSFC



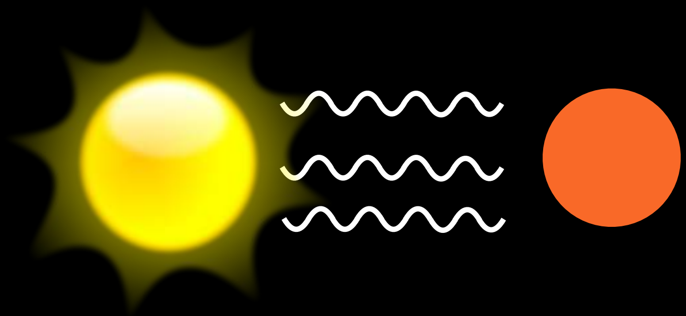
Our next generation of instruments
aim at atmospheric composition


Distance

Rank by most interesting target for habitability



… without knowing any surface properties

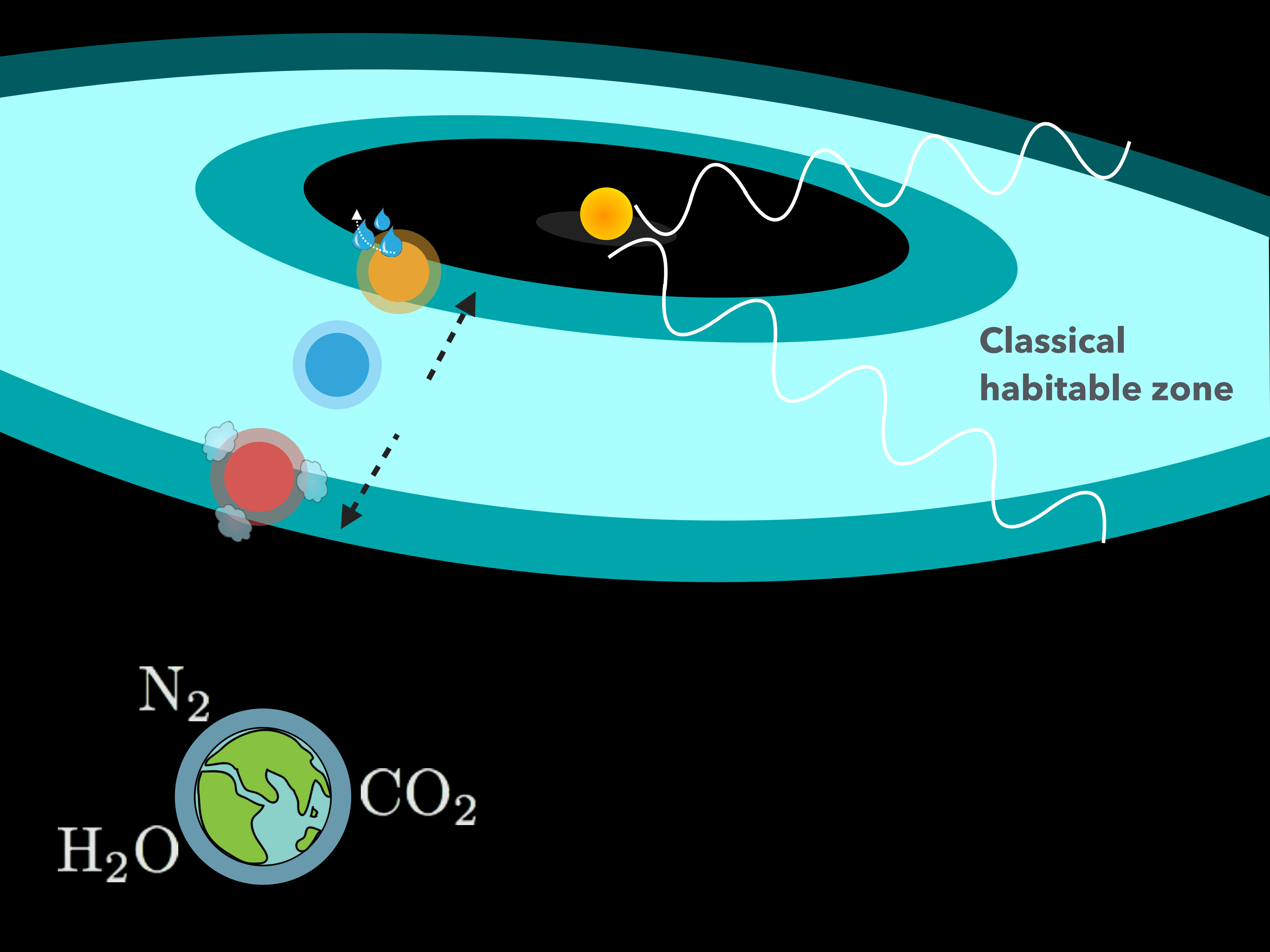


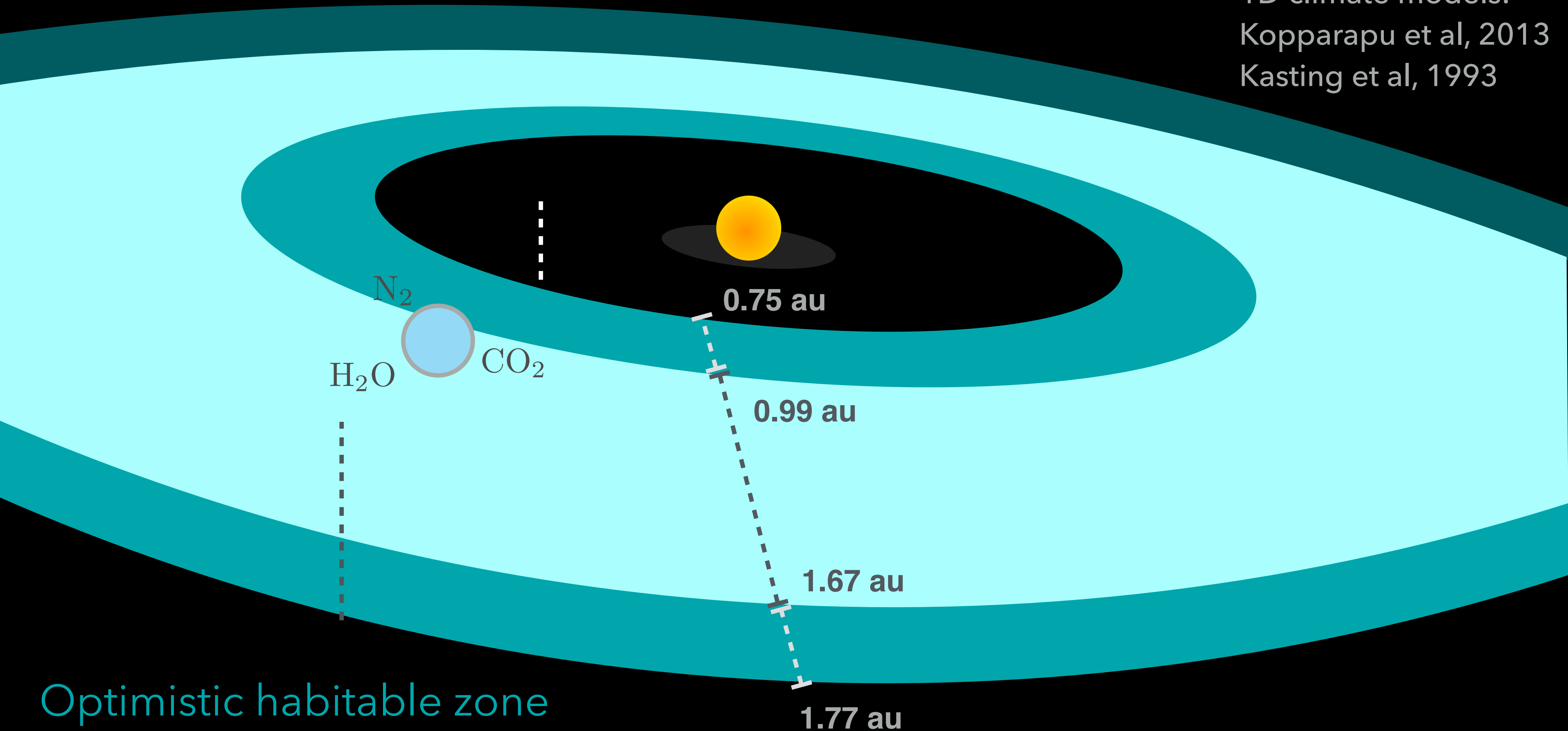
Easiest to recognise Earth-like life
(water & carbon-based chemistry)

Needs to be detectable
(surface water needed)

How much insolation does an
Earth-like planet need?

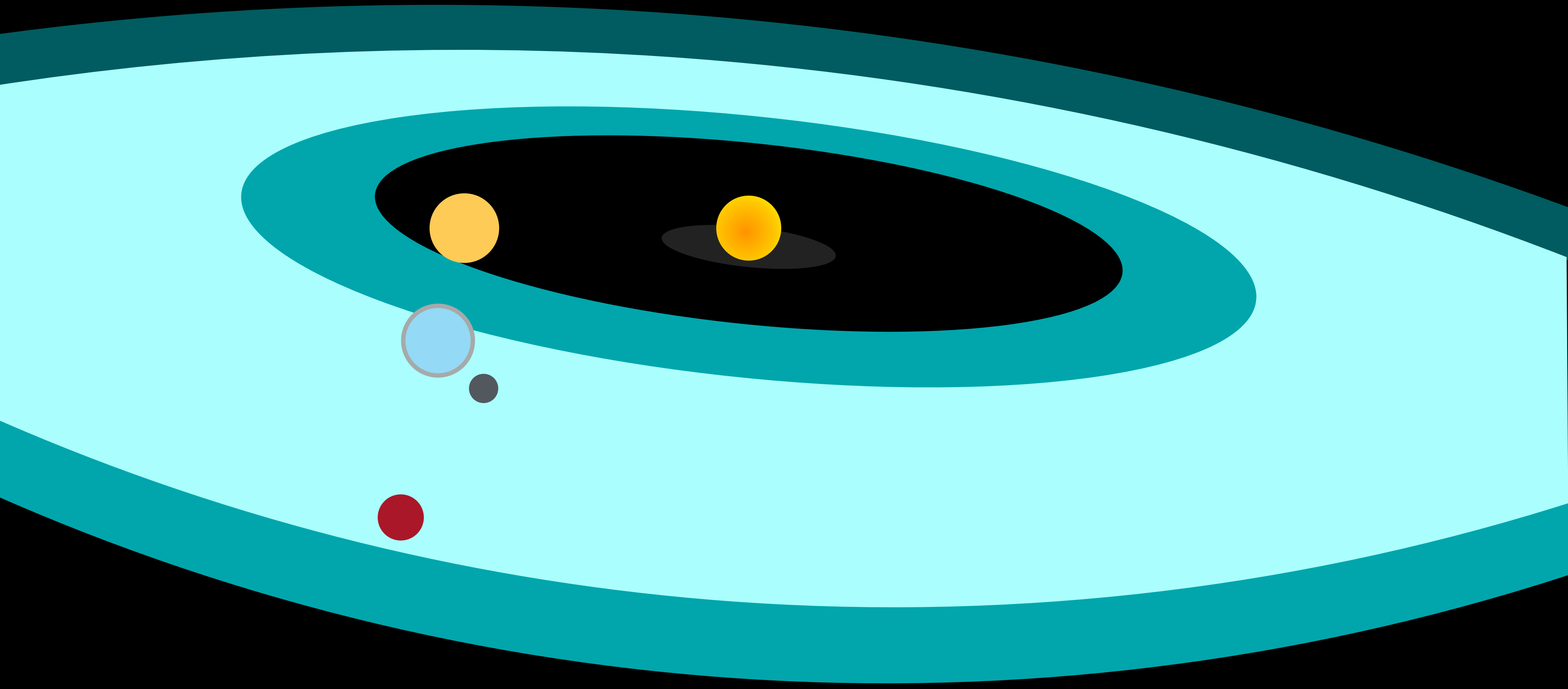
“Classical Habitable Zone”


Classical
habitable zone
N_2
CO_2
H_2O



Optimistic habitable zone

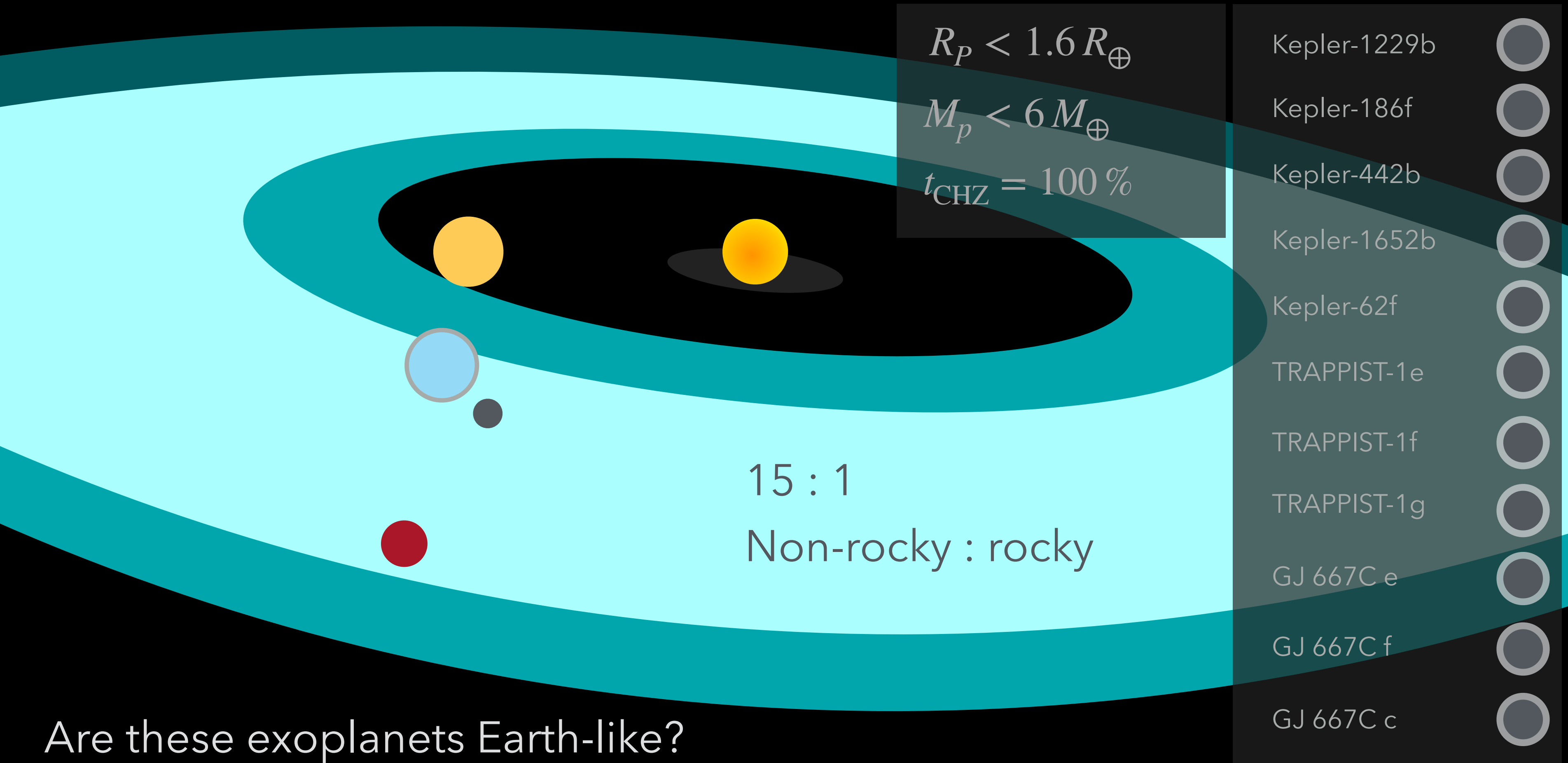
Based on empirical data that Venus & Mars once had surface liquid water 1 - 3.8 Gyrs ago



The classical habitable zone is
only for an Earth-like planet.

Different planets might have a habitable
zone at a different location…

… or not at all.



Are these exoplanets Earth-like?

We don't know.

Can only say:

If we found another habitable Earth-like planet, it would be in the habitable zone.

Conclusions

We’ve discovered thousands of exoplanets, many of which are similar in size to the Earth.

But at the moment, we have no way of knowing what their surfaces are like (note that the Earth and Venus are both “Earth-sized planets”.)

Our next generation of telescopes will be able to detect the atmosphere of these worlds and tell us something about their surfaces for the first time.

The habitable zone is a useful concept for selecting planets for the new telescopes, but it offers no guarantee that a planet is habitable.

Suggested Reading

To see how different even an Earth-like planet might be, try:

earthlike.world

@earthlikeworld

NASA NExSS 'Many Worlds' blog: www.manyworlds.space

Technical overview of exoplanet biosignatures:

Yuka Fujii et al,
Astrobiology, Vol. 18, No. 6, 2018
DOI: 10.1089/ast2017.1733

References

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