

Title: Elizabeth Tasker, Japan Aerospace Exploration Agency

Speakers:

Collection: Perimeter Public Lectures

Date: November 06, 2019 - 7:00 PM

URL: <http://pirsa.org/19110049>

Abstract: Since the discovery of the first exoplanets in the early 1990s, we have detected more than 4,000 worlds beyond our solar system. Many of these are similar in size to our Earth, leading to an obvious question: could any be habitable?

For now, we typically only know the size and orbit of these planets, but nothing about their surface conditions. Although we cannot know for sure if these worlds could support life, we can use models to speculate on what we might find there.

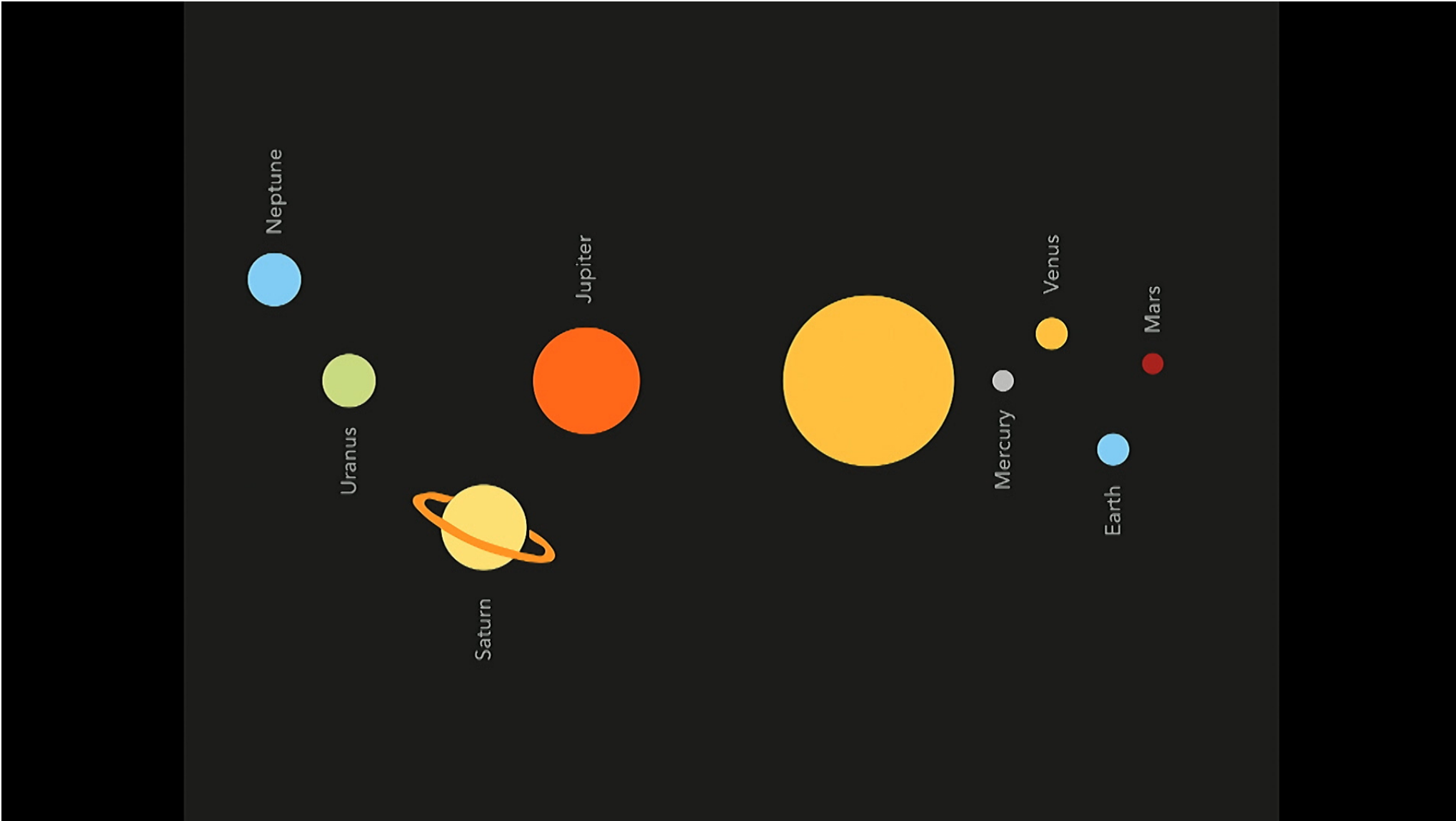
In her Nov. 6 talk at Perimeter Institute, astrophysicist and author Elizabeth Tasker will take audiences for a speculative stroll through a few of the alien worlds we've discovered in the galaxy, and ponder whether someone else may already call them home.

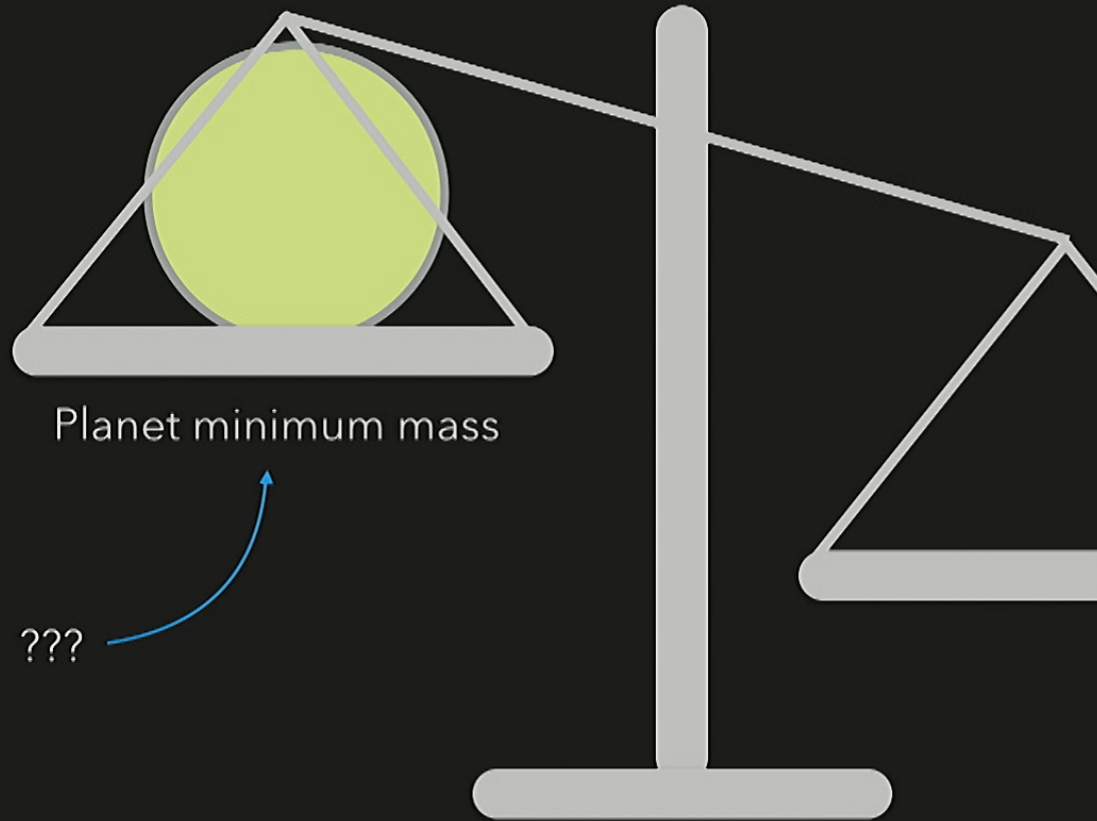
Elizabeth Tasker is an astrophysicist at the Japan Aerospace Exploration Agency (JAXA). Her research explores the formation of stars and planets using computer simulations. She is particularly interested in how diverse planets might be and what different conditions might exist beyond our Solar System. Elizabeth is also a keen science communicator and writer for the NASA NExSS "Many Worlds" online column. Her popular science book, *The Planet Factory*, was published in Canada last April.

Home away from home

The hunt for habitable planets

Elizabeth Tasker  @girlandkat

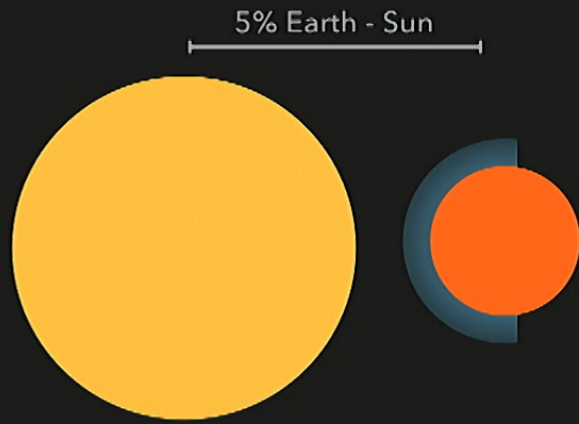






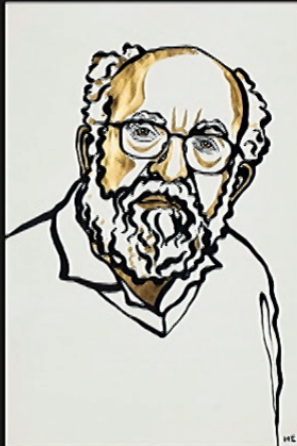
51 Pegasi b

First exoplanet
discovered around
a sun-like star



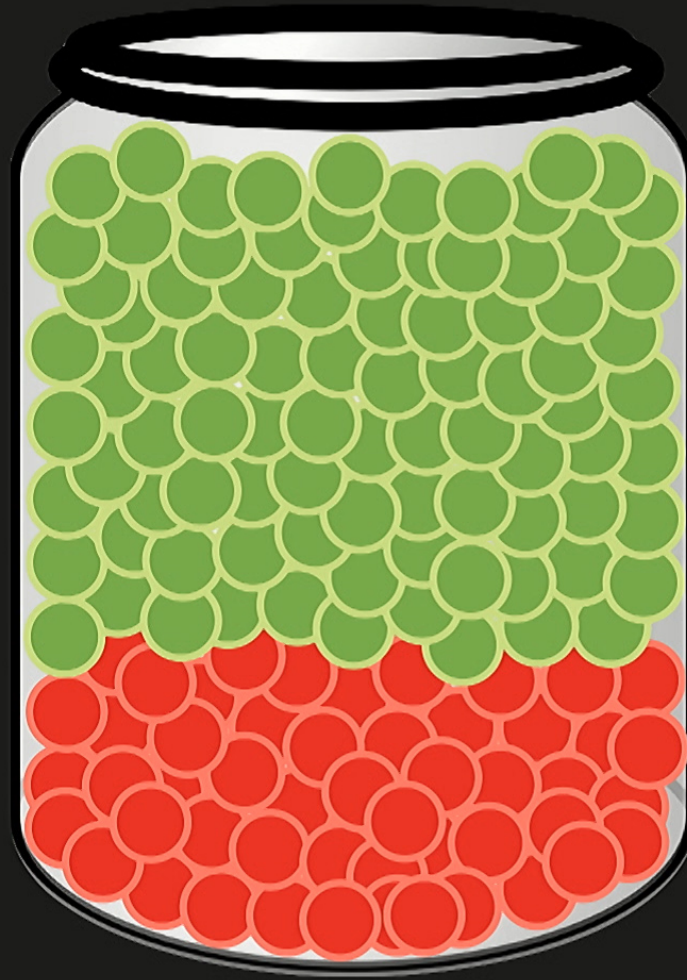
51 Pegasi b
Orbit 4 days

First exoplanet
discovered around
a sun-like star



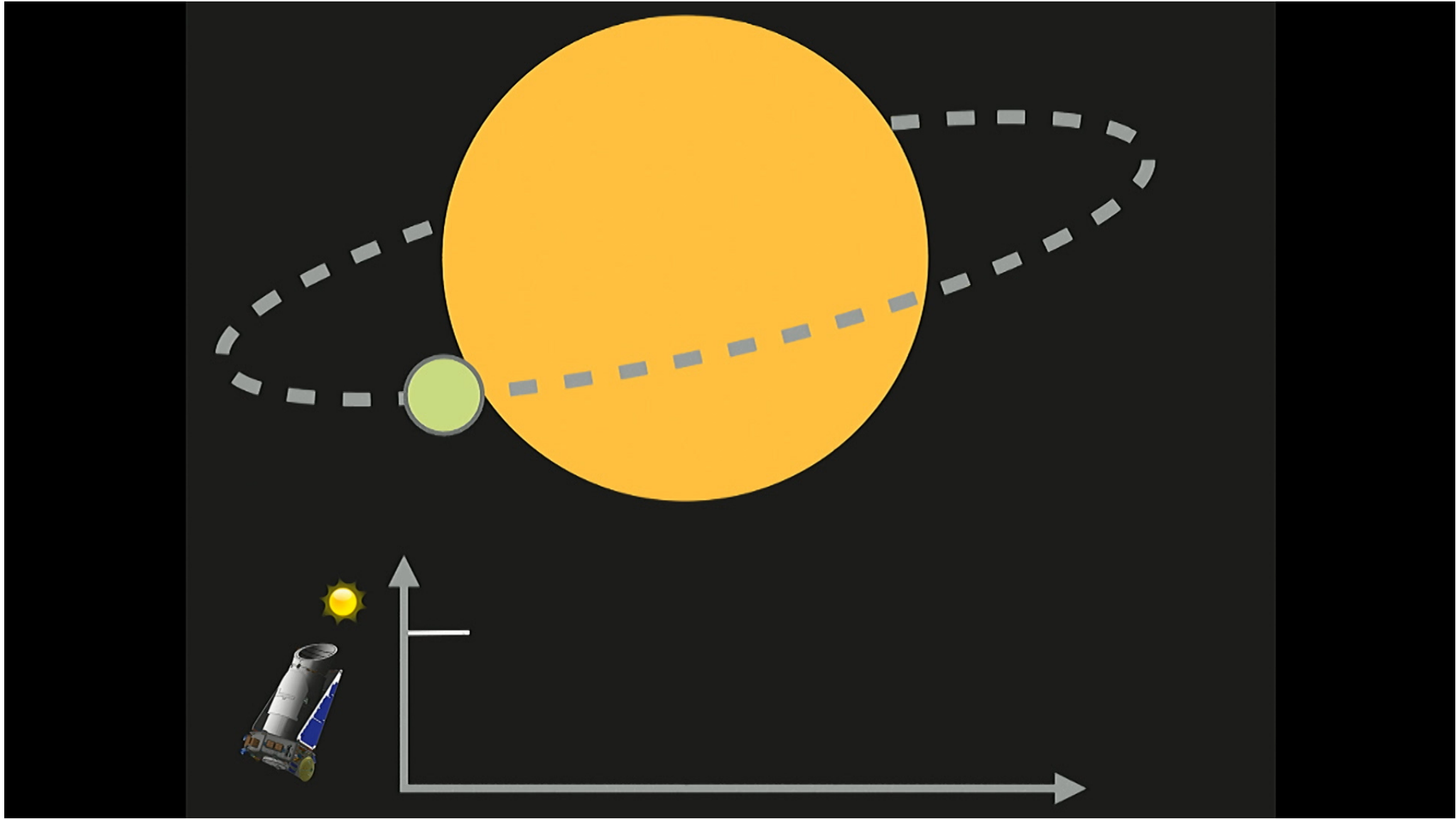
Nobel Prize in Physics 2019

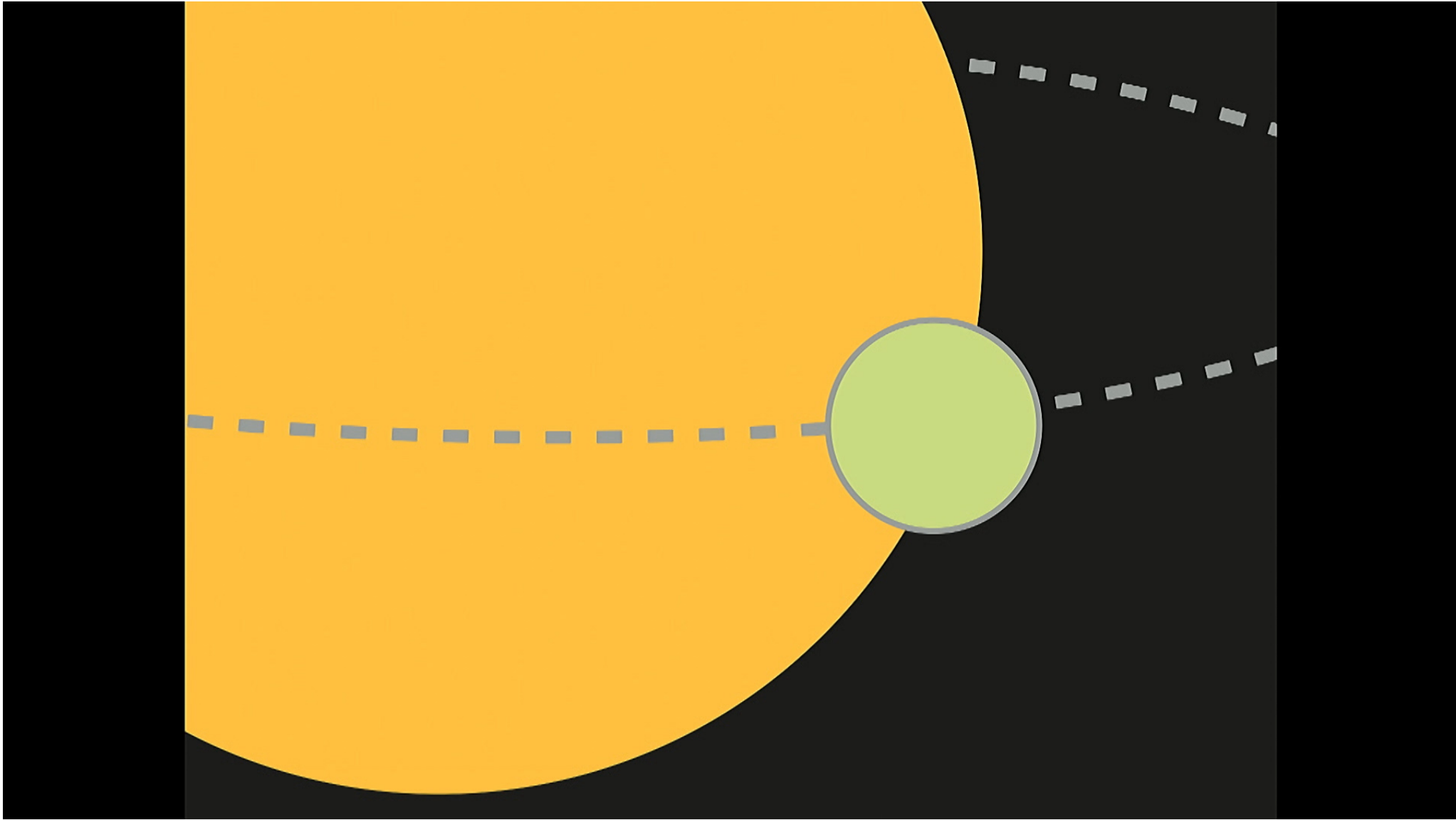
Michel Mayor & Didier Queloz

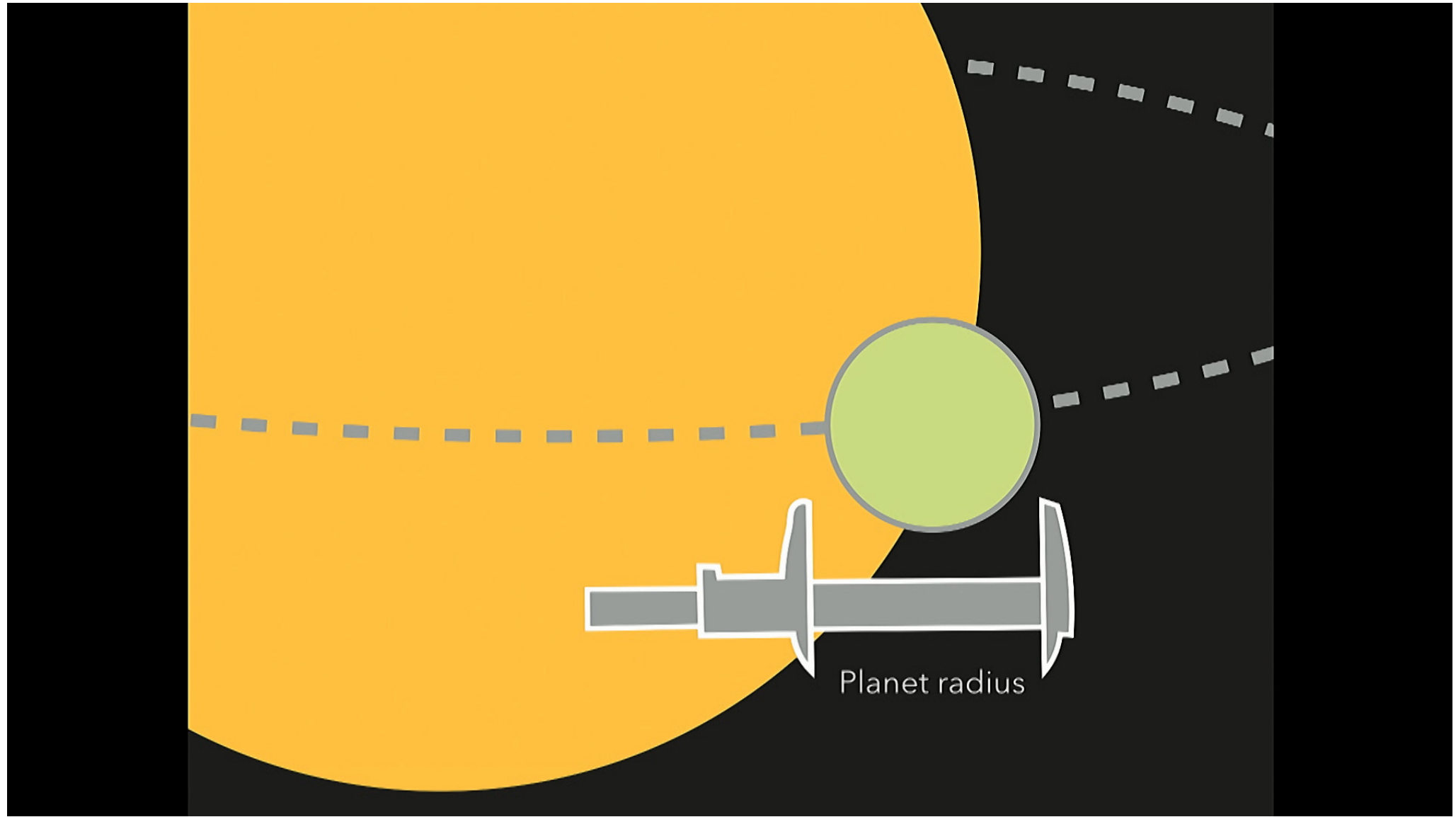


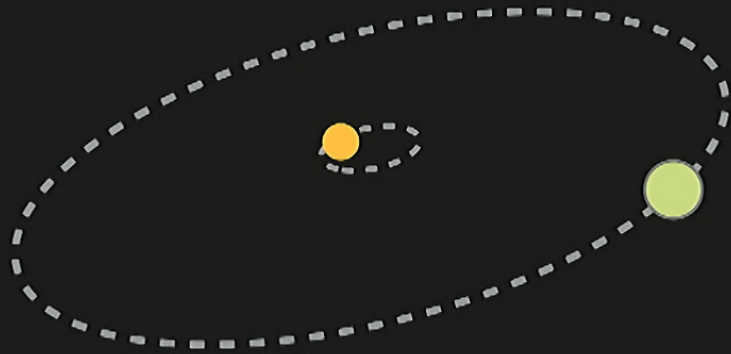
Transit
~75%

Radial velocity
~20%

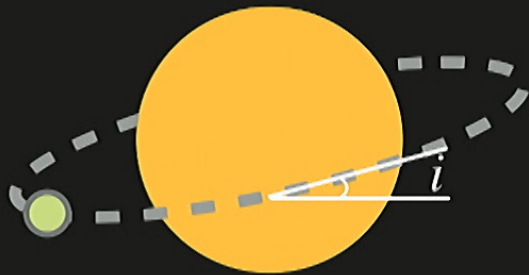
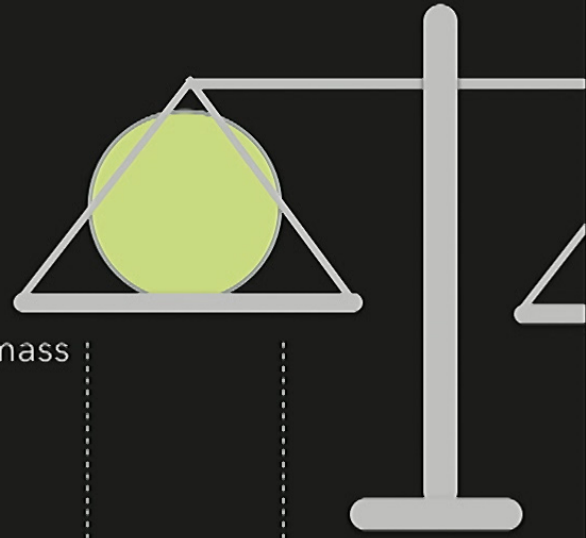


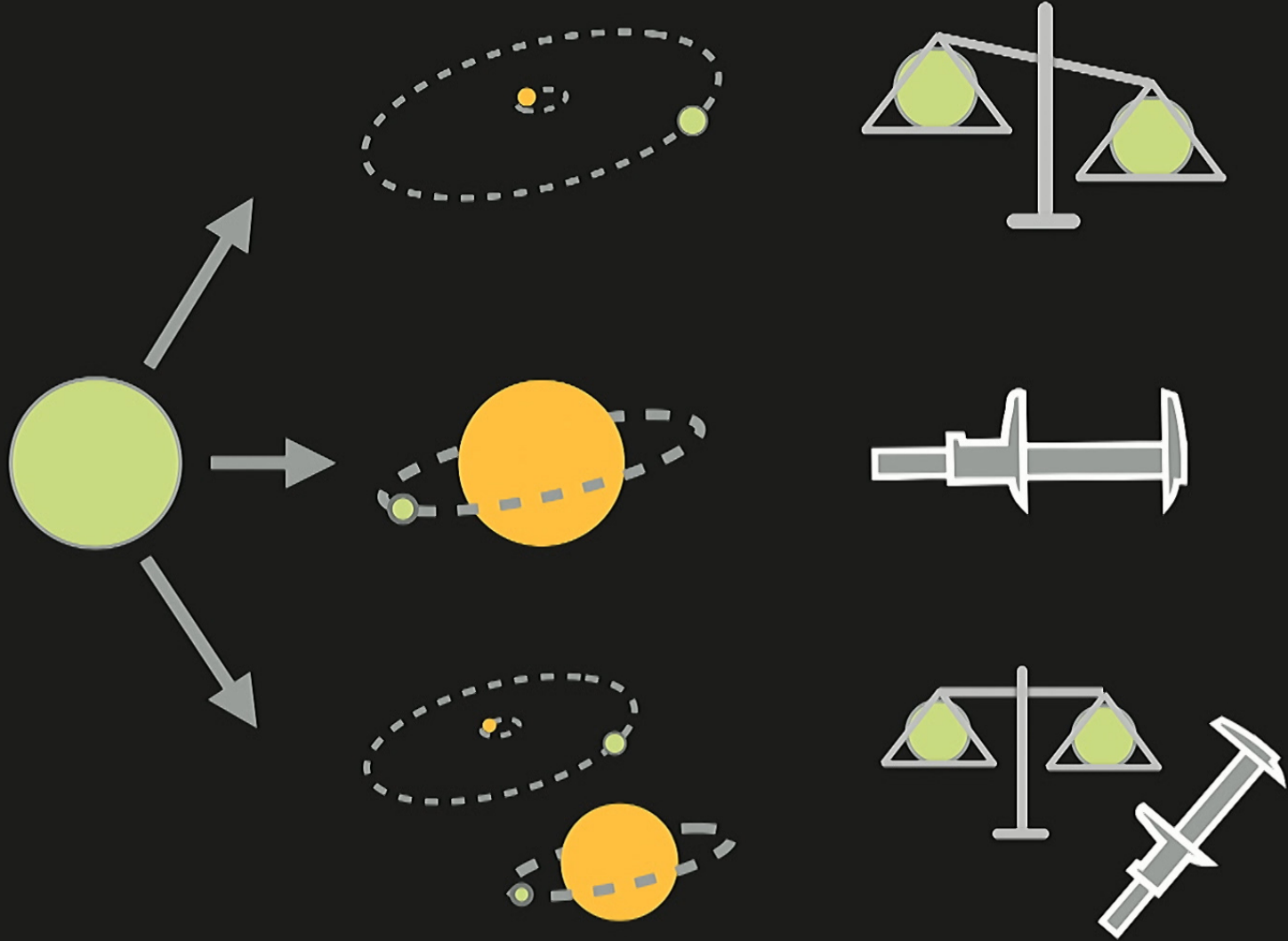


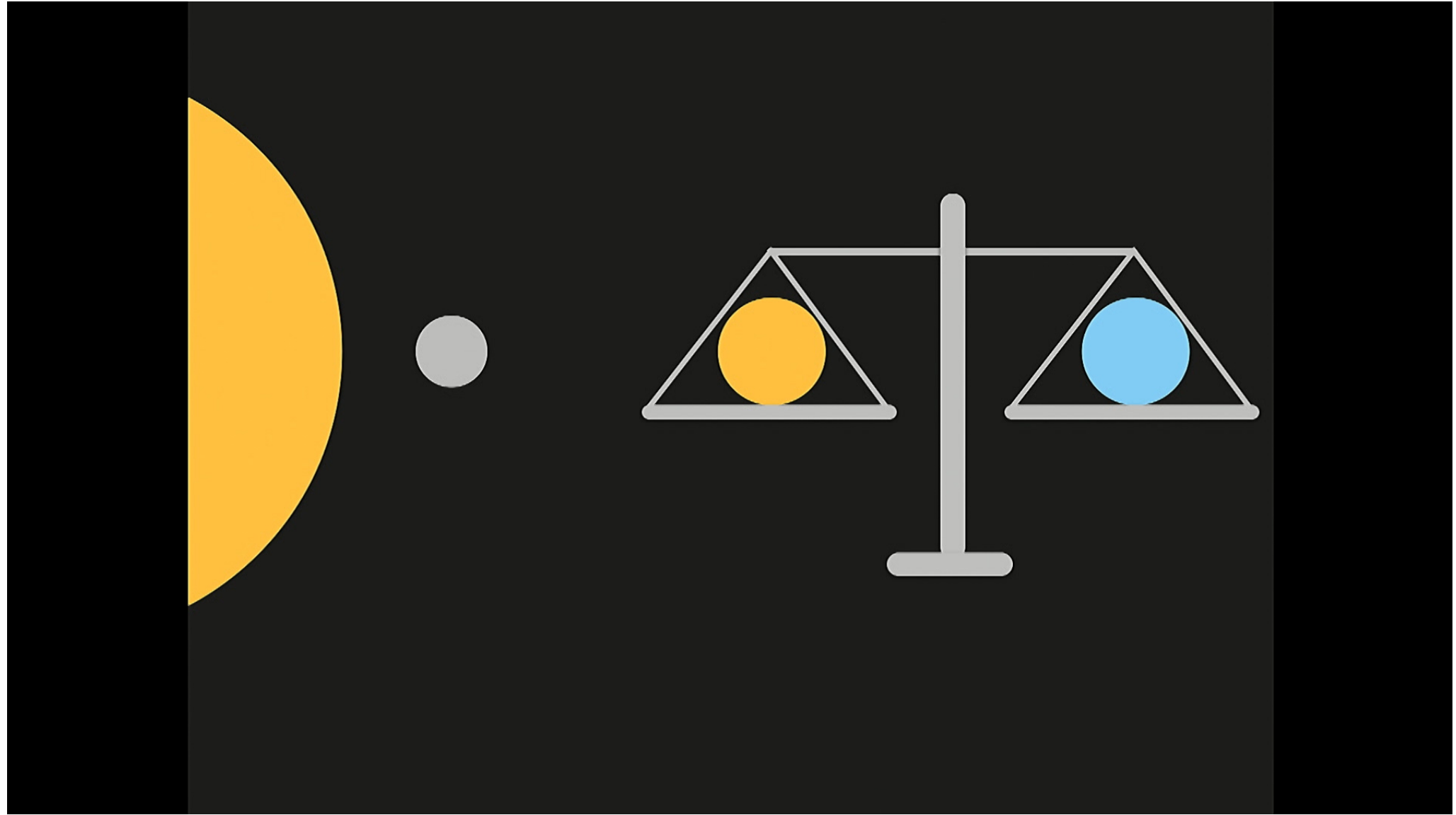




true mass



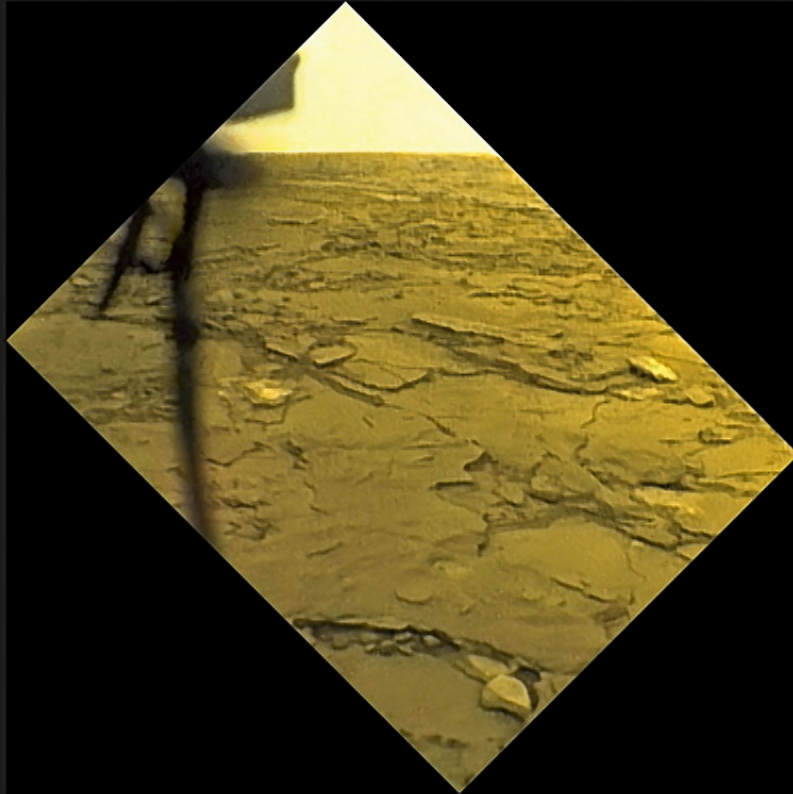




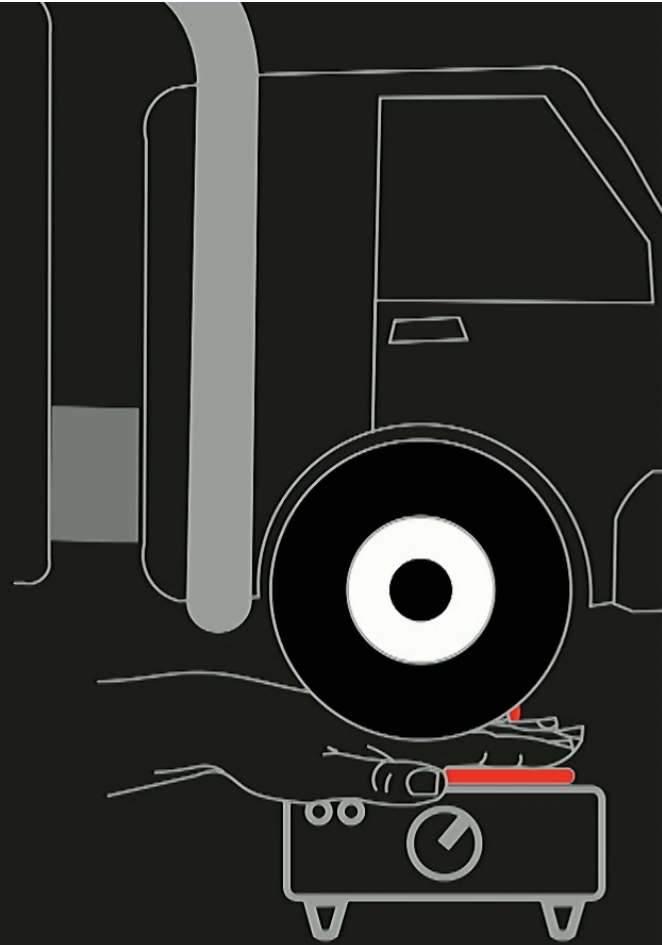
Voyage to the Prehistoric Planet (1965)



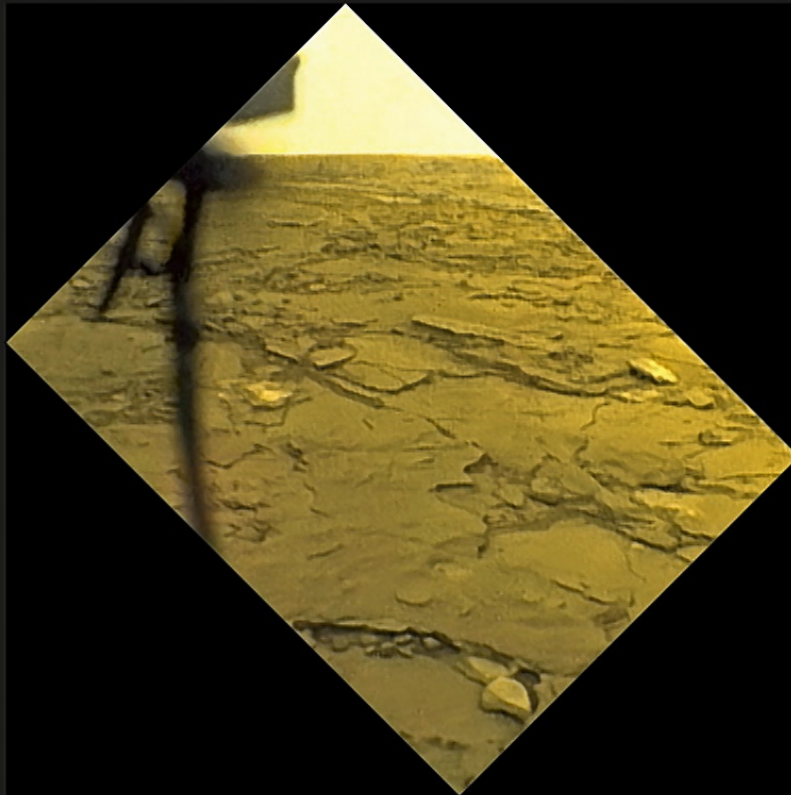
Venera 4 (launch 1967)
water ready!



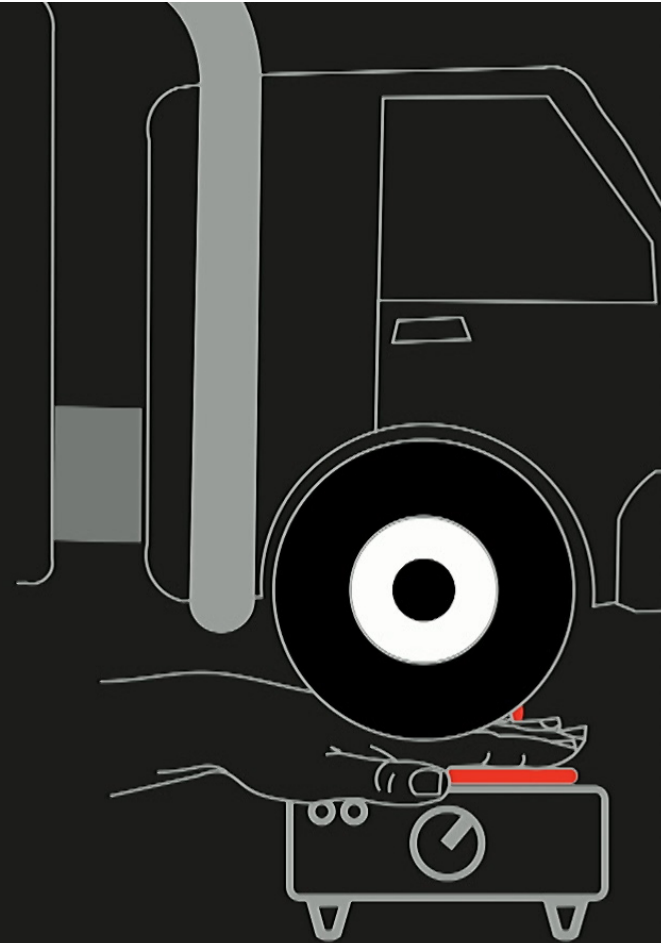
Venera 14 (1982)



460°C

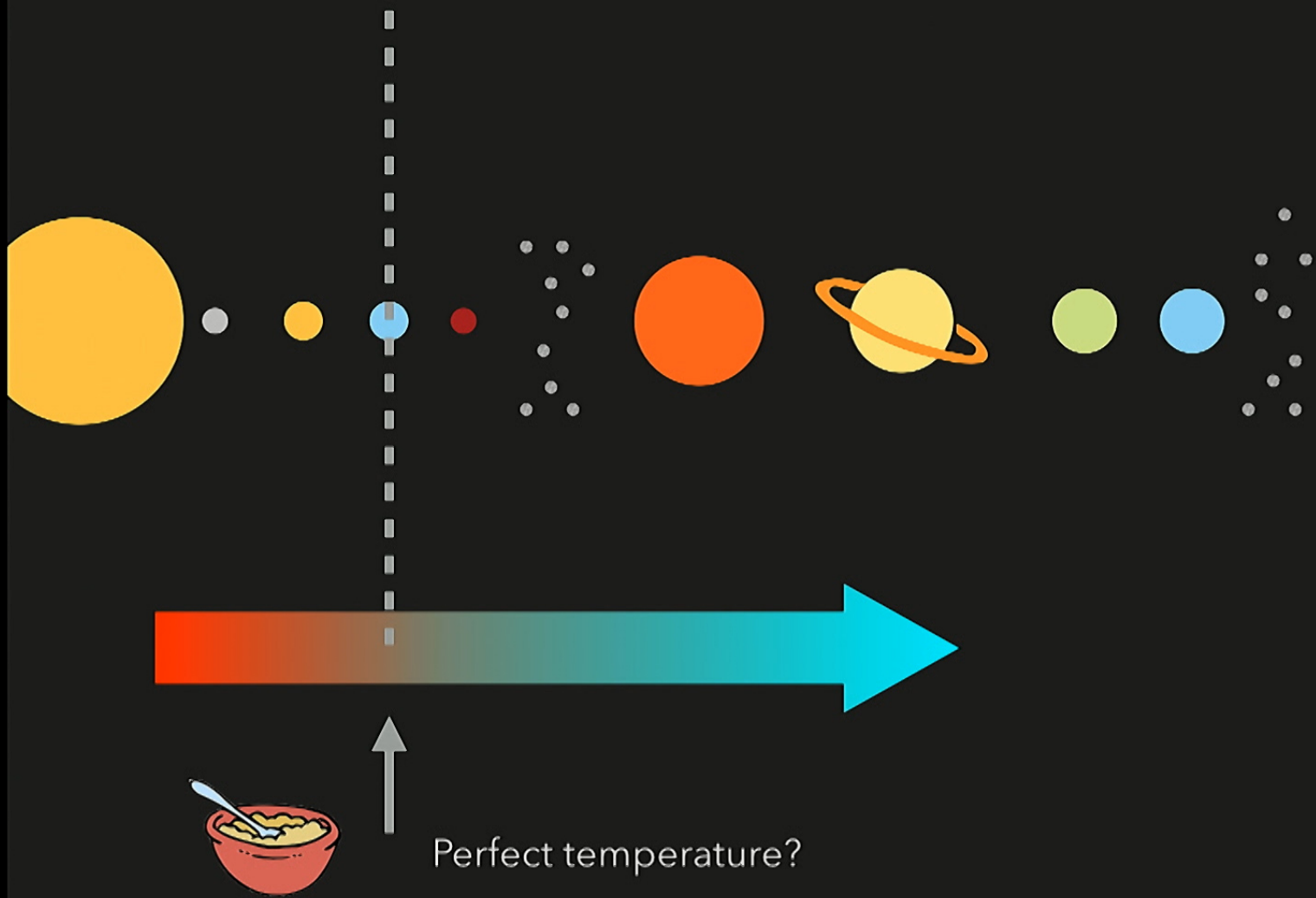


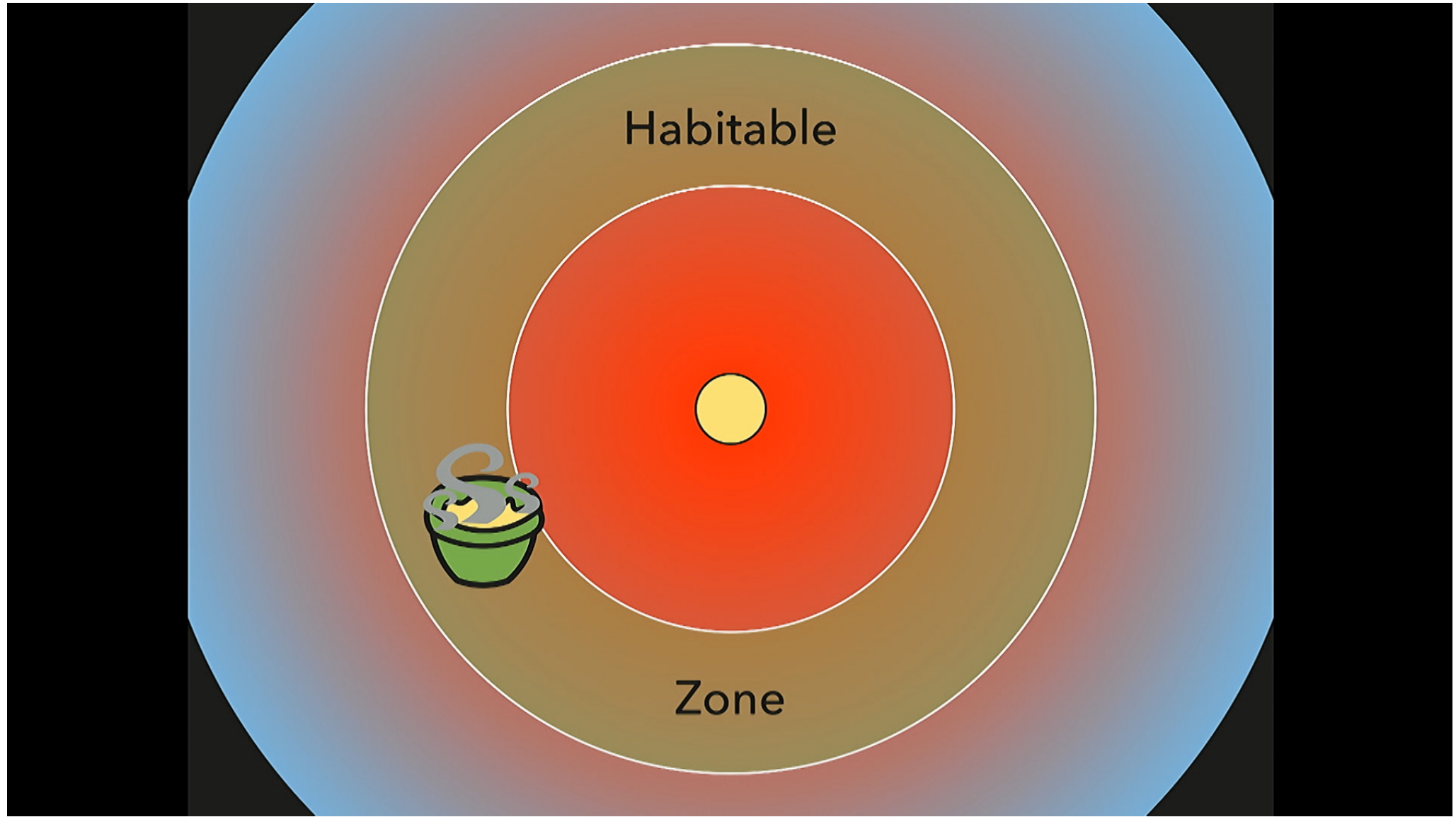
Venera 14 (1982)



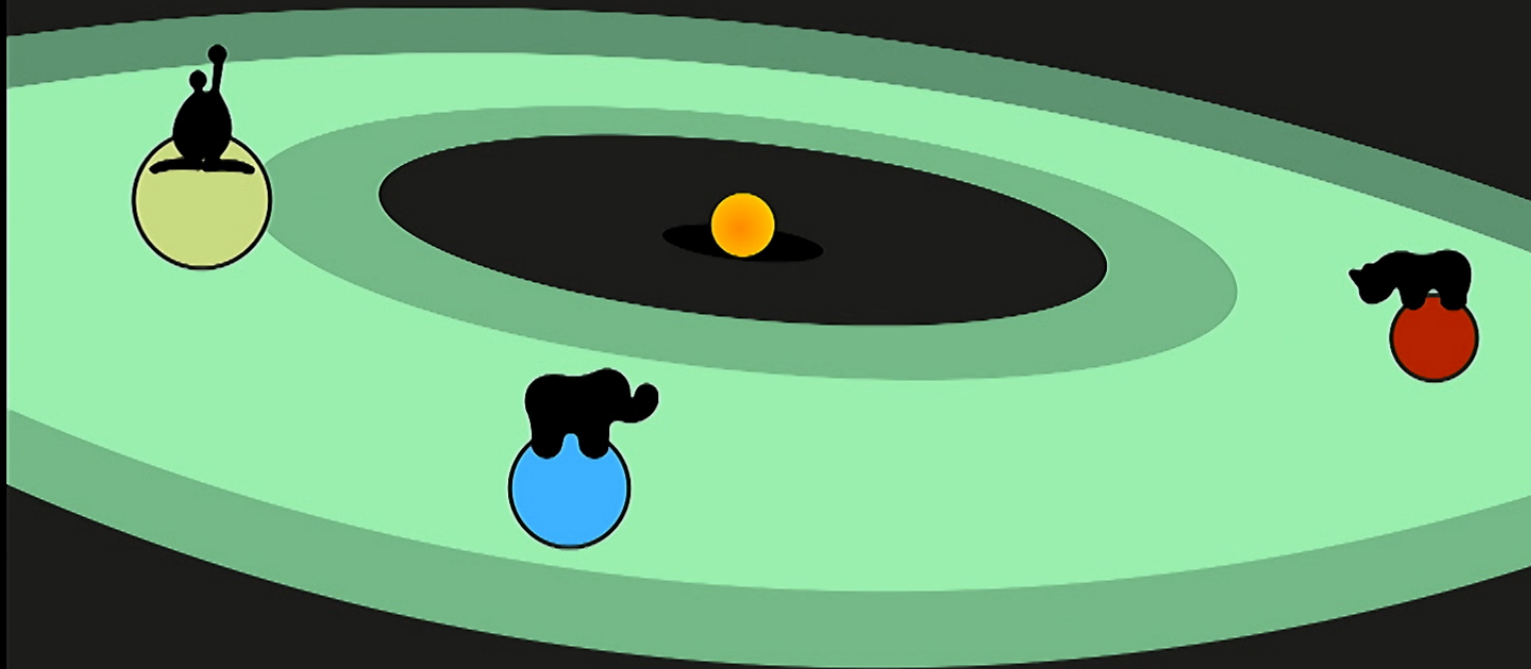
460°C

90 atmospheres

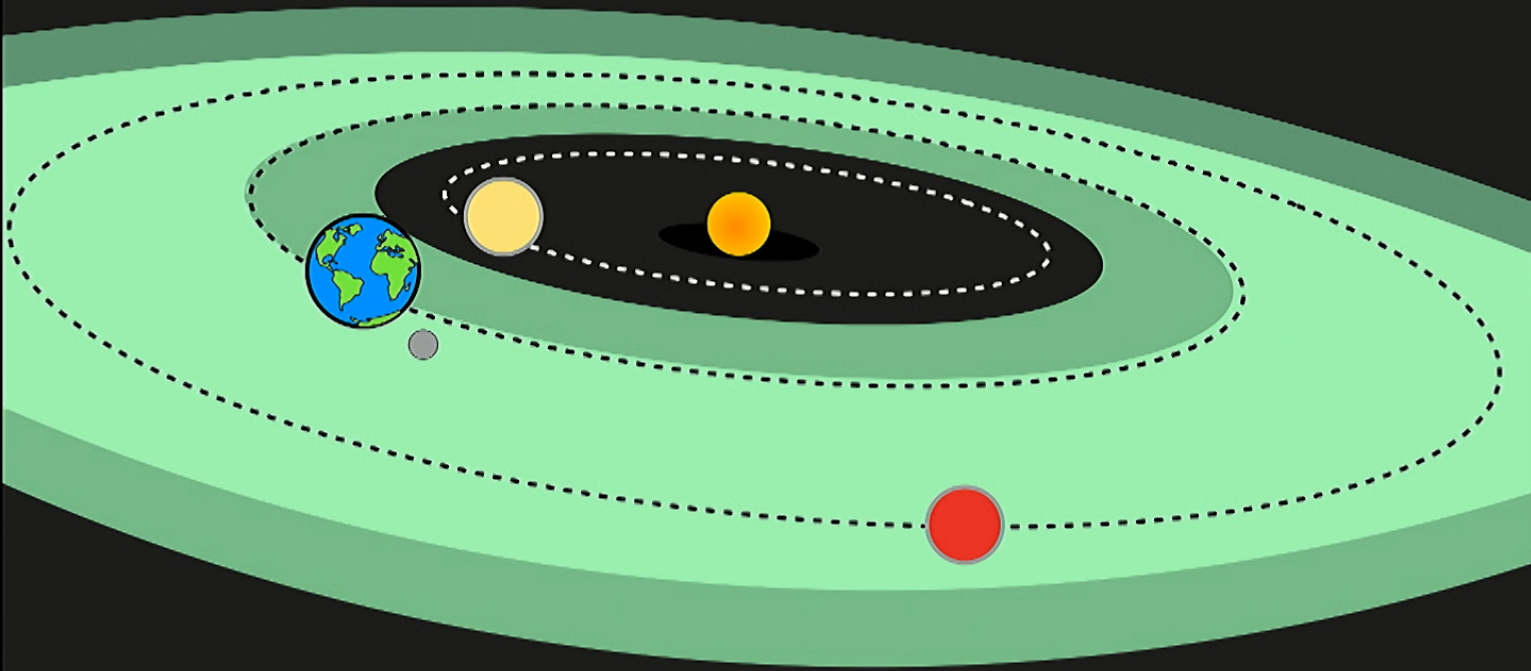


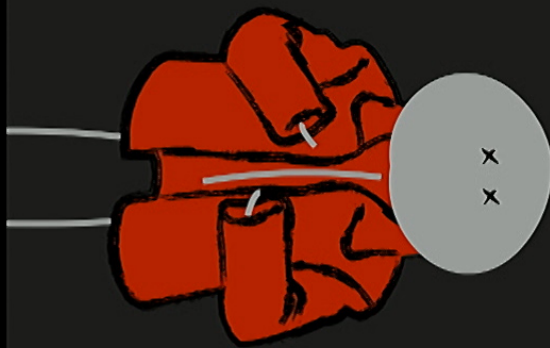


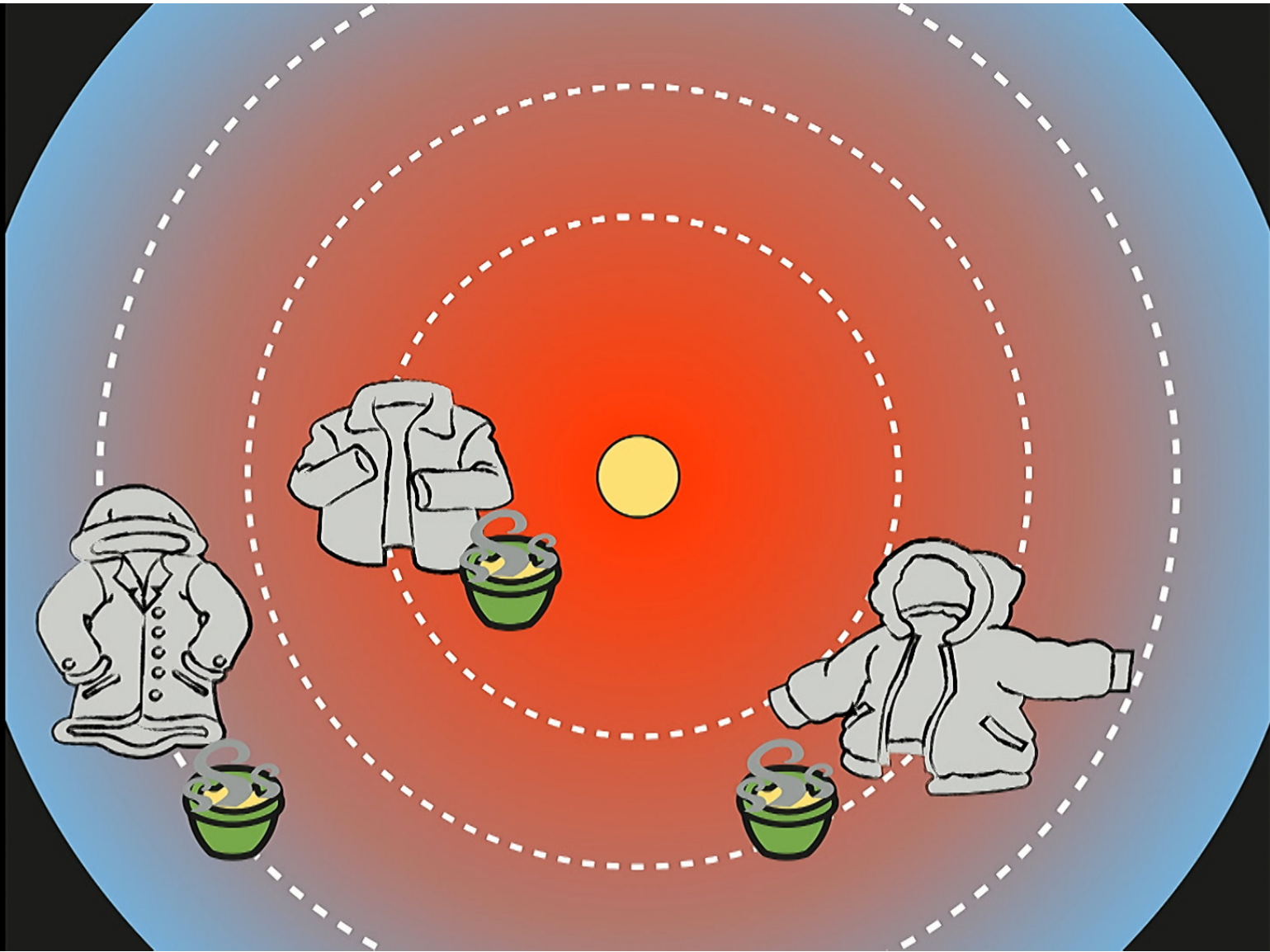
REALITY CHECK

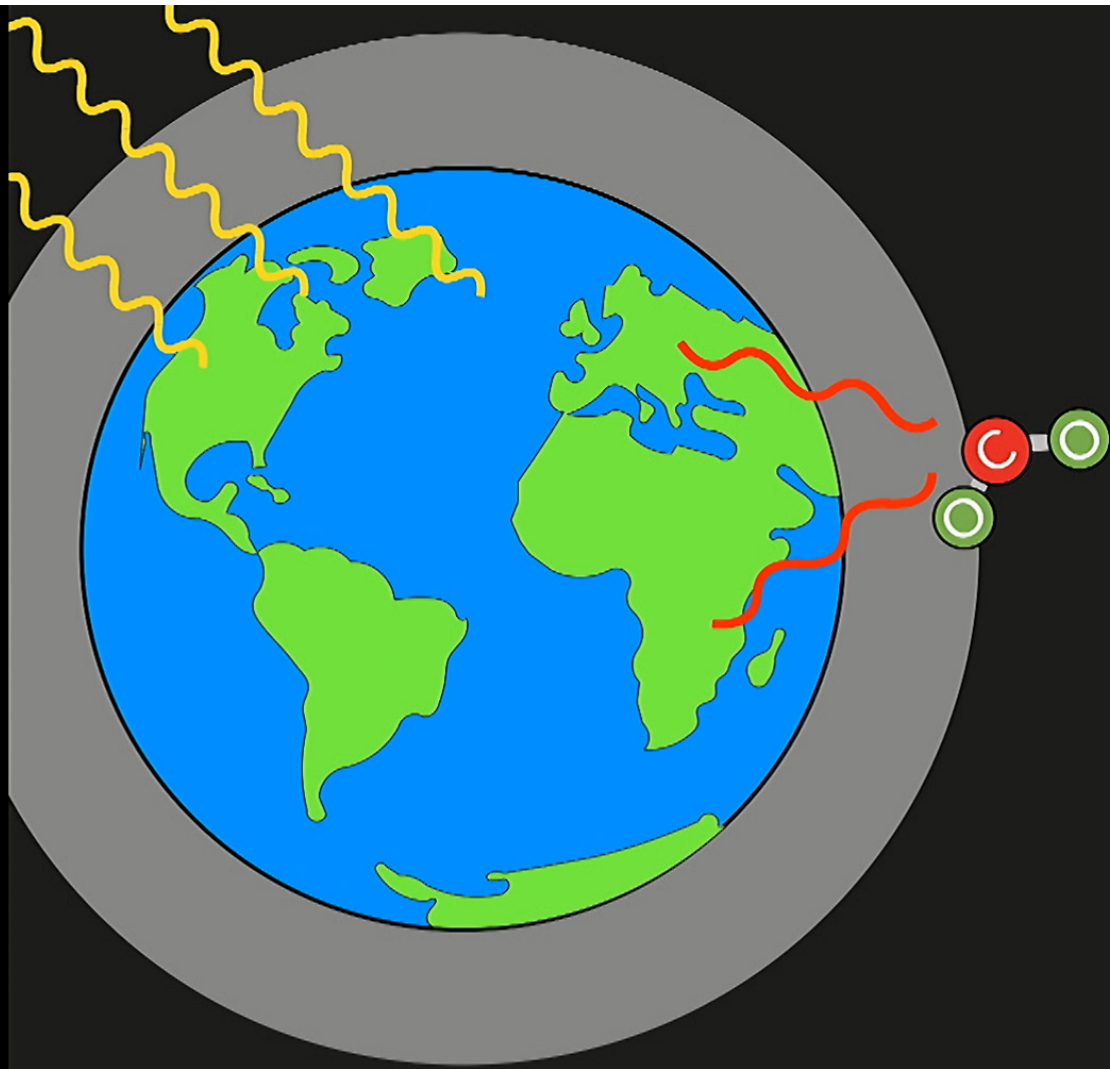


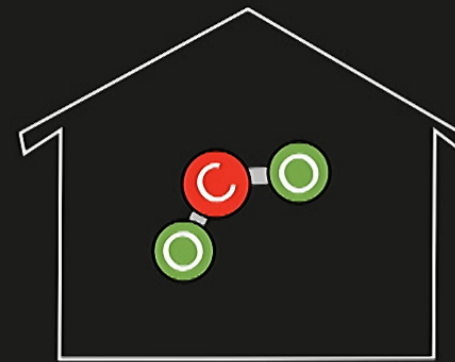
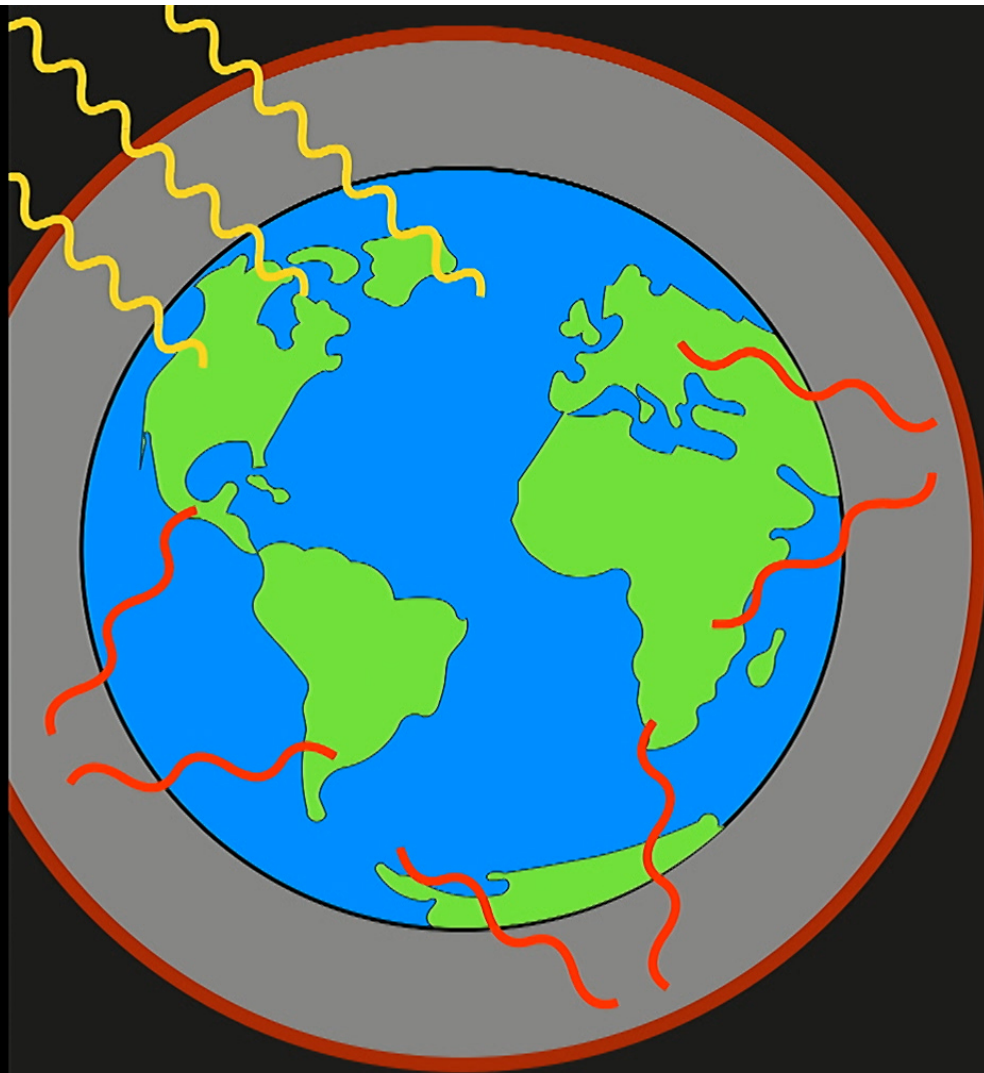
A zone in which planets are habitable?



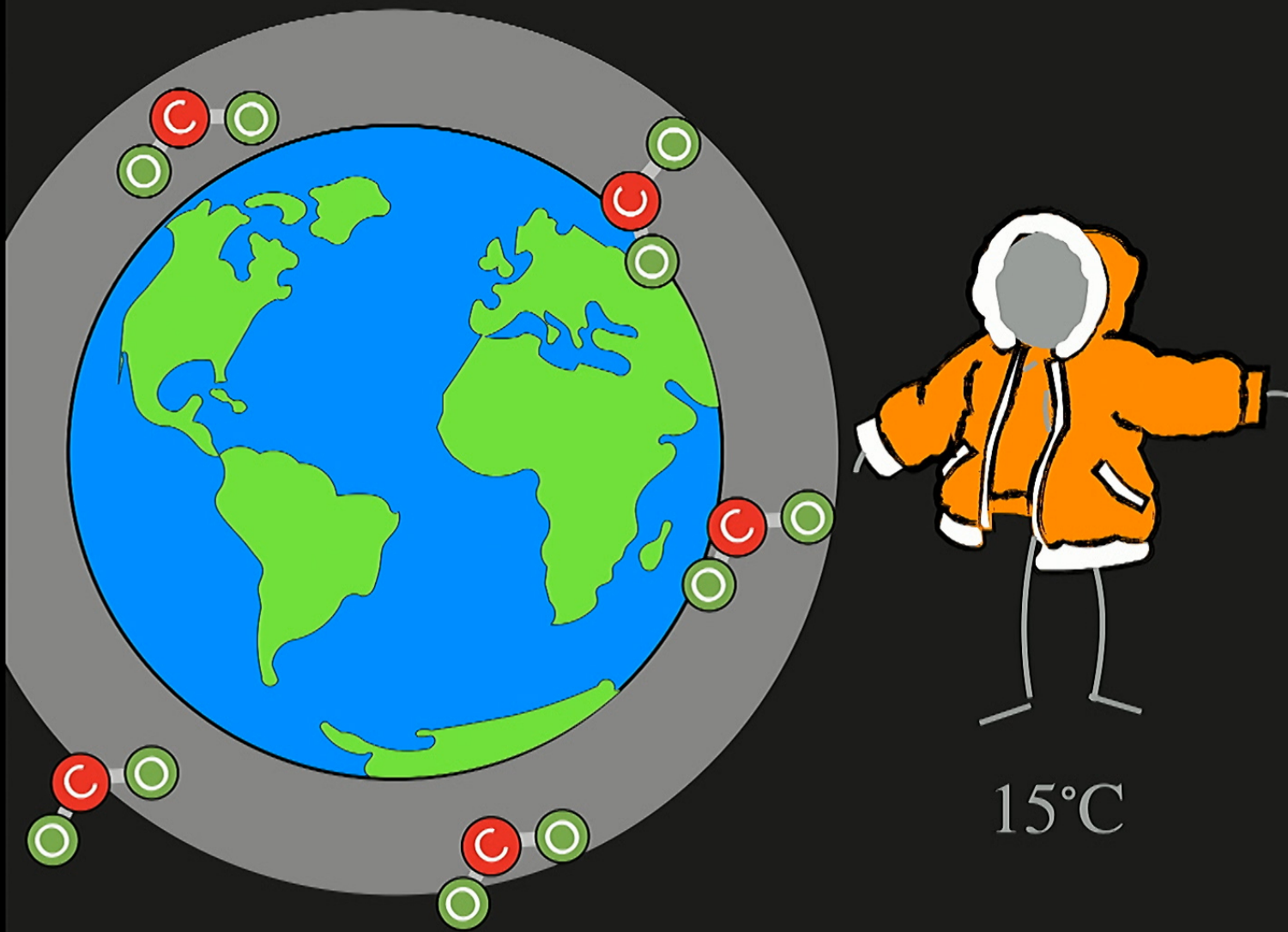


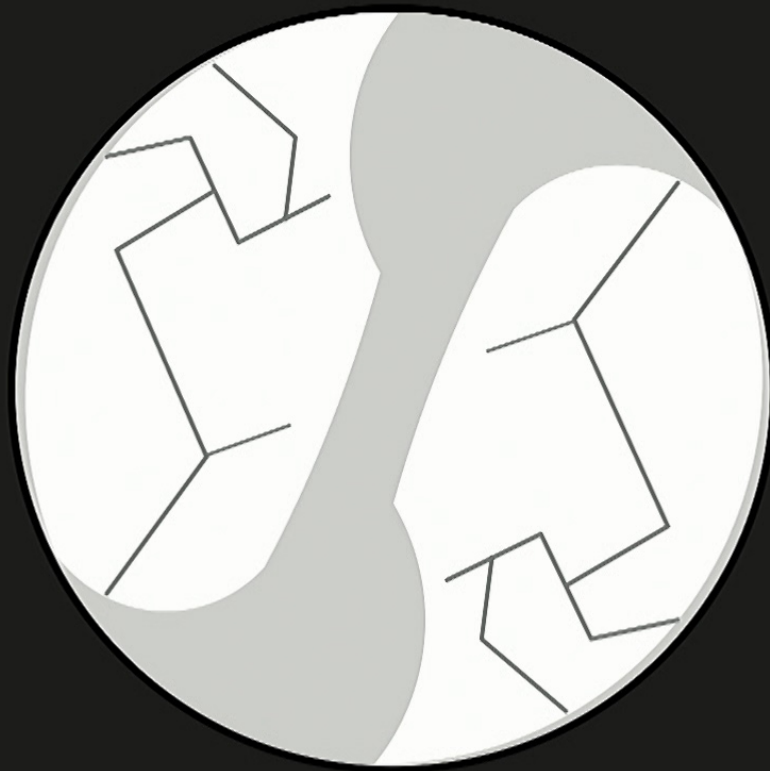




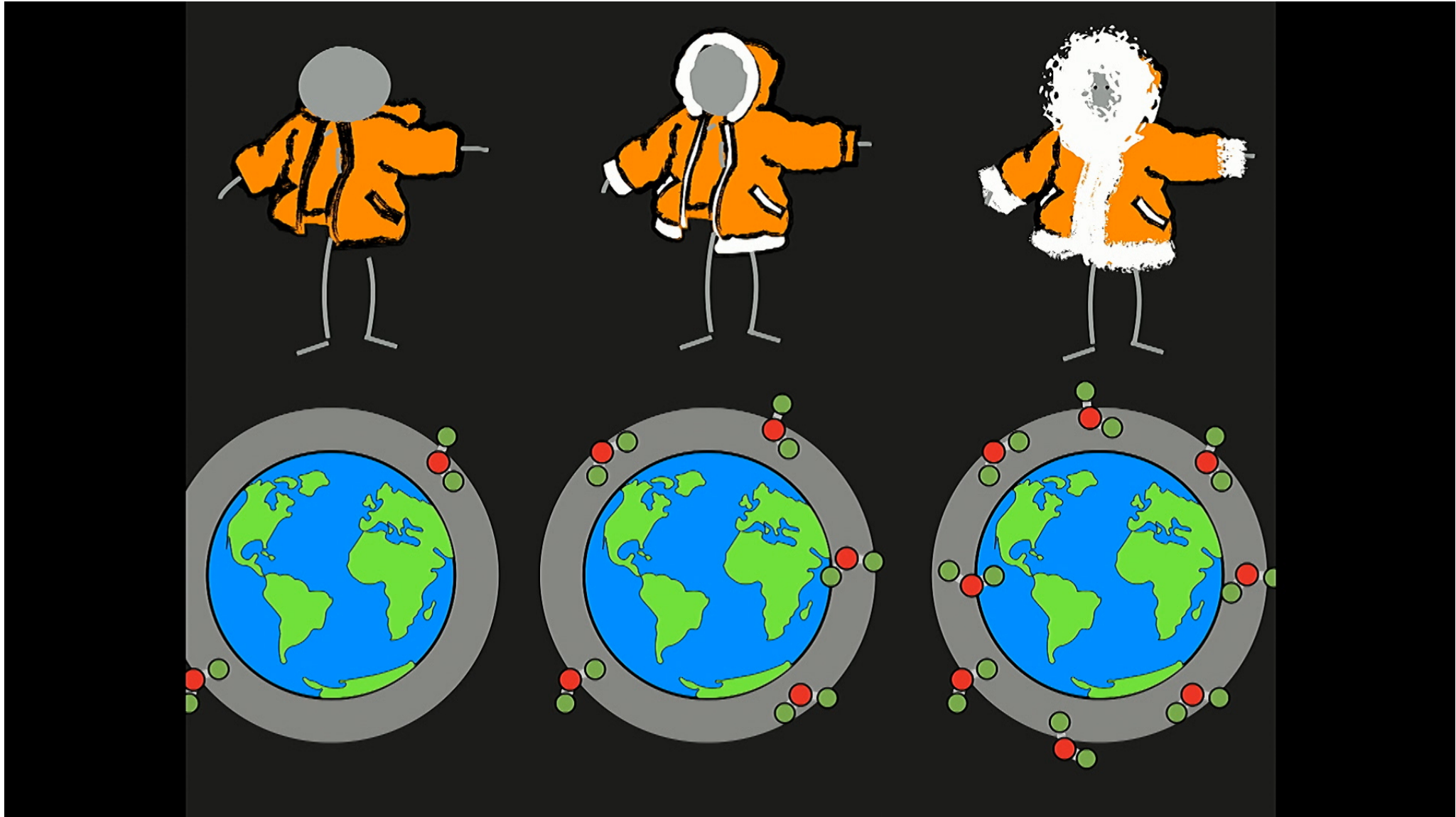


Greenhouse gas

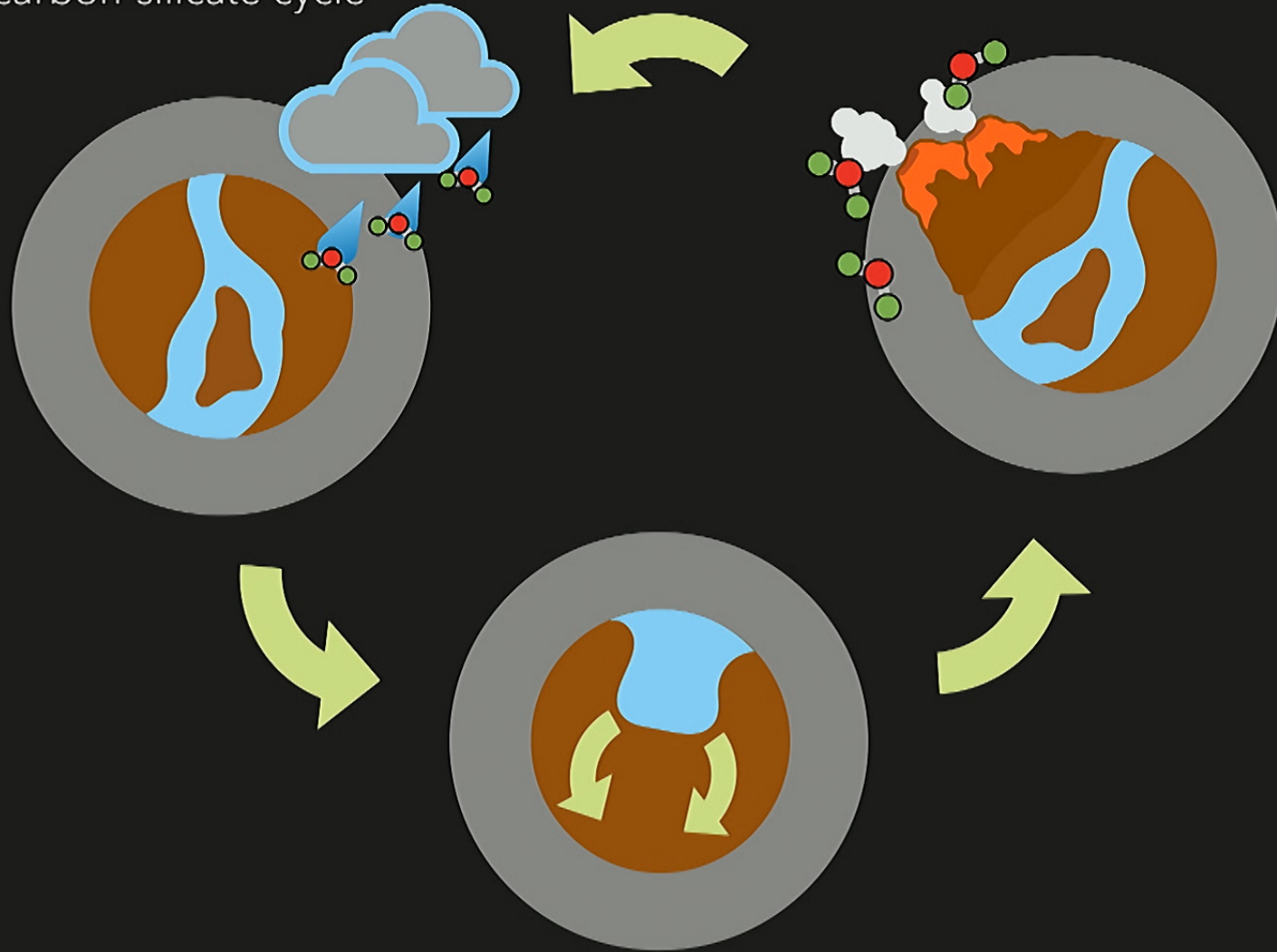


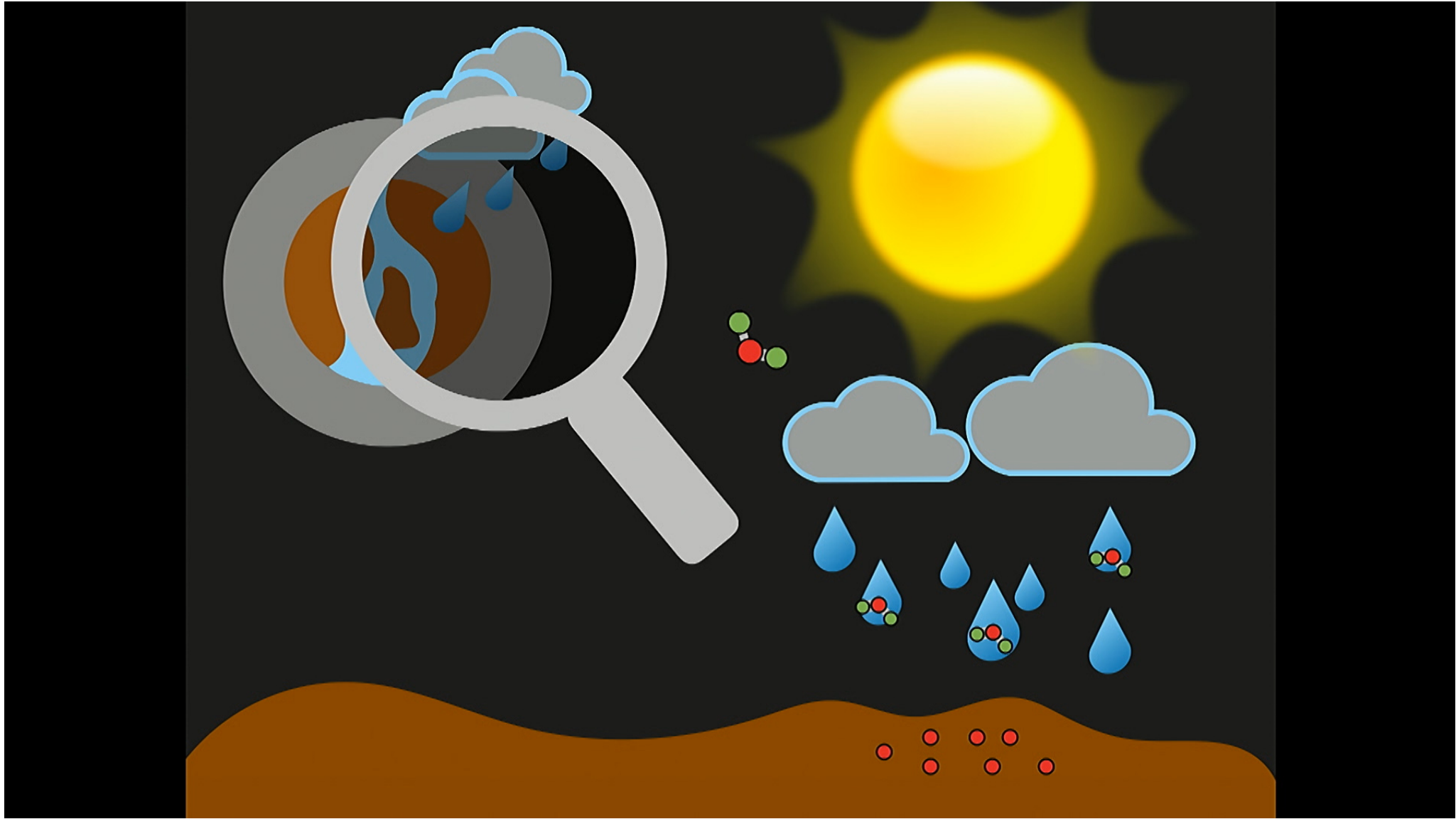


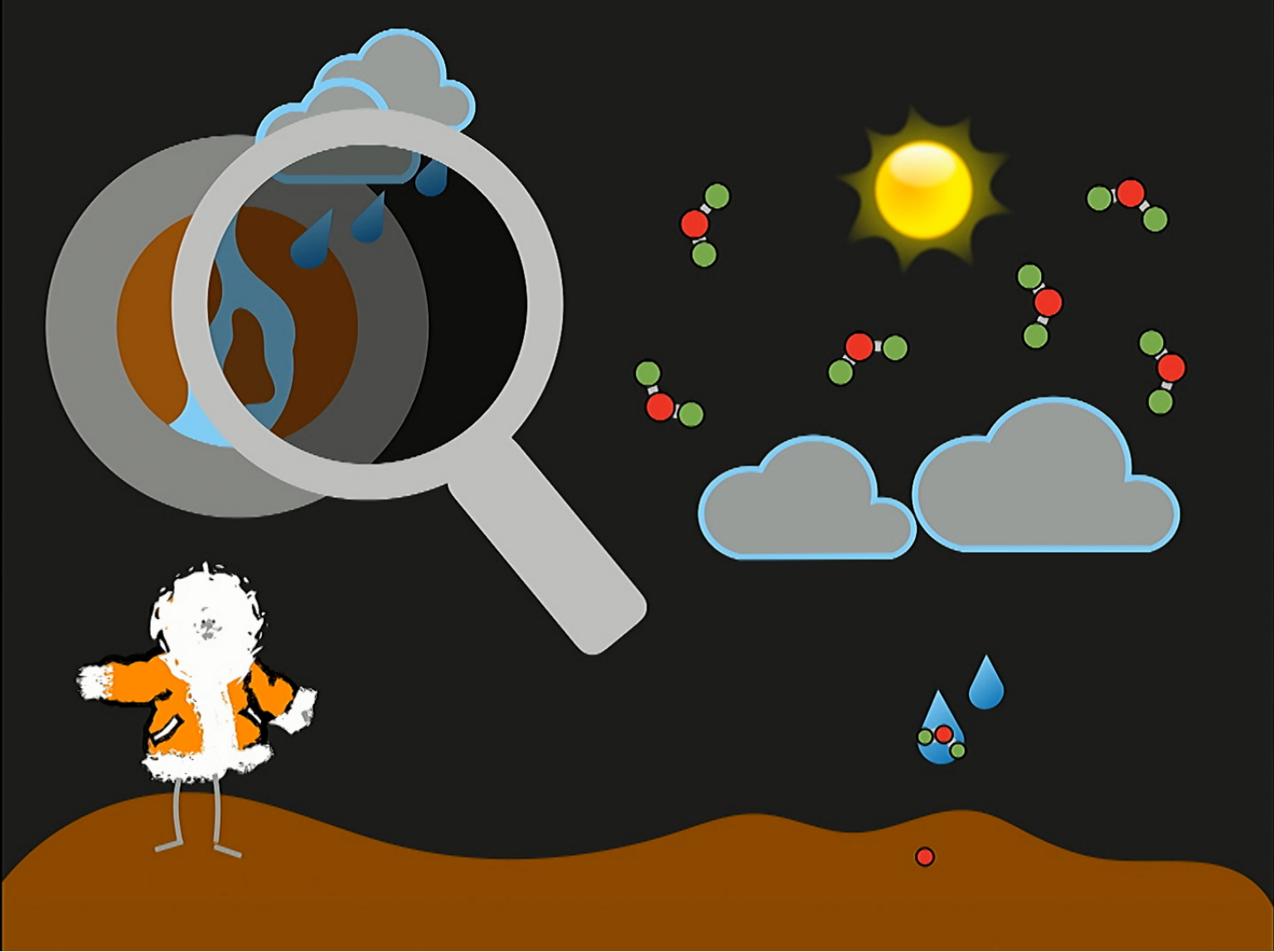
-18°C

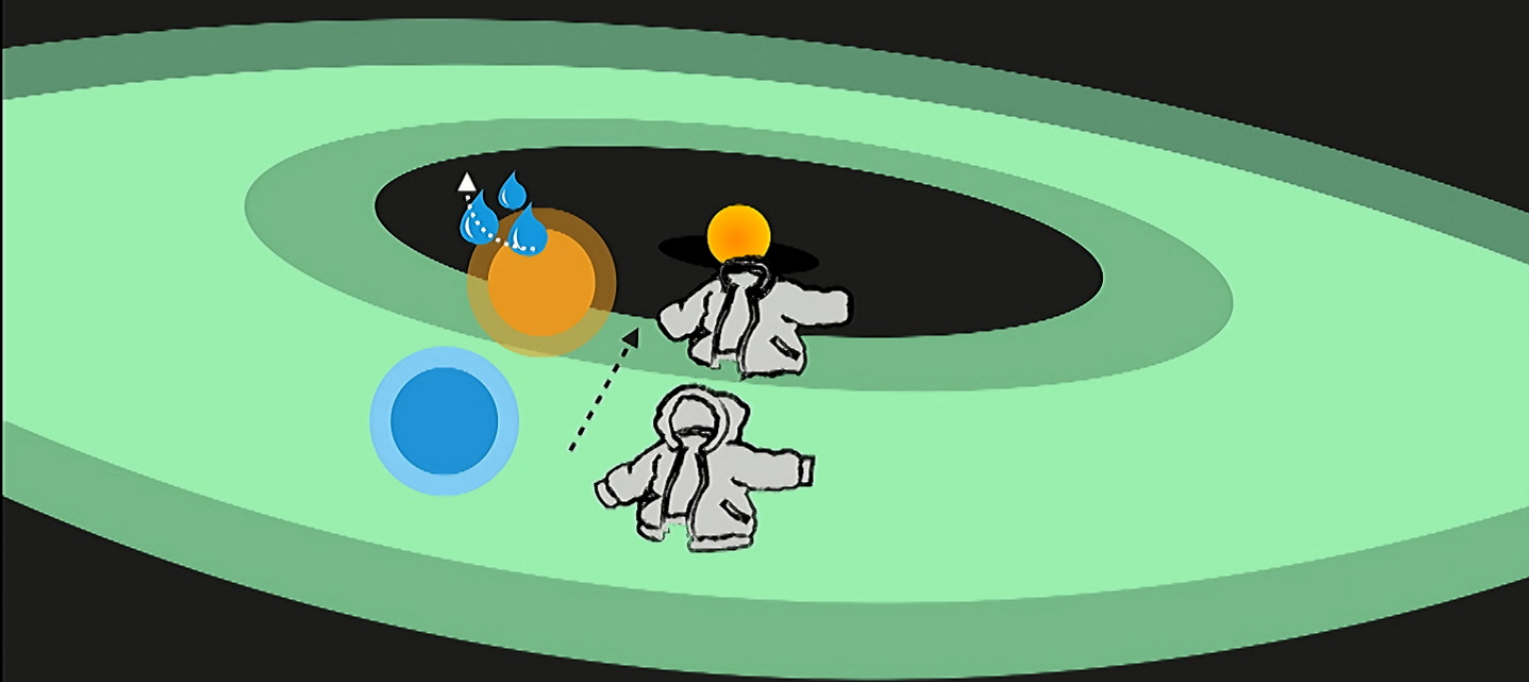


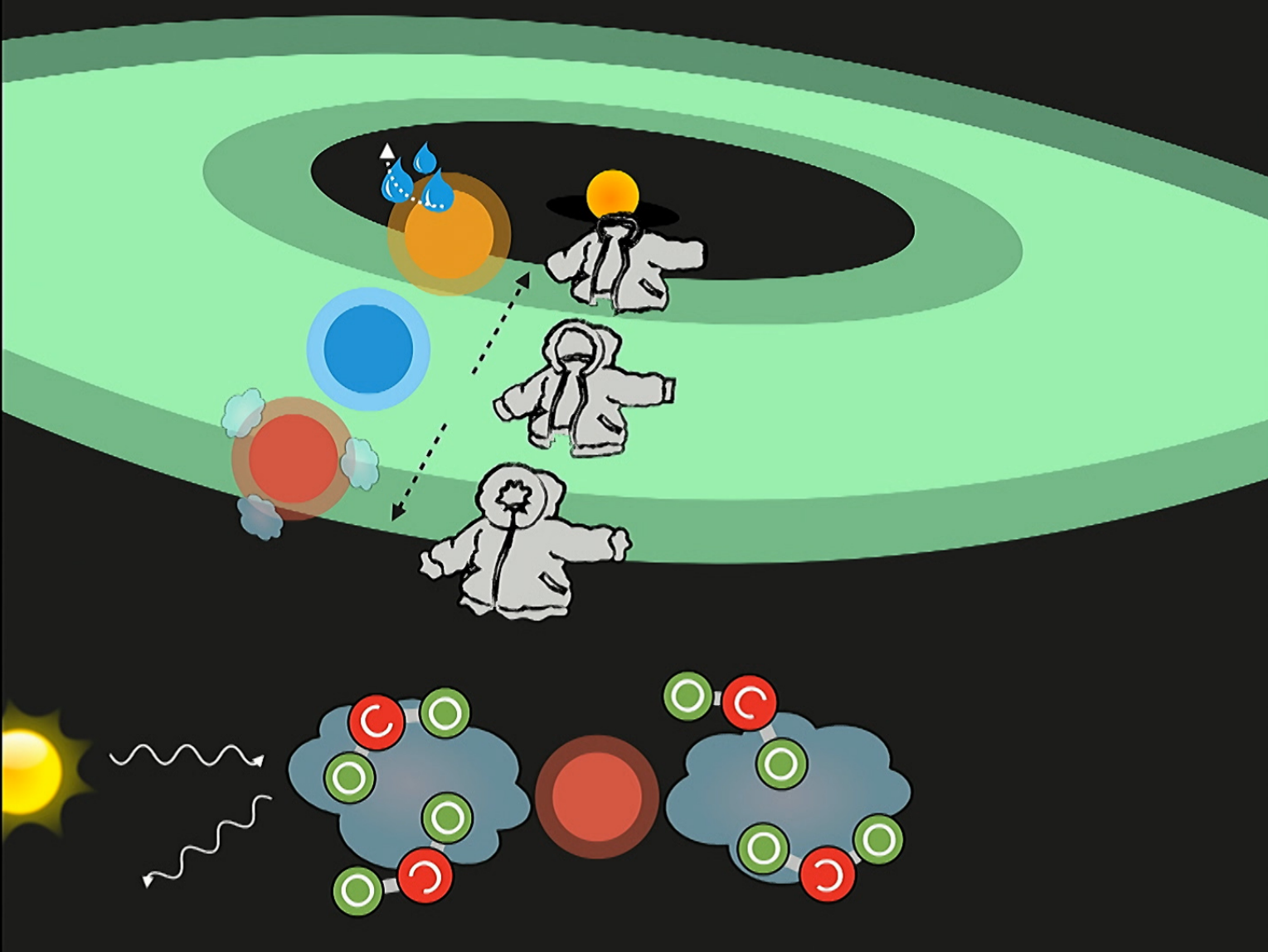
carbon-silicate cycle



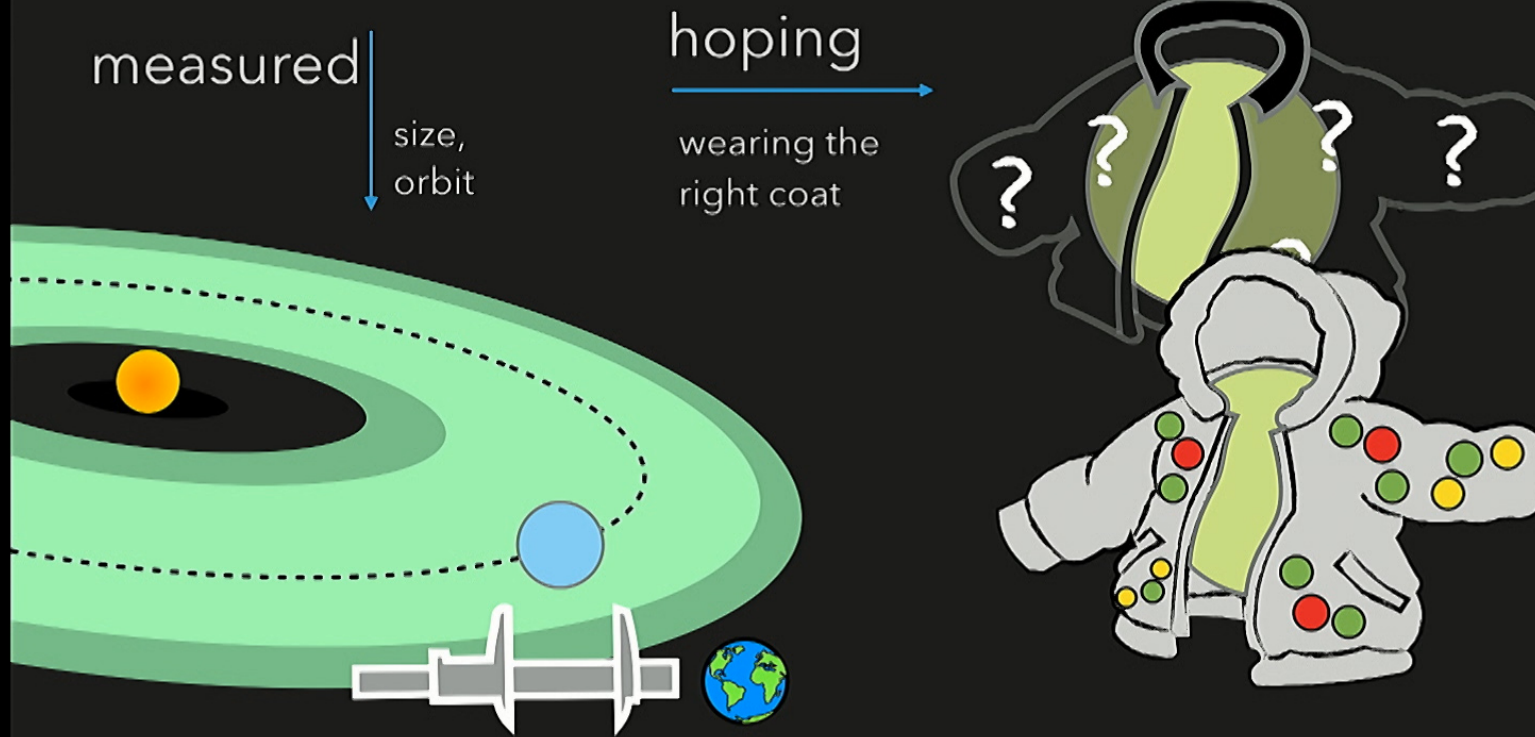




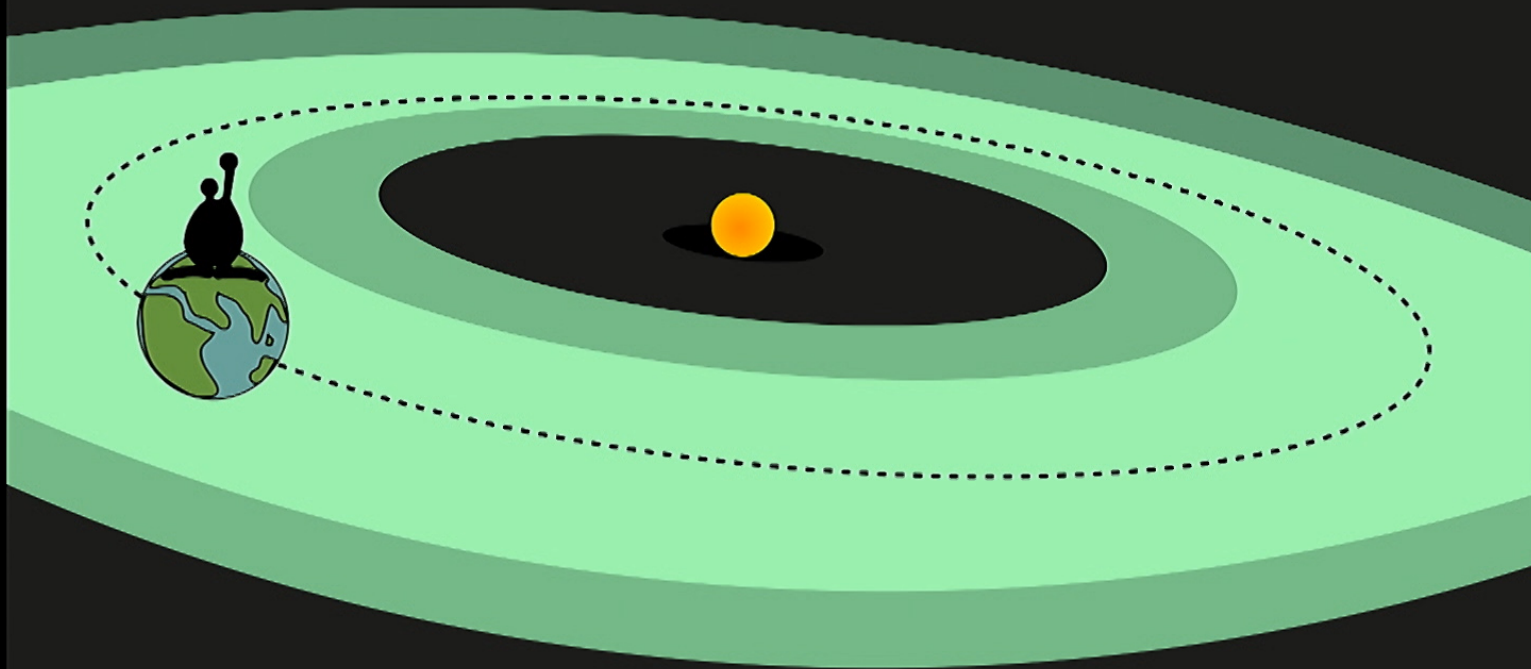




'We've found dozens of potentially habitable planets - now we need to study them in detail'



If there is another Earth out there...

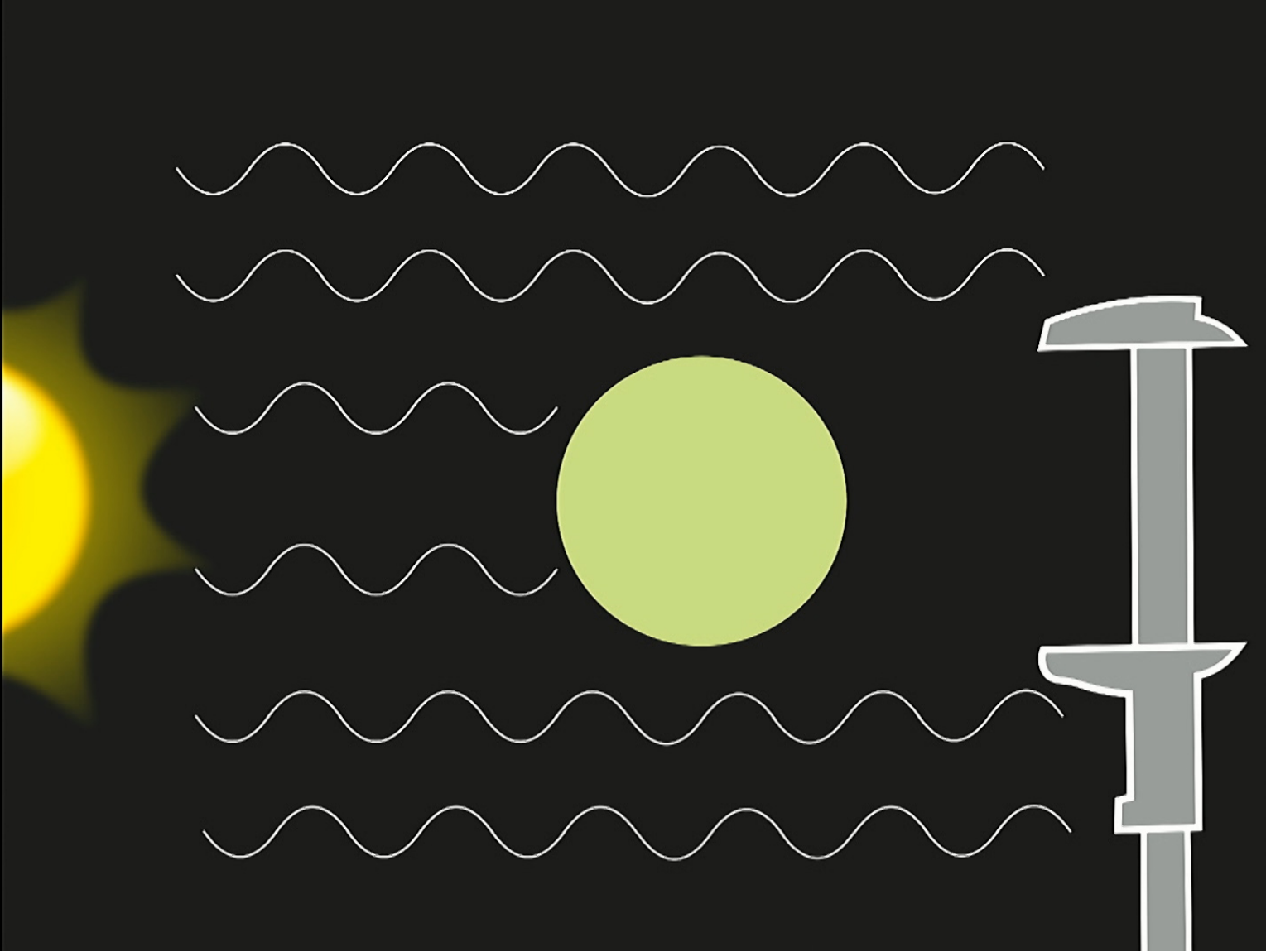


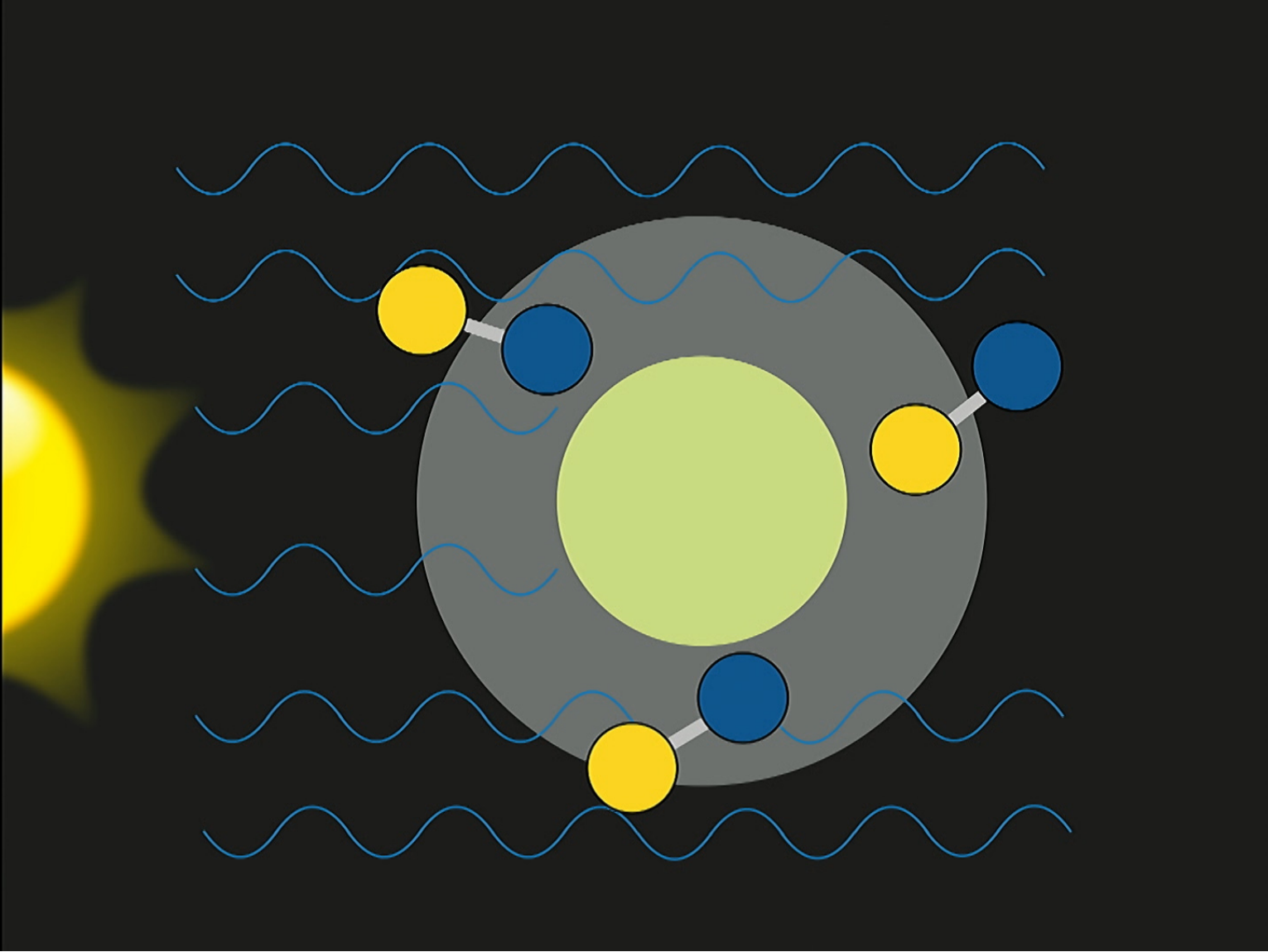
...we'll find it in the habitable zone

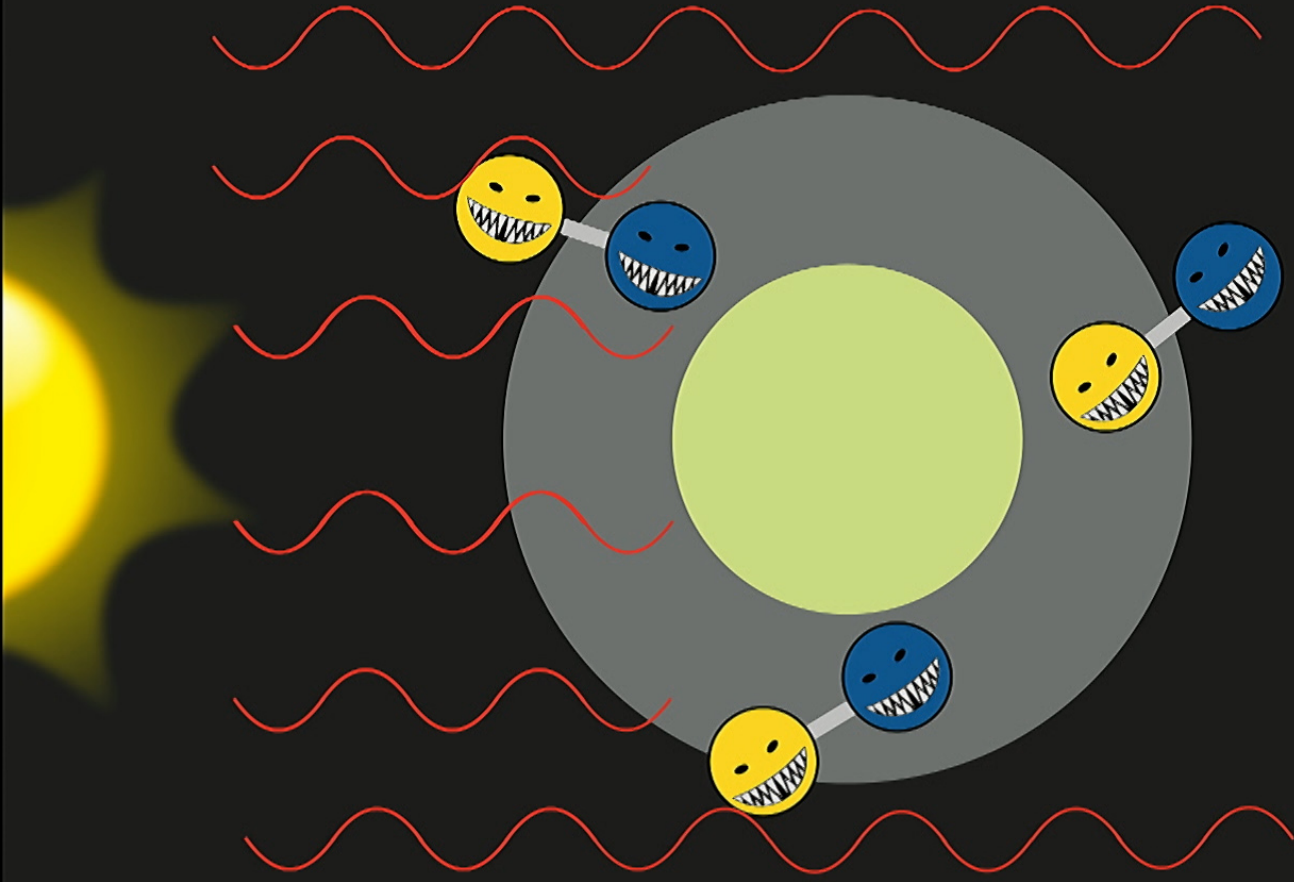
Another name?

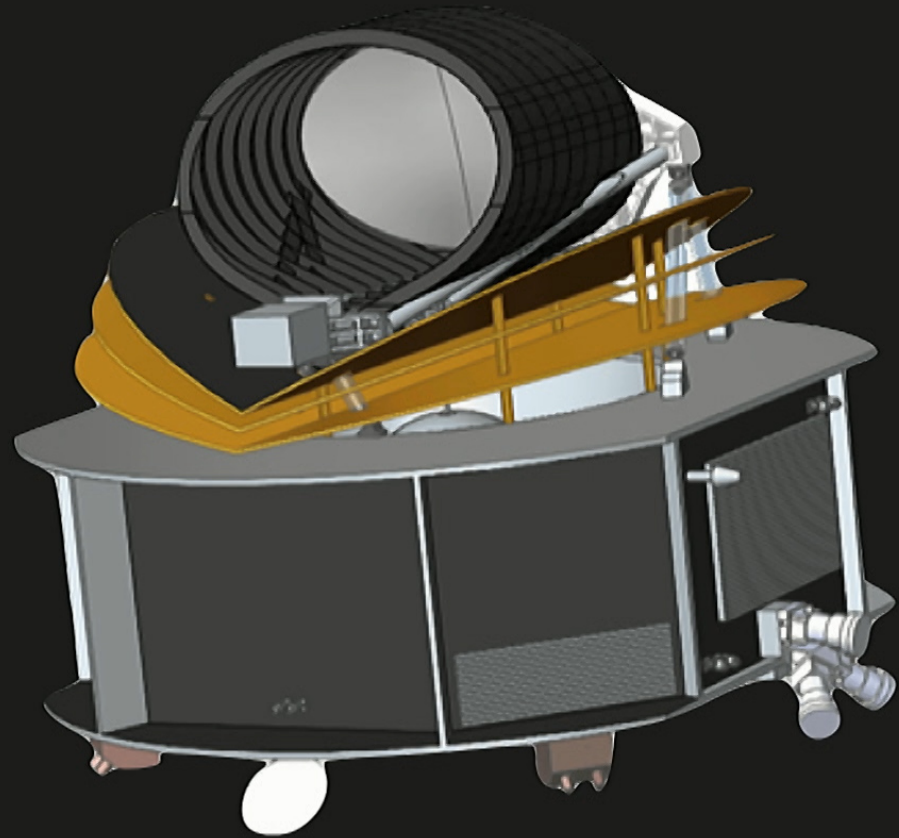
(river god idea: Chris Lintott)

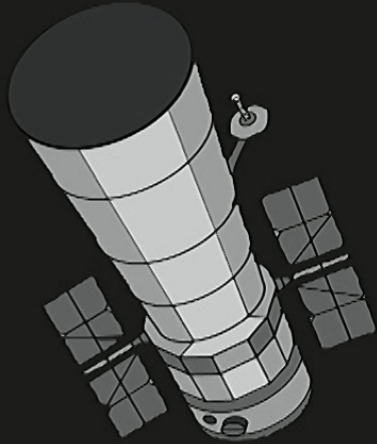
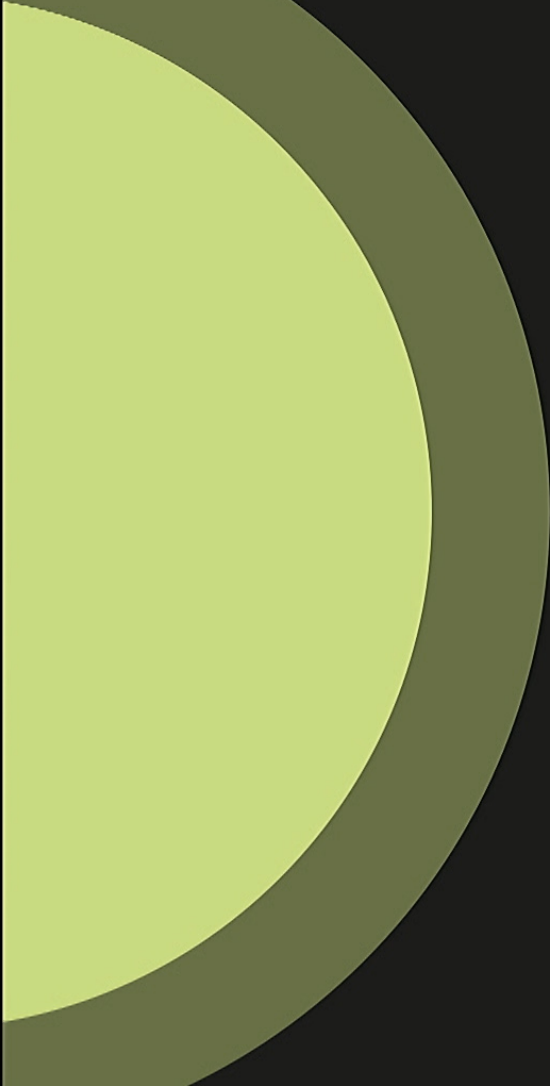








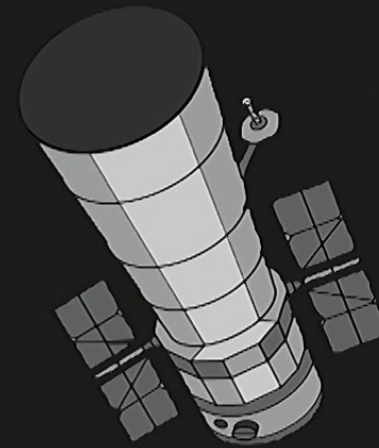




Hubble Space Telescope

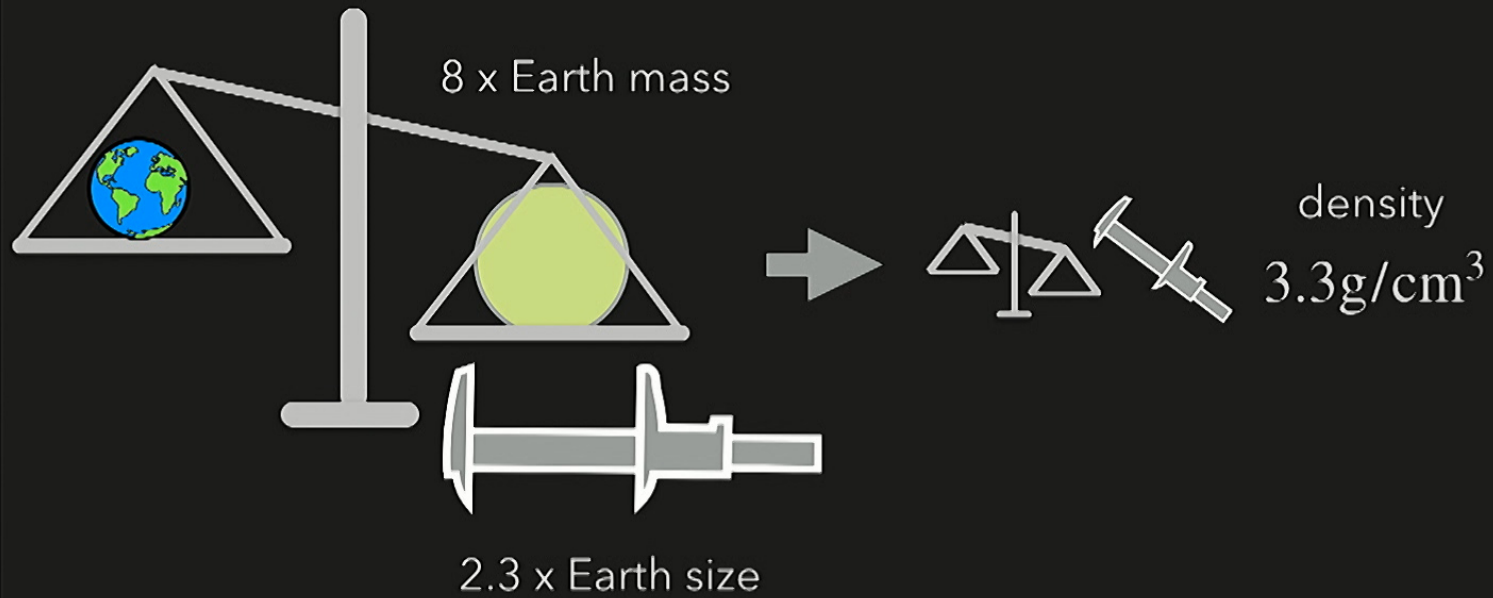
Launch: 1990 (!)

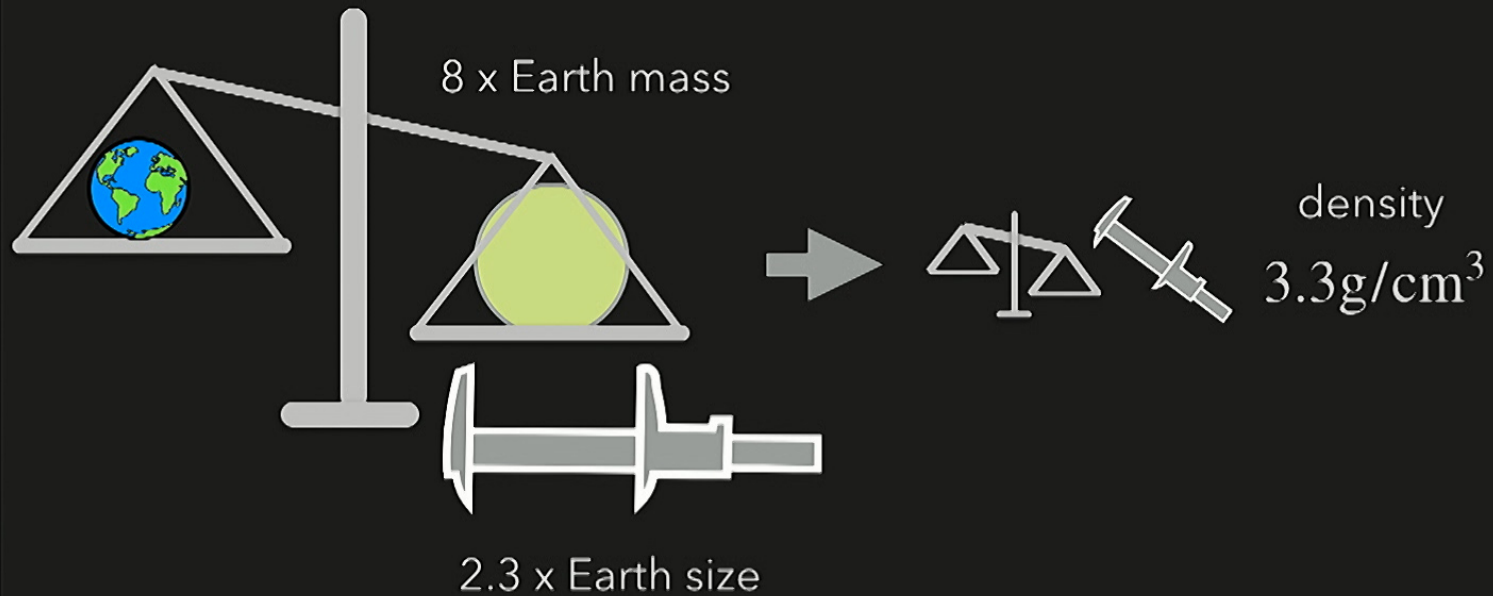
K2 18b

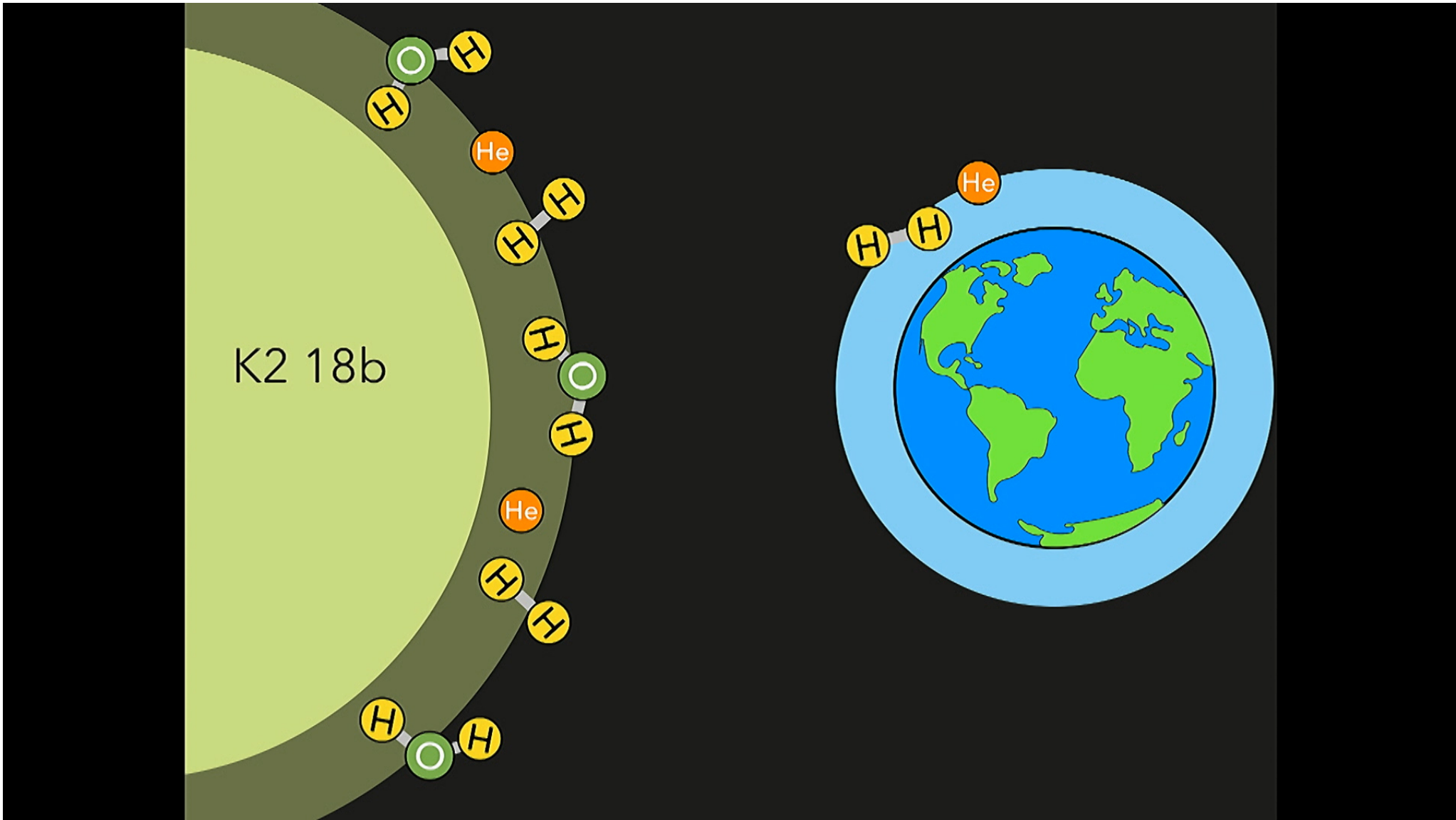


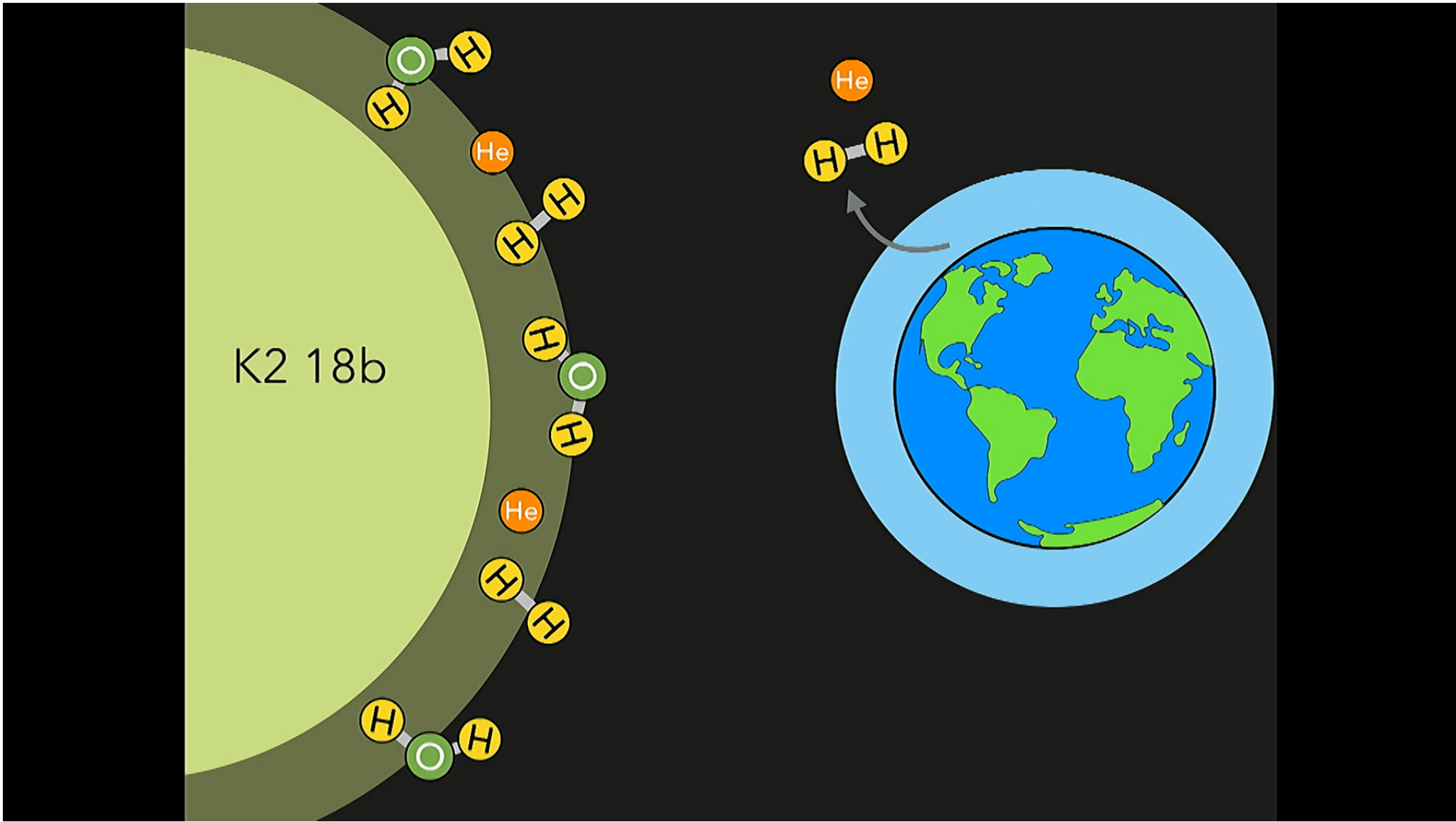
Hubble Space Telescope

Launch: 1990 (!)





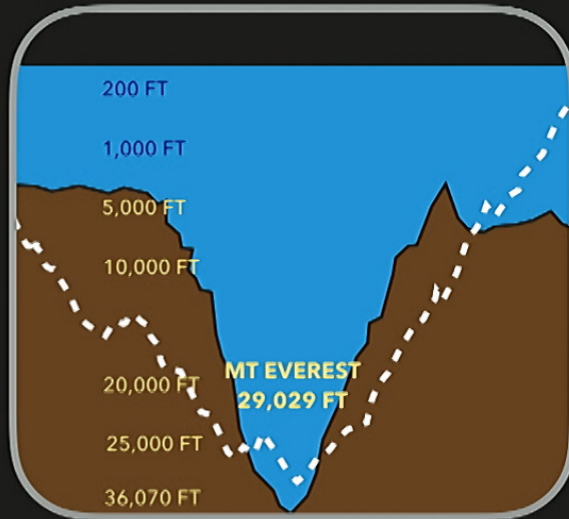






3.3g/cm^3

H, He ~ 0.7% mass



Surface: Pressure > 20 x bottom of Mariana Trench

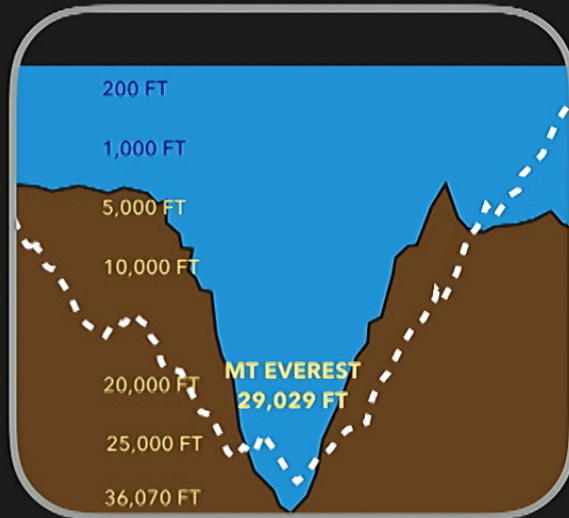


(Lopez & Fortney, ApJ, 2013)



3.3g/cm^3

H, He $\sim 0.7\%$ mass

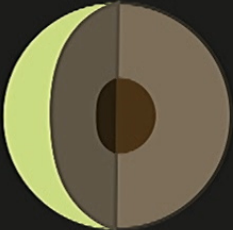
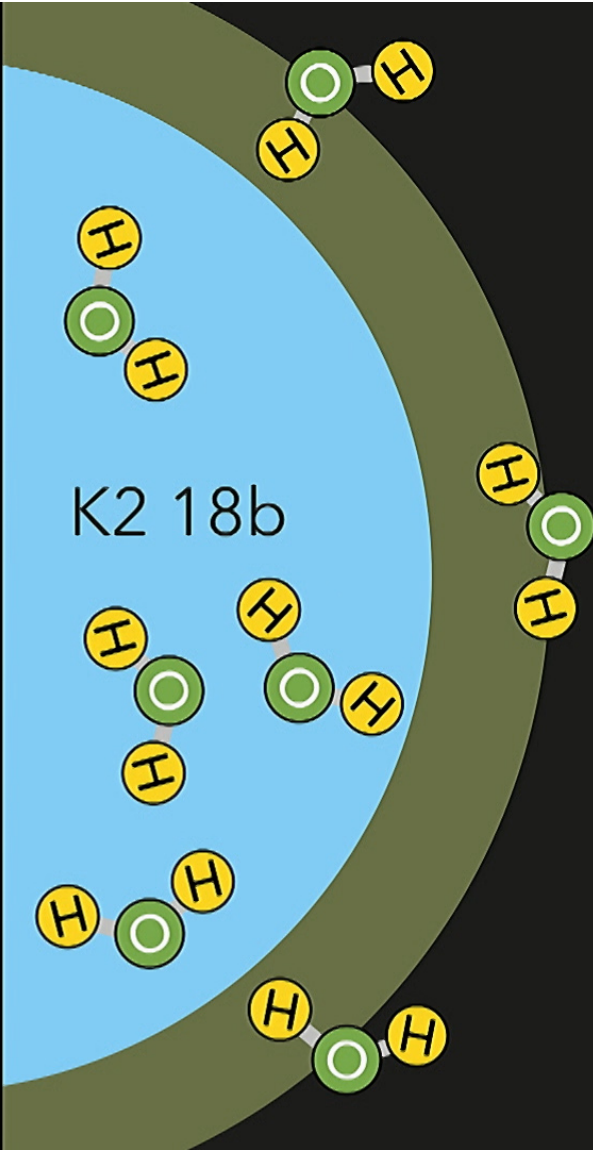


Surface: Pressure > 20 x bottom of Mariana Trench

Temperature 1000s $^{\circ}\text{C}$



(Lopez & Fortney, ApJ, 2013)



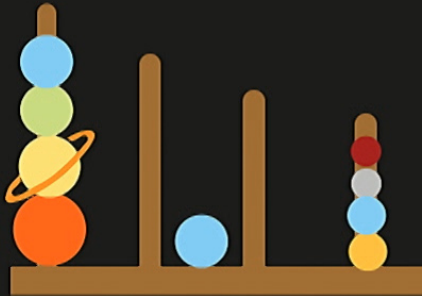
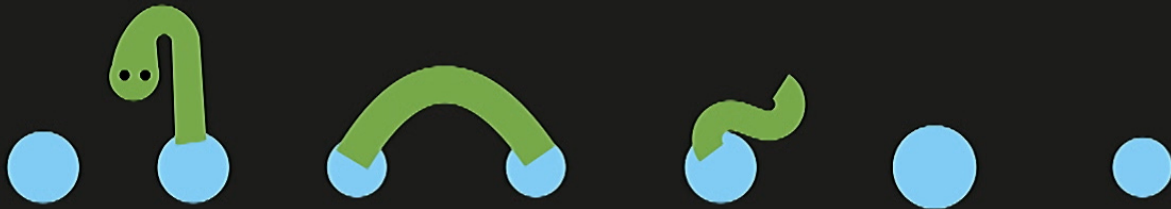
3.3g/cm^3
water ~ 50% mass

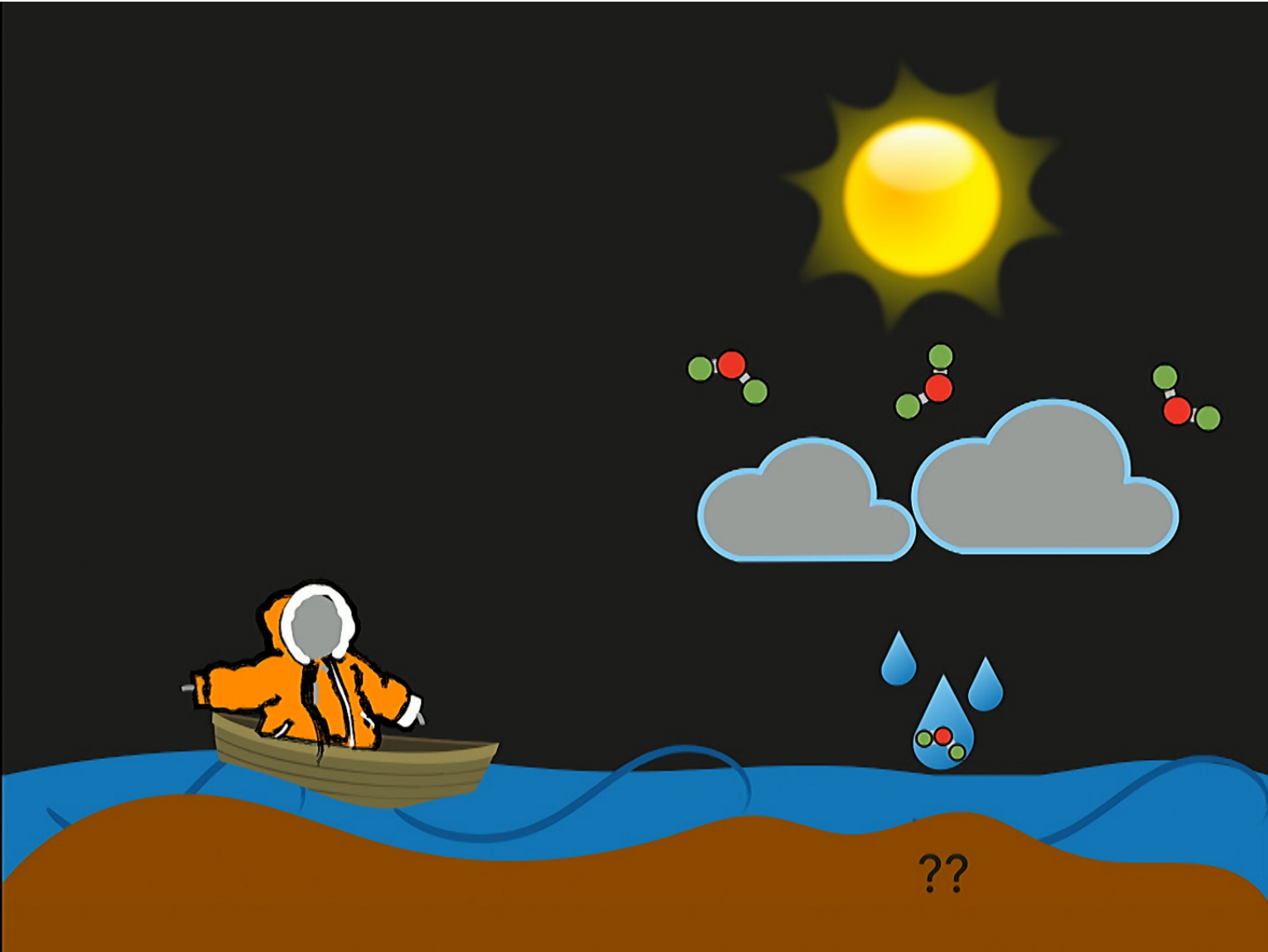


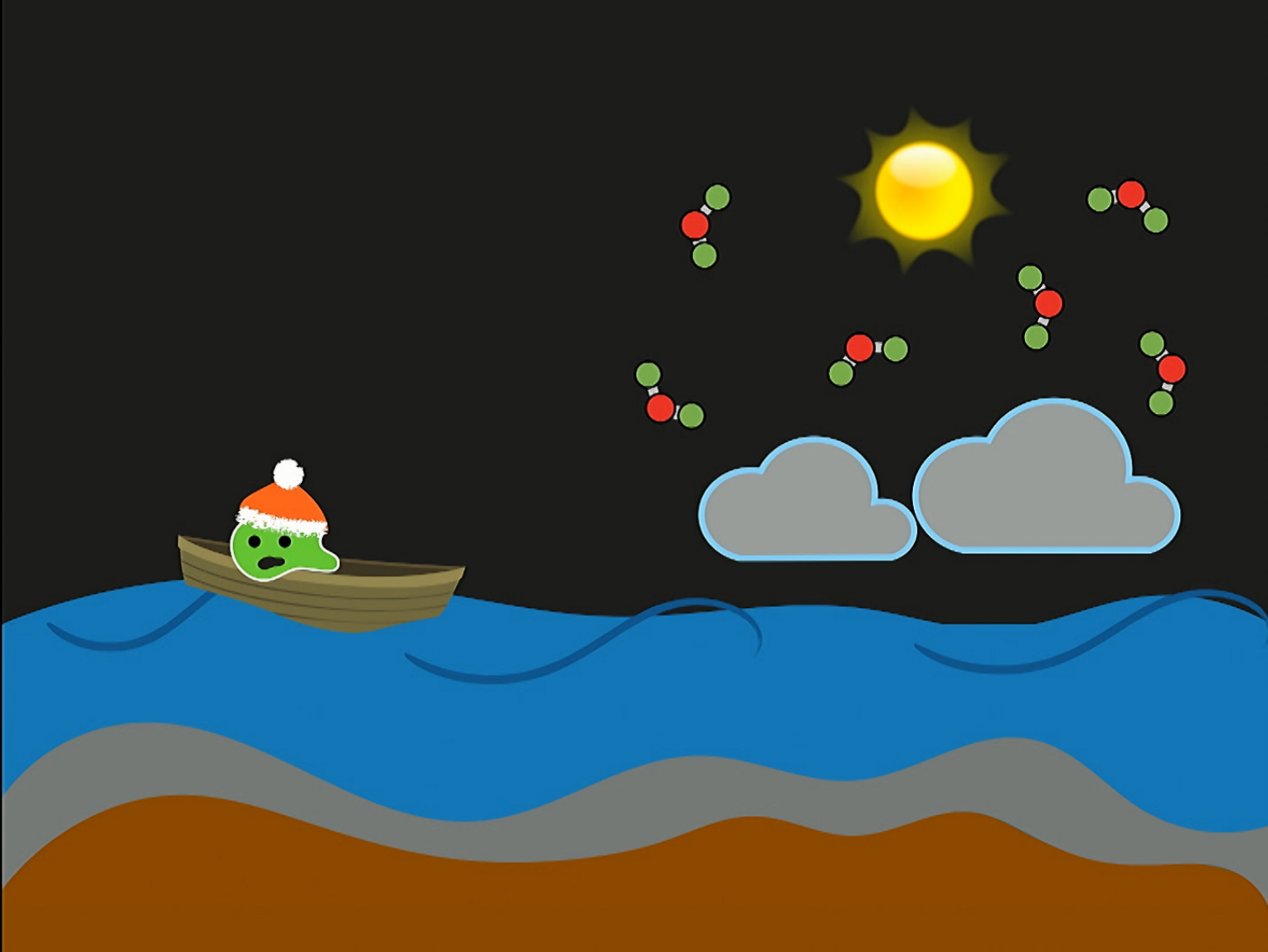
water < 0.1% mass

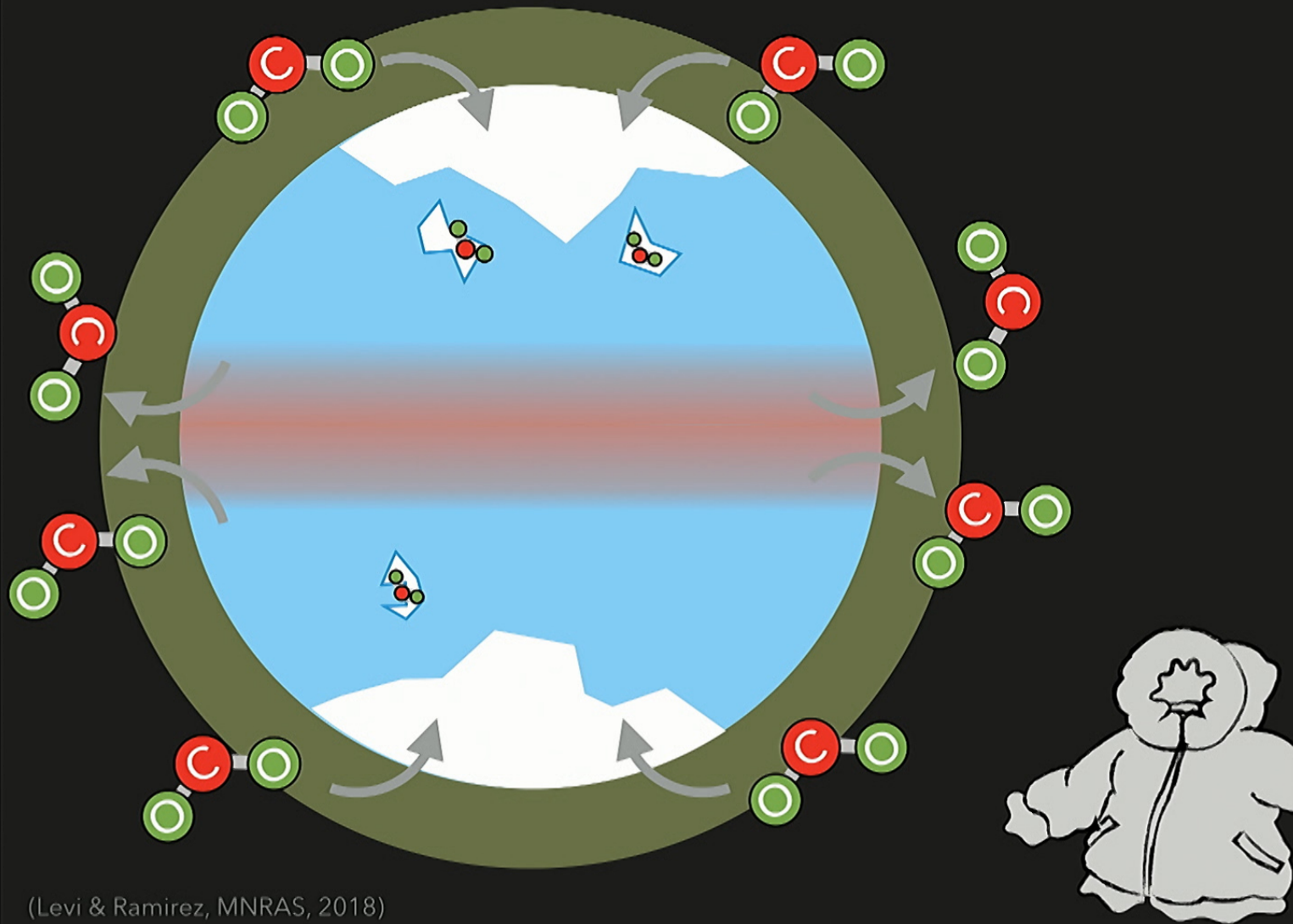


Trappist-1

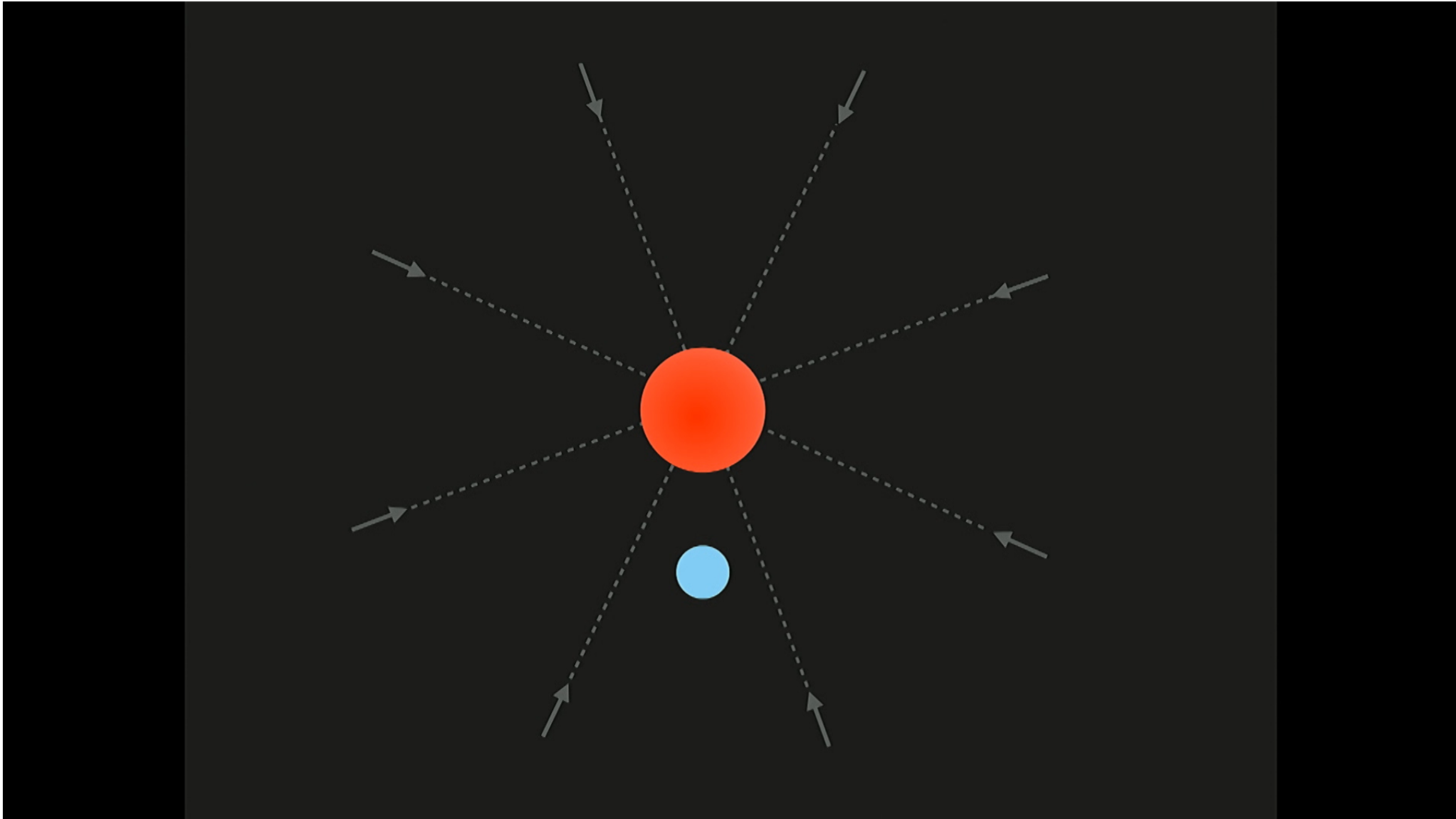


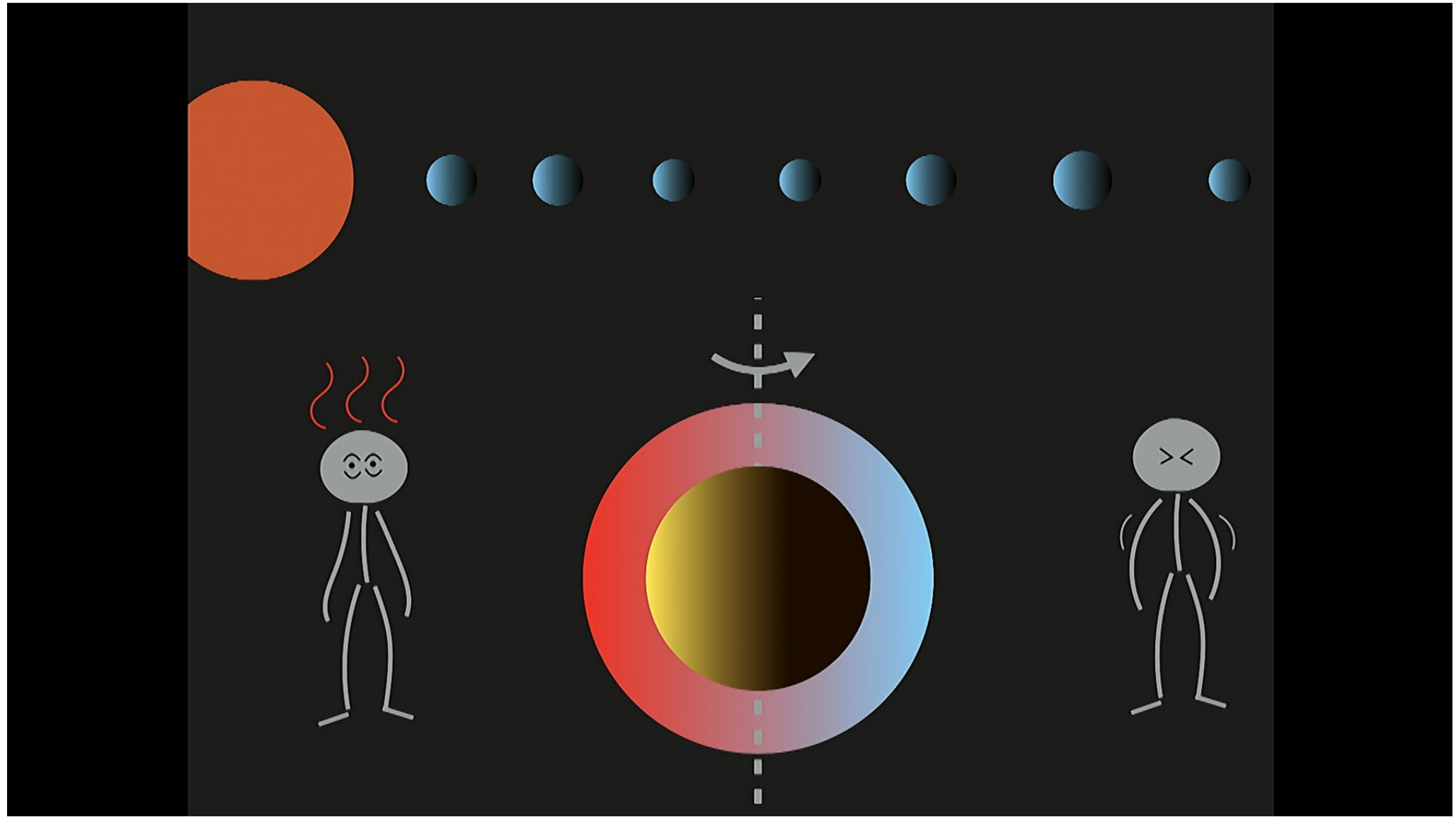


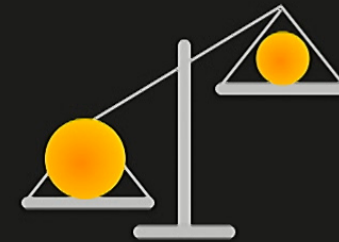
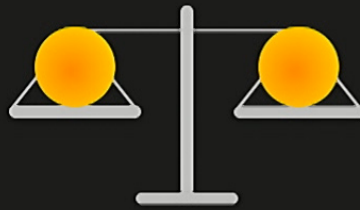


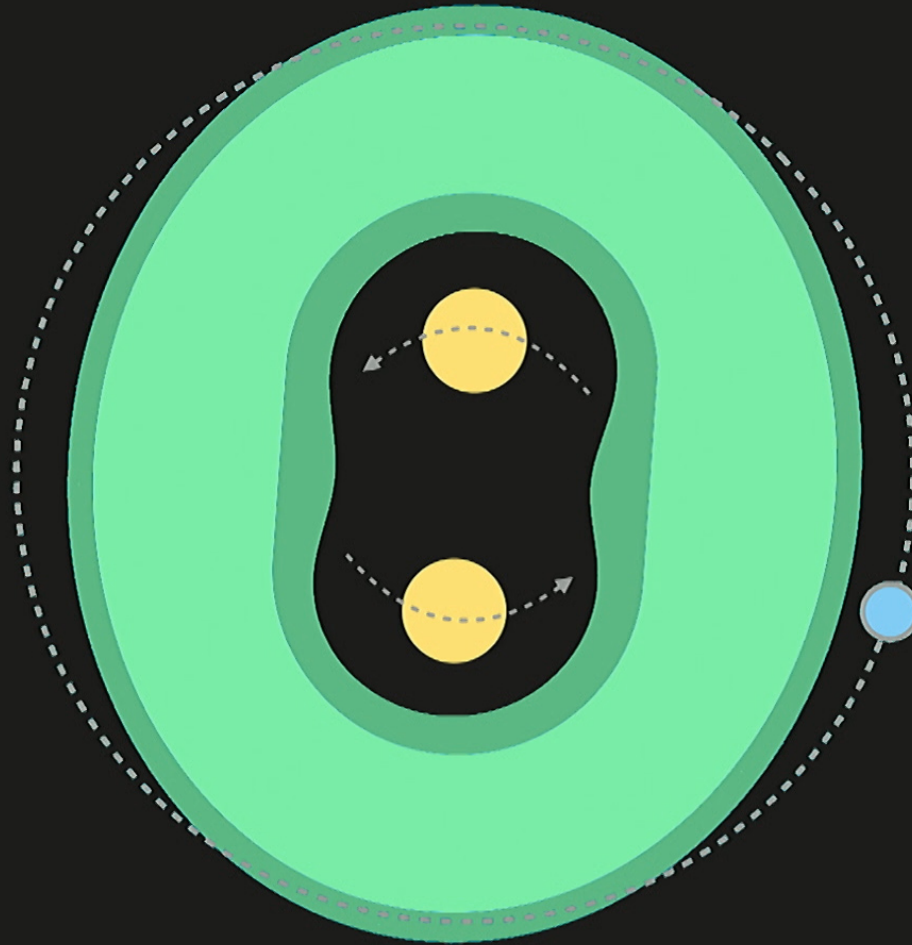


(Levi & Ramirez, MNRAS, 2018)









RELAX ON
KEPLER-16b

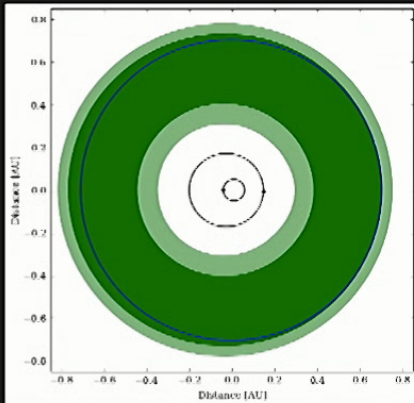
THE LAND OF TWO SUNS
WHERE YOUR SHADOW ALWAYS HAS COMPANY

Like Luke Skywalker's planet "Tatooine" in Star Wars, Kepler-16b orbits a pair of stars. Depicted here as a terrestrial planet, Kepler-16b might also be a gas giant like Saturn. Prospects for life on this unusual world aren't good, as it has a temperature similar to that of dry ice. But the discovery indicates that the movie's heroic double sunset is anything but science fiction.

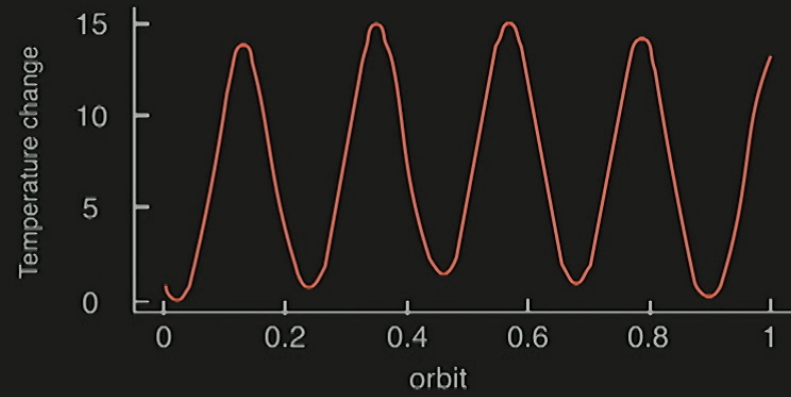
NASA's Exoplanet Exploration Program, Jet Propulsion Laboratory, Pasadena, CA
www.nasa.gov

Discovered 2011

x 100 ~



<http://astro.twam.info/hz/>



(Kane & Hinkel, 2013)

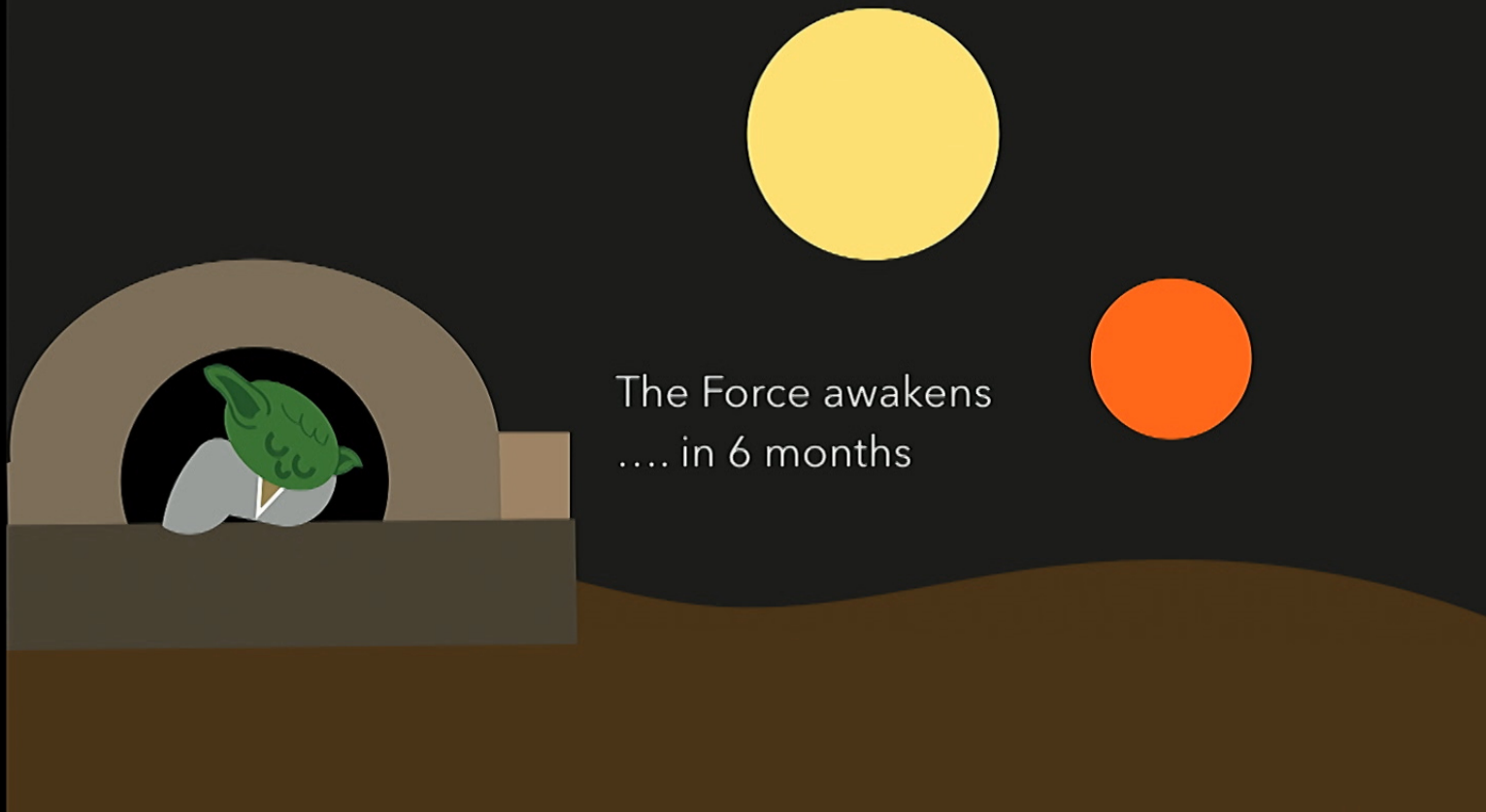
Little ice age (~1600s): 1 - 2 °C



Frozen Thames, 1677 (Abraham Hondius)

Life might hibernate during inhospitable spells

(Kane et al. 2012)

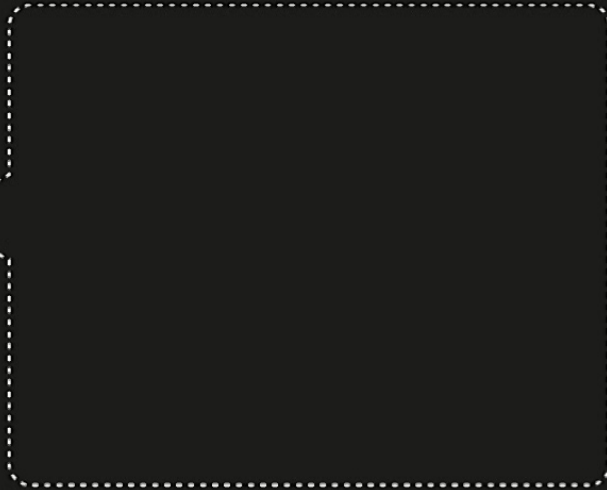


HOW TO...

... die horrifyingly inside the habitable zone



EARTH-LIKE



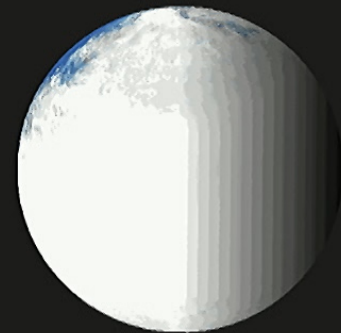
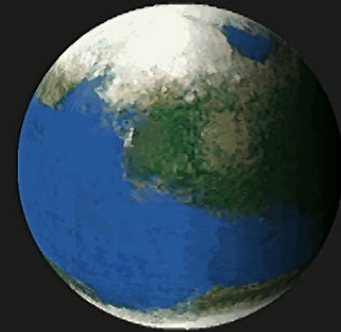
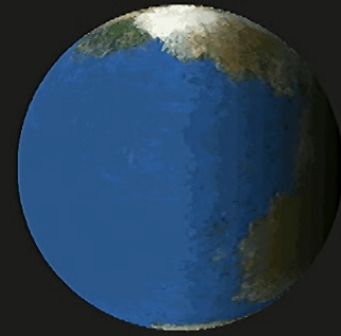
How different can Earth-like be?



<http://earthlike.world>



@earthlikeworld



EARTH-LIKE



Hey @EarthLikeWorld,
I'd like a planet with a
land fraction of 0.6
and volcanism rate of
2.5 with a habitable
zone position of 0.86!

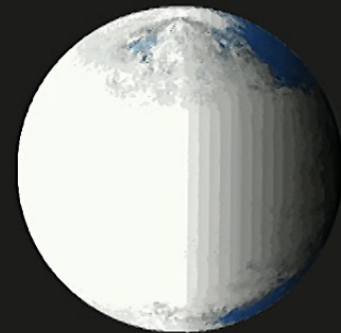
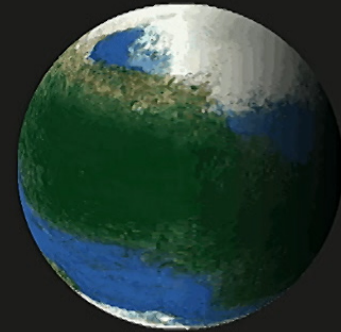
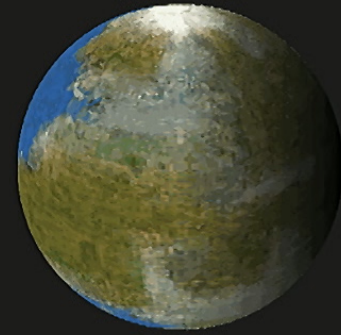
How different can Earth-like be?



<http://earthlike.world>

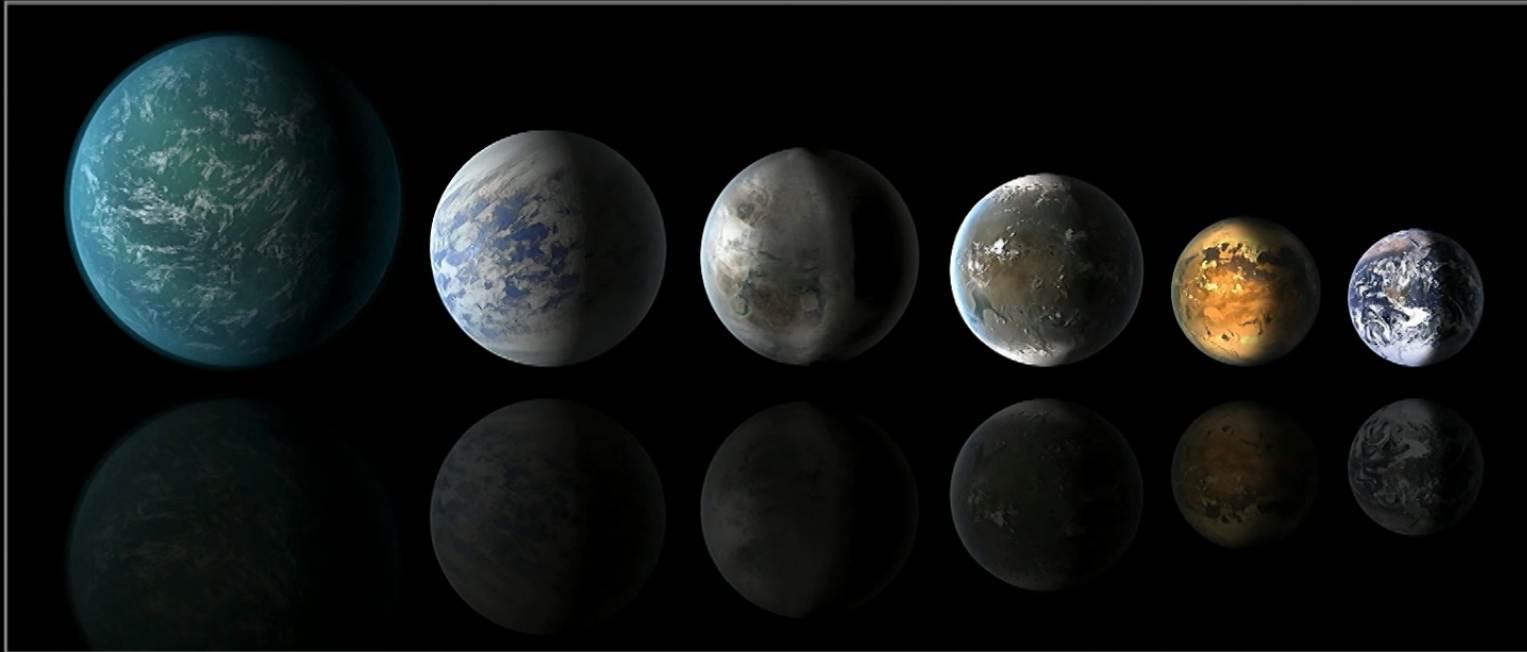


@earthlikeworld



MANY WORLDS

NASA NExSS column for in-depth exoplanet & astrobiology stories



<http://www.manyworlds.space>

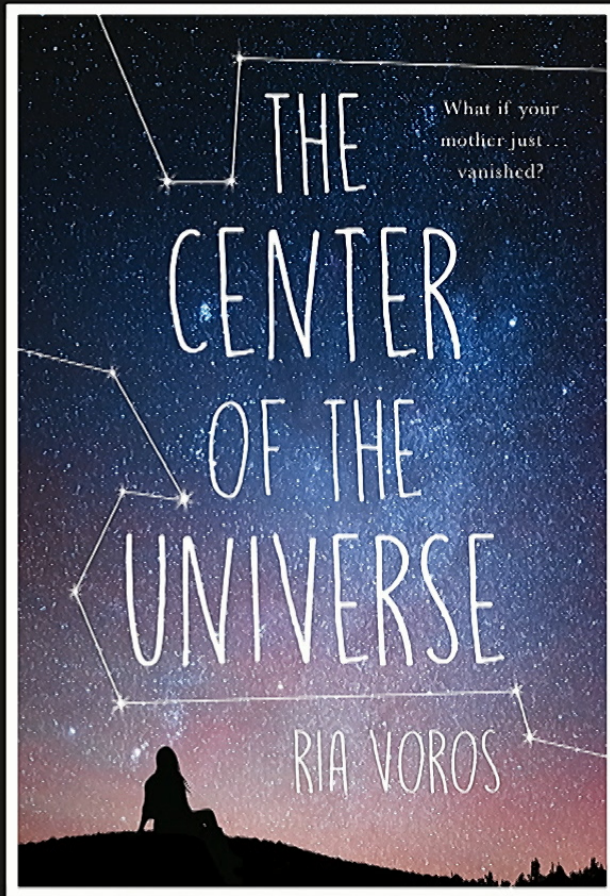


@nexssmanyworlds



nexssmanyworlds

THE CENTER OF THE UNIVERSE



SHAMELESS PITCH!

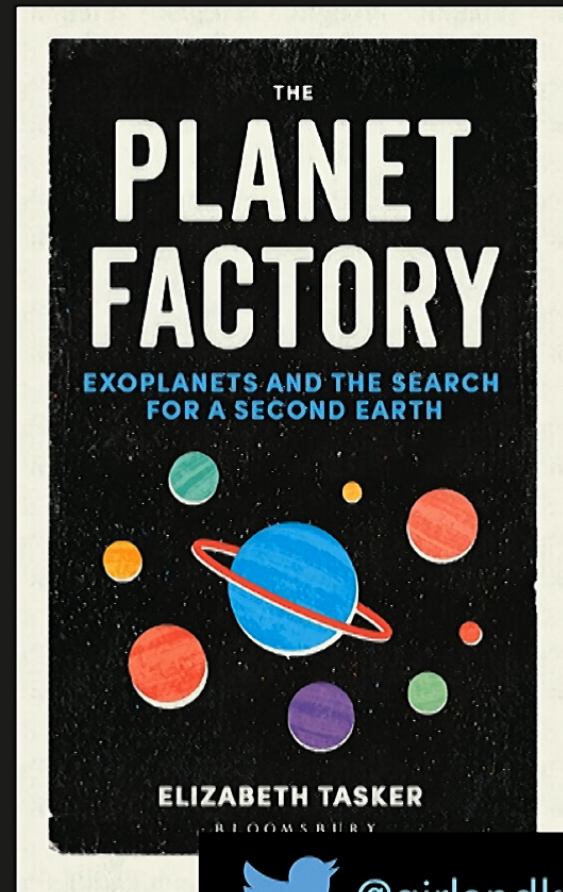
utterly

Shiny book, full of truly awful planets

Hot Jupiters, Tatooine worlds with 2 stars, rogue worlds with no star, planets with seas of lava or tar ...



Death awaits...



@girlandkat