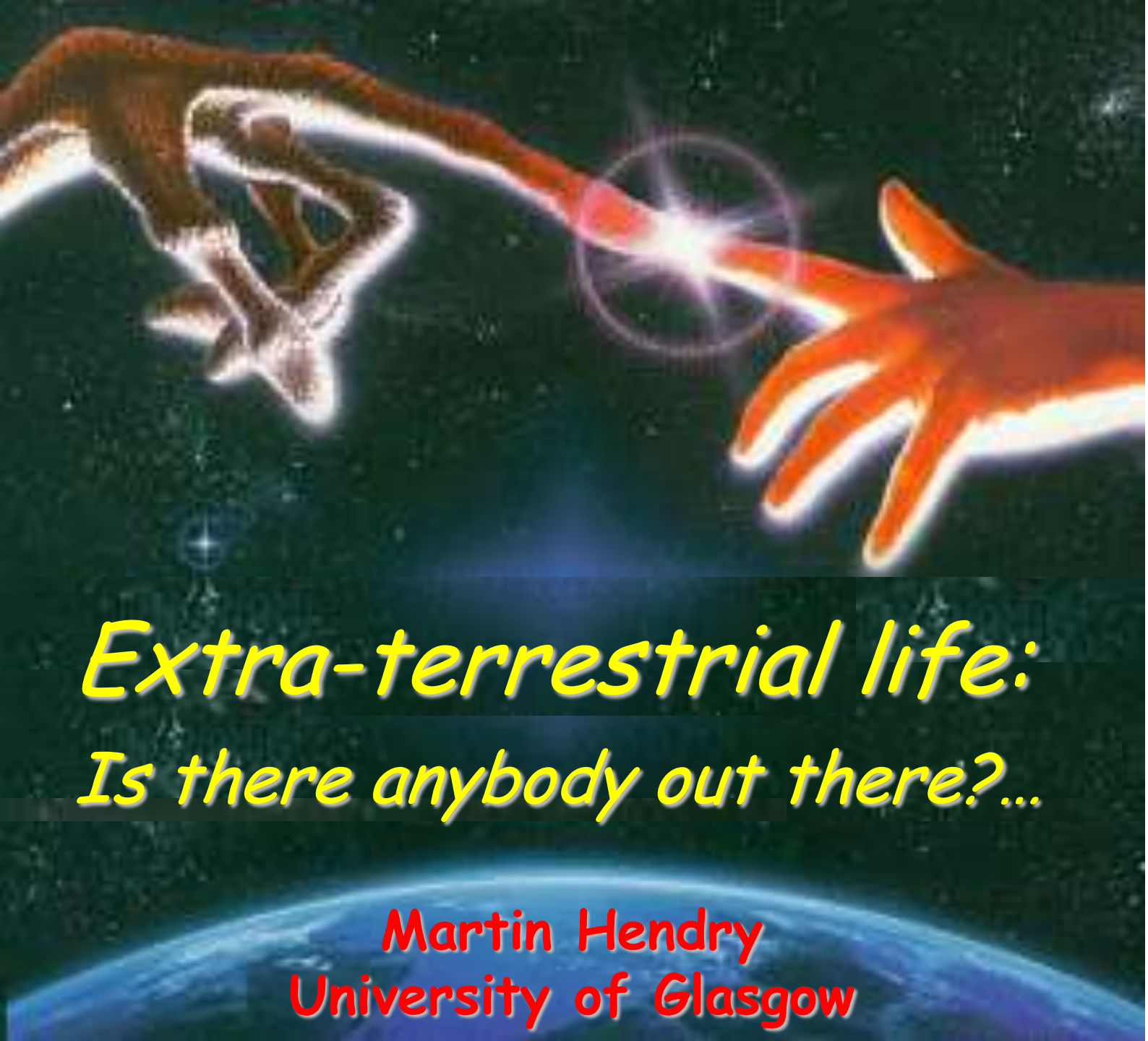


Extra-terrestrial life:
Is there anybody out there?...

Martin Hendry
University of Glasgow

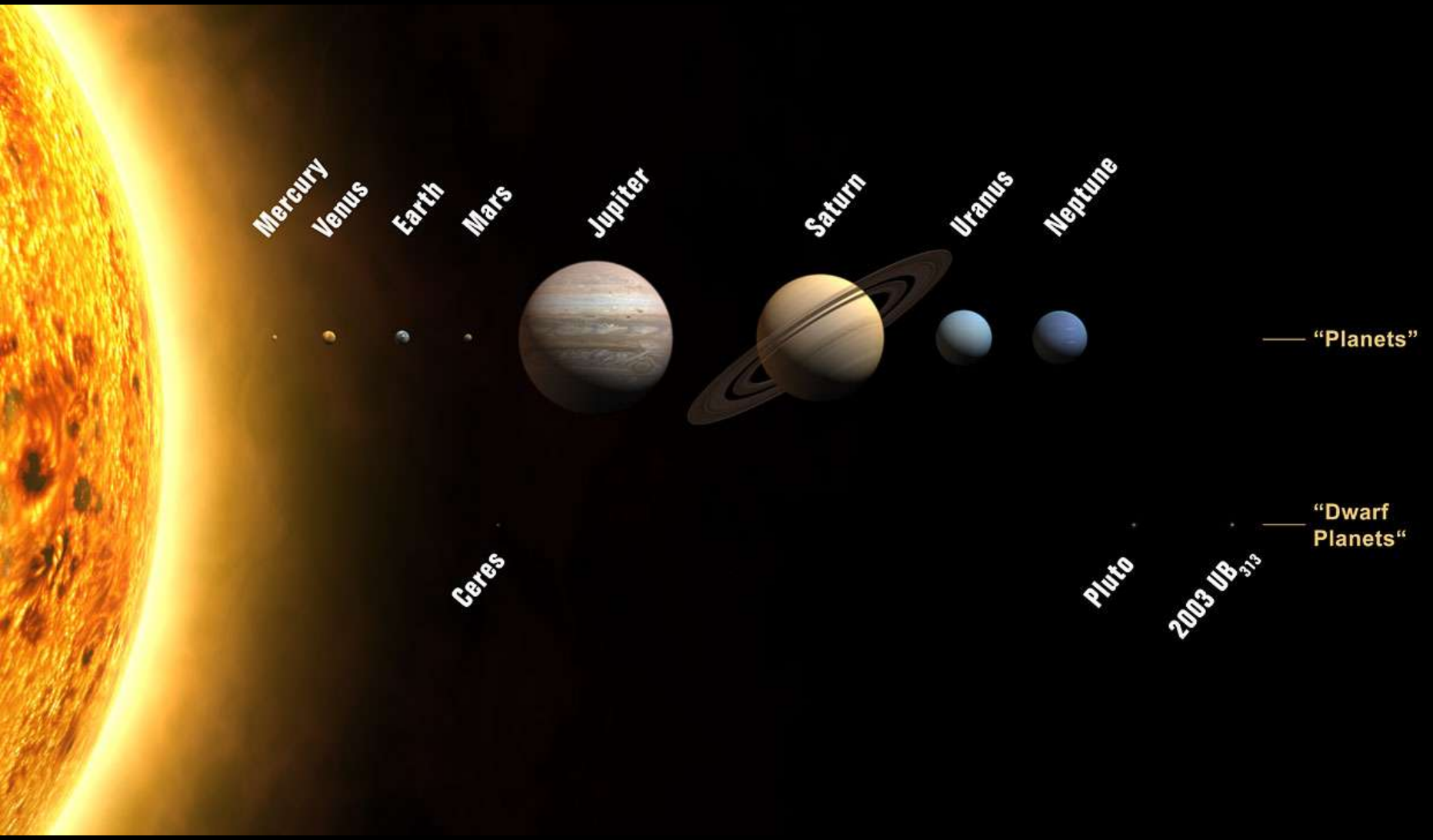
University of Glasgow

Science & Technology Facilities Council

THE UNIVERSE YOURS TO DISCOVER
BEYOND
INTERNATIONAL YEAR OF ASTRONOMY

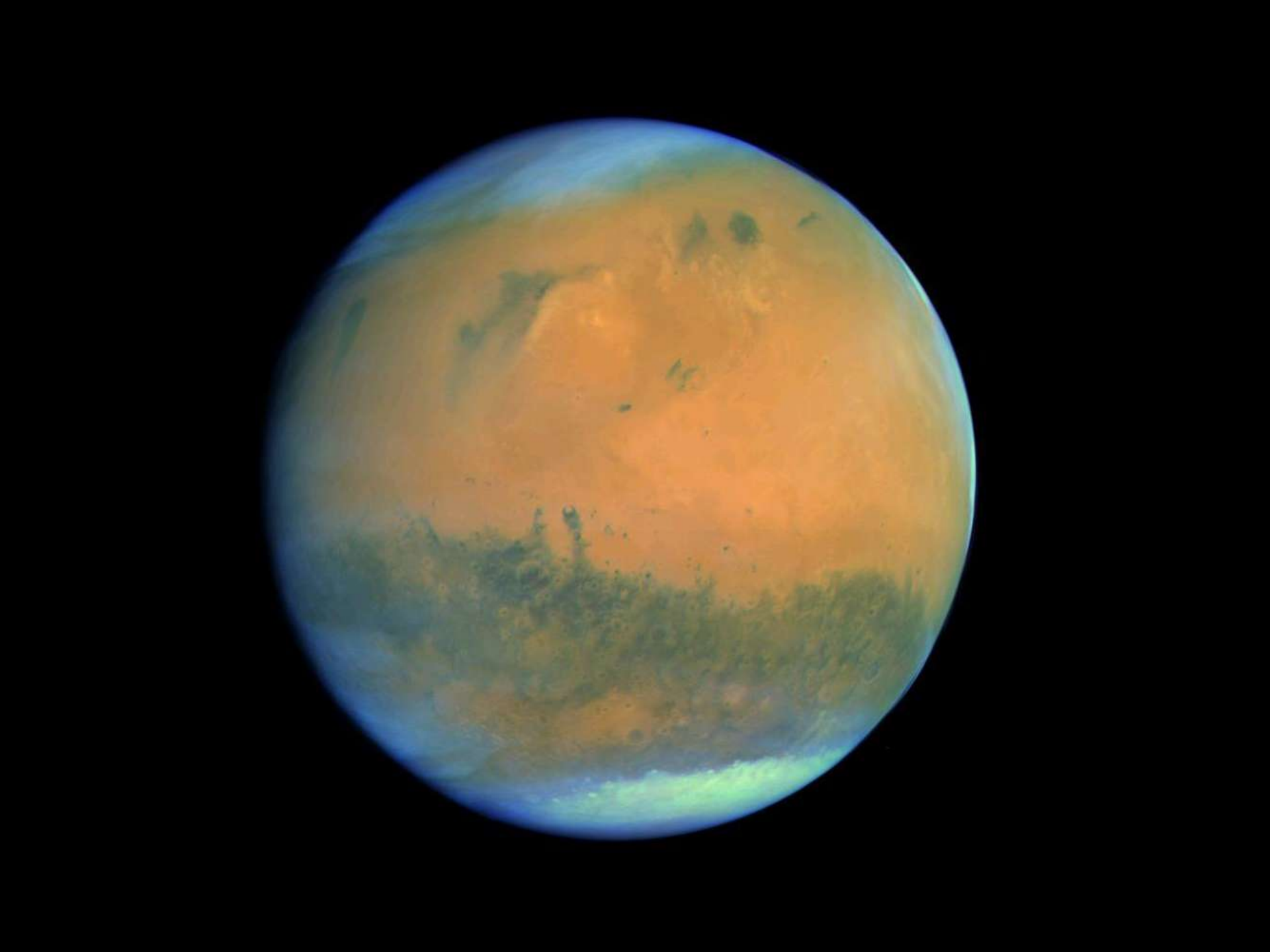
Orkney

Dec 2011


Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
"Planets"
Ceres
Pluto
2003 UB313
"Dwarf Planets"

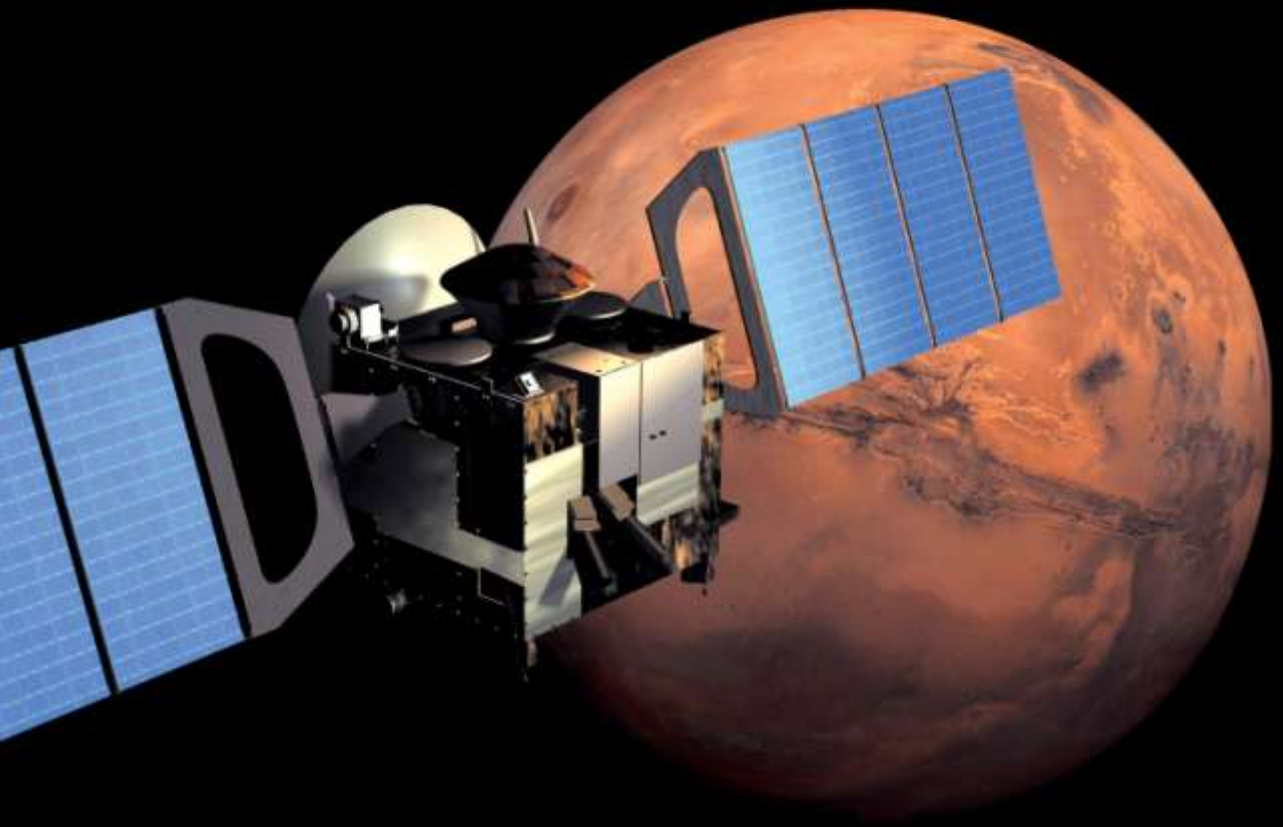
- Liquid Water
- Oxygen
- Carbon Dioxide

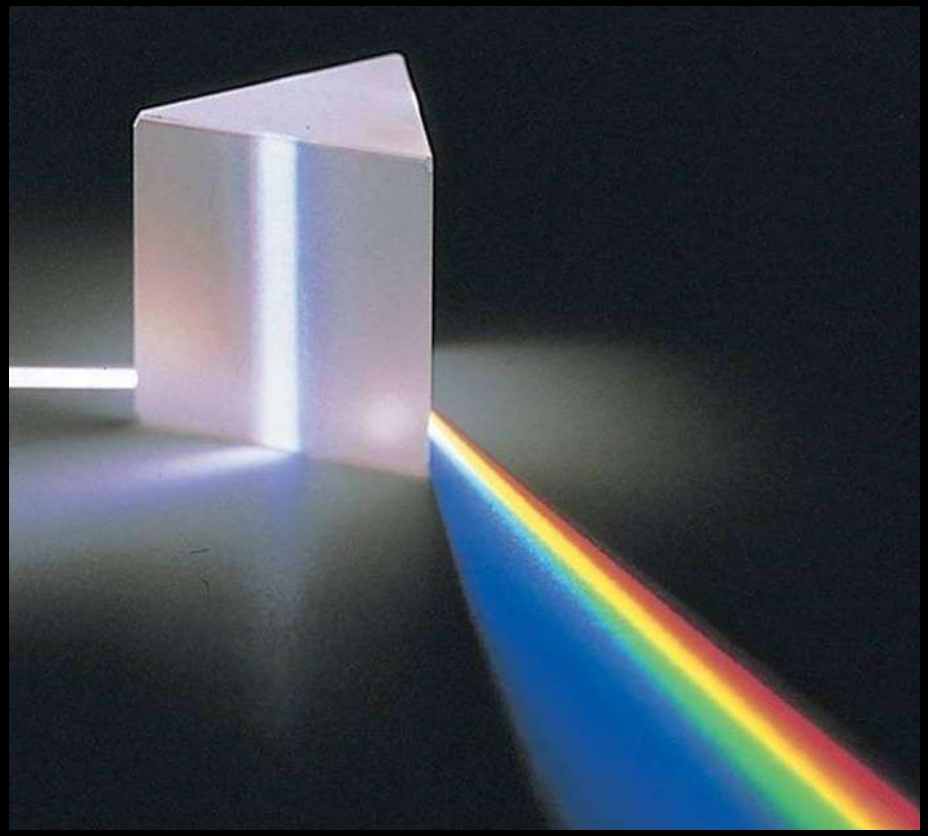
= life!

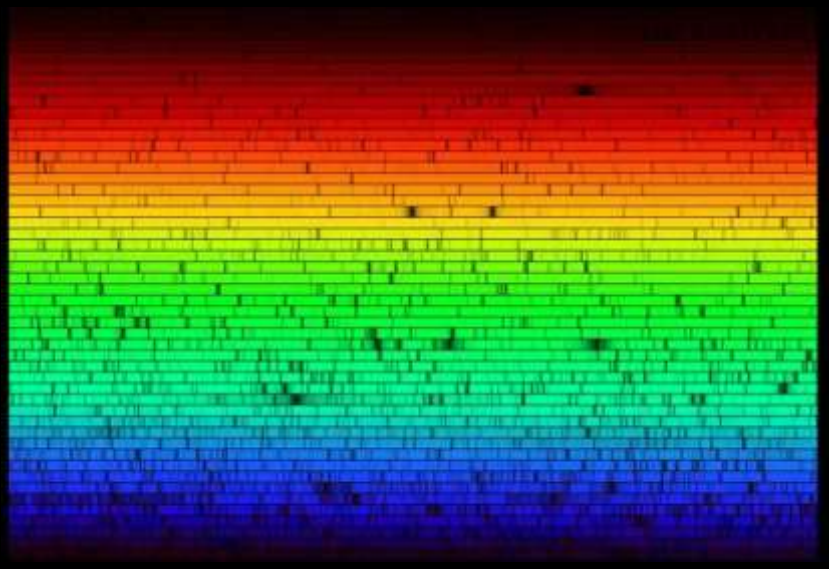


Mars is the best bet:

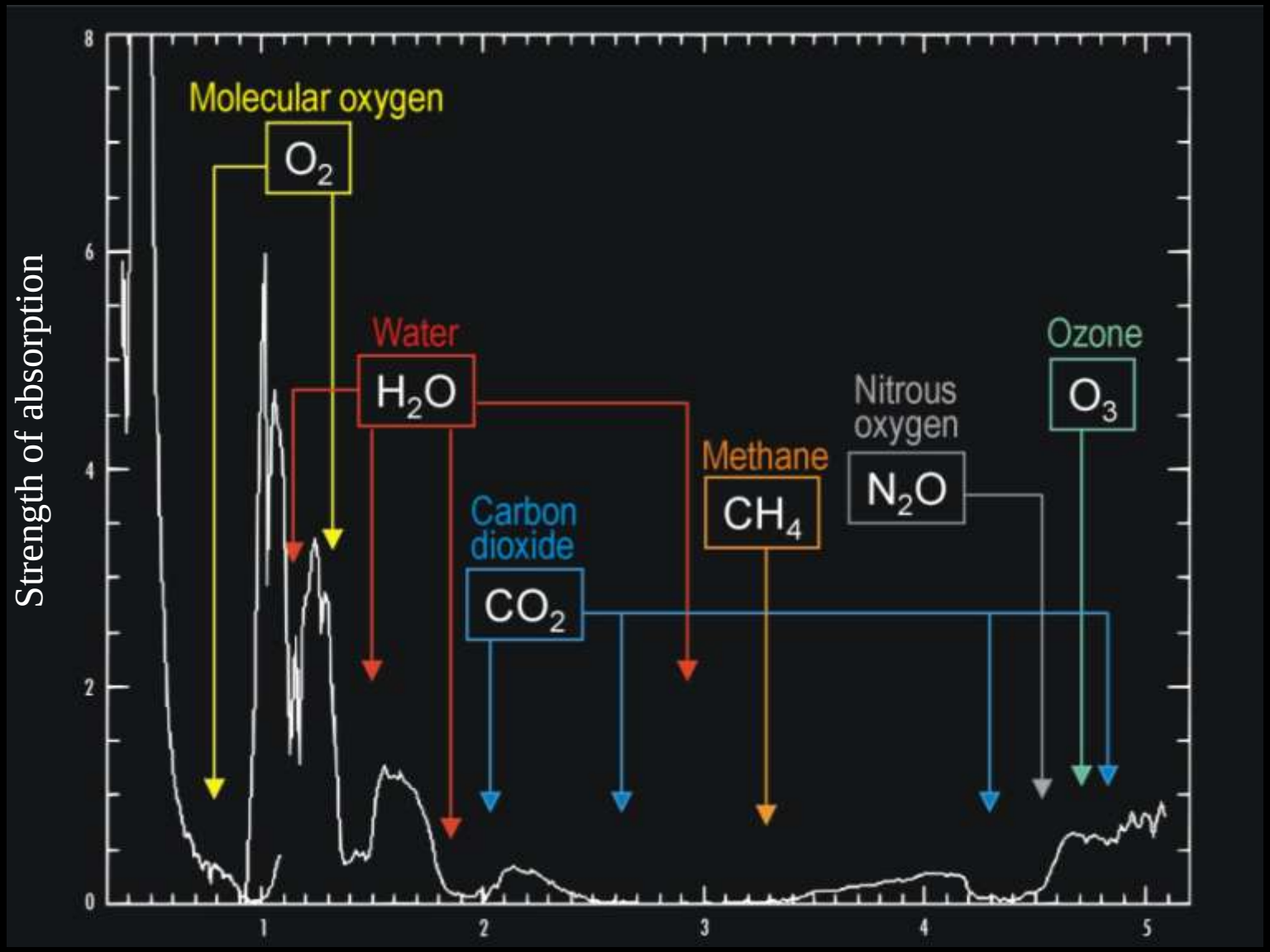
- Mars Express (+ Beagle 2)
- Spirit + Opportunity



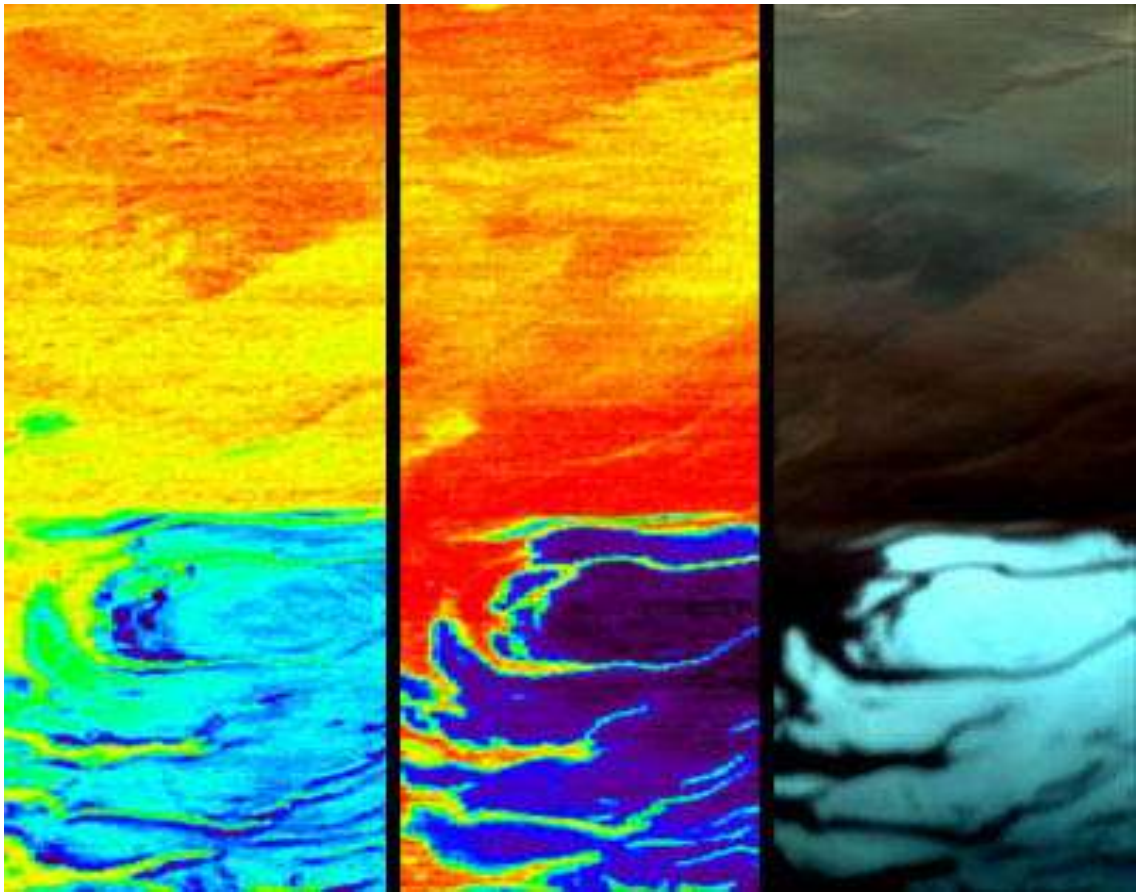




We can use **spectral lines**, like fingerprints, to identify the chemicals that stars and planets are made of.



Composition of the Earth by the Mars Express OMEGA Spectrometer

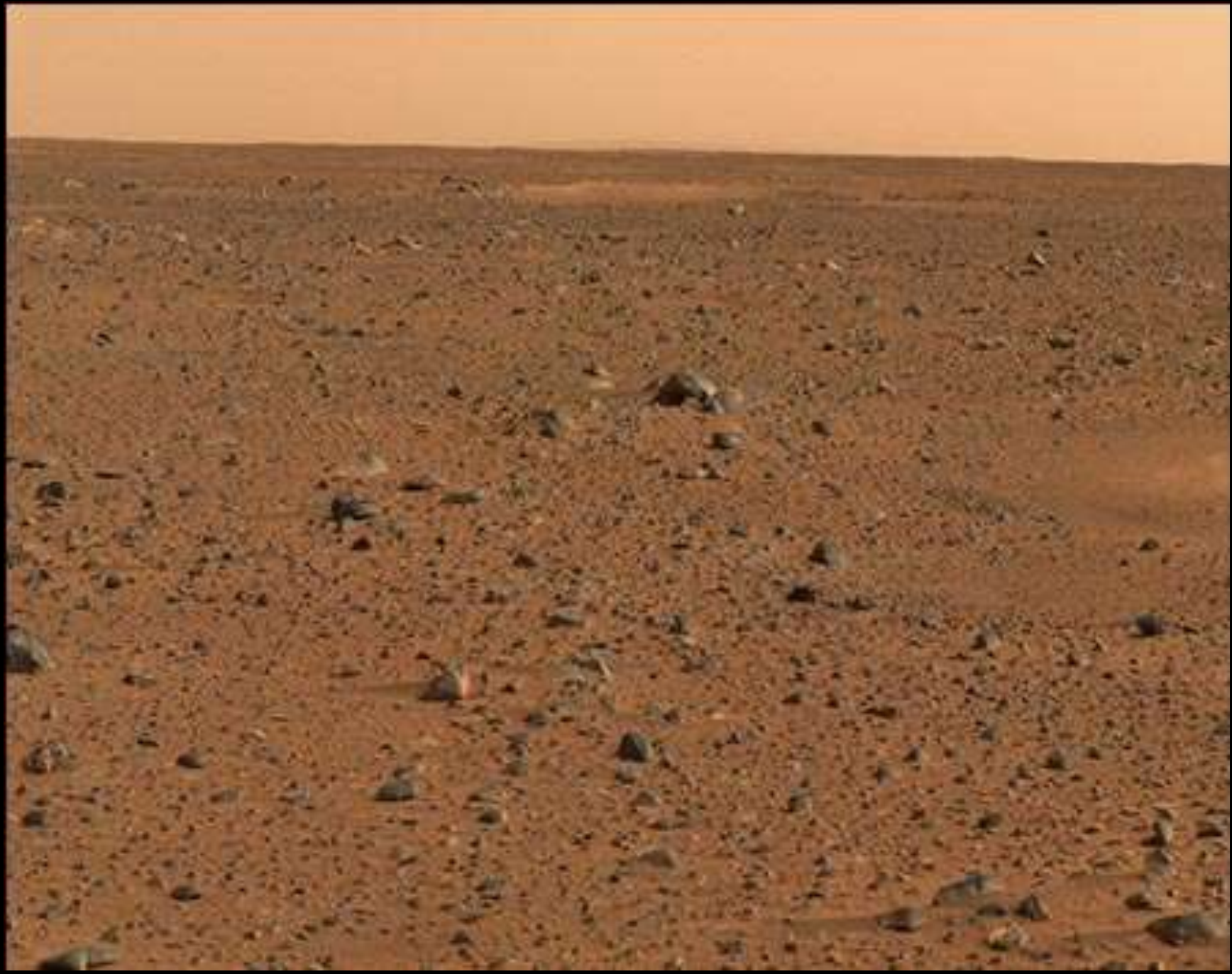


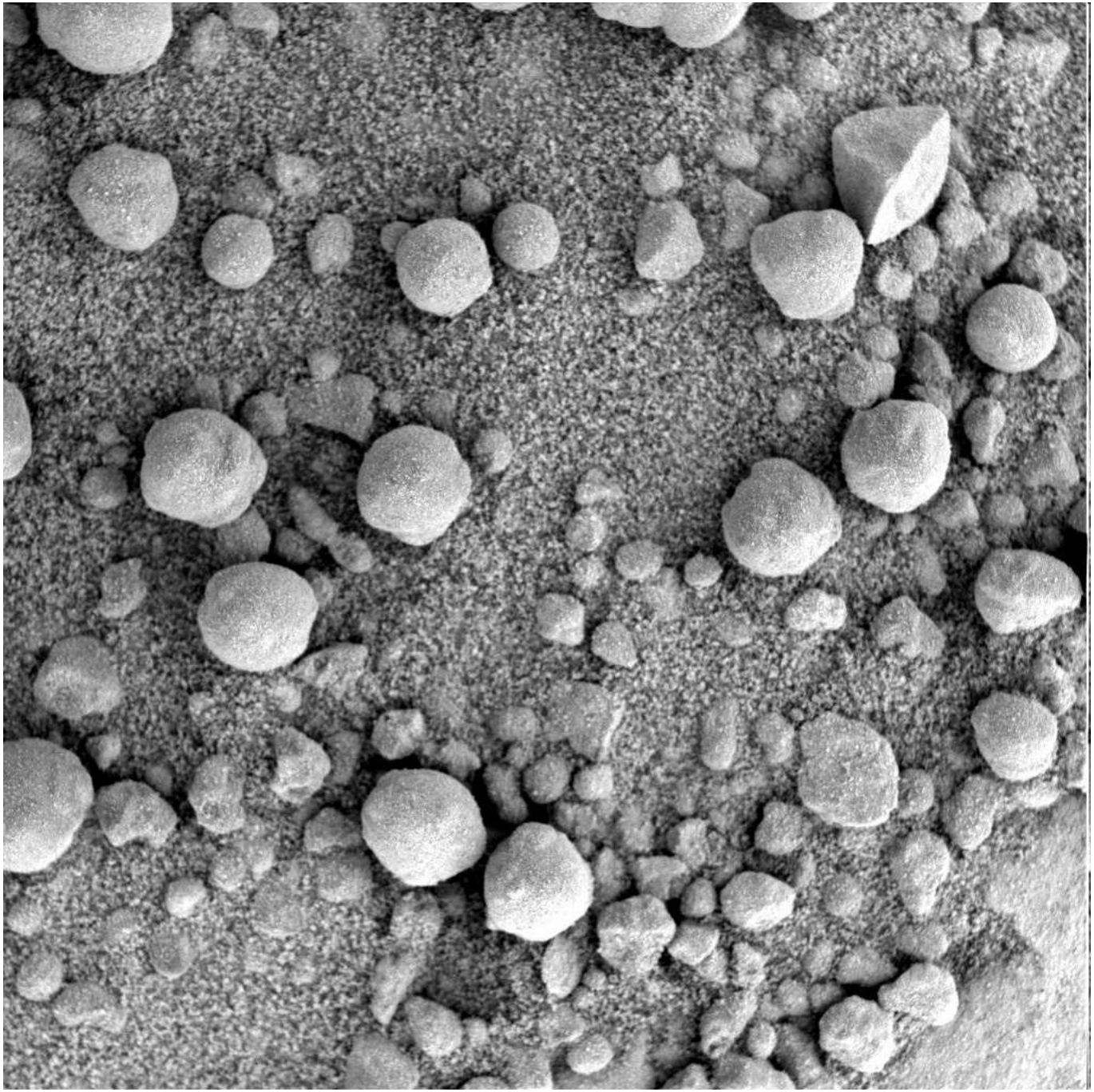
H_2O CO_2 Visible light

2004:

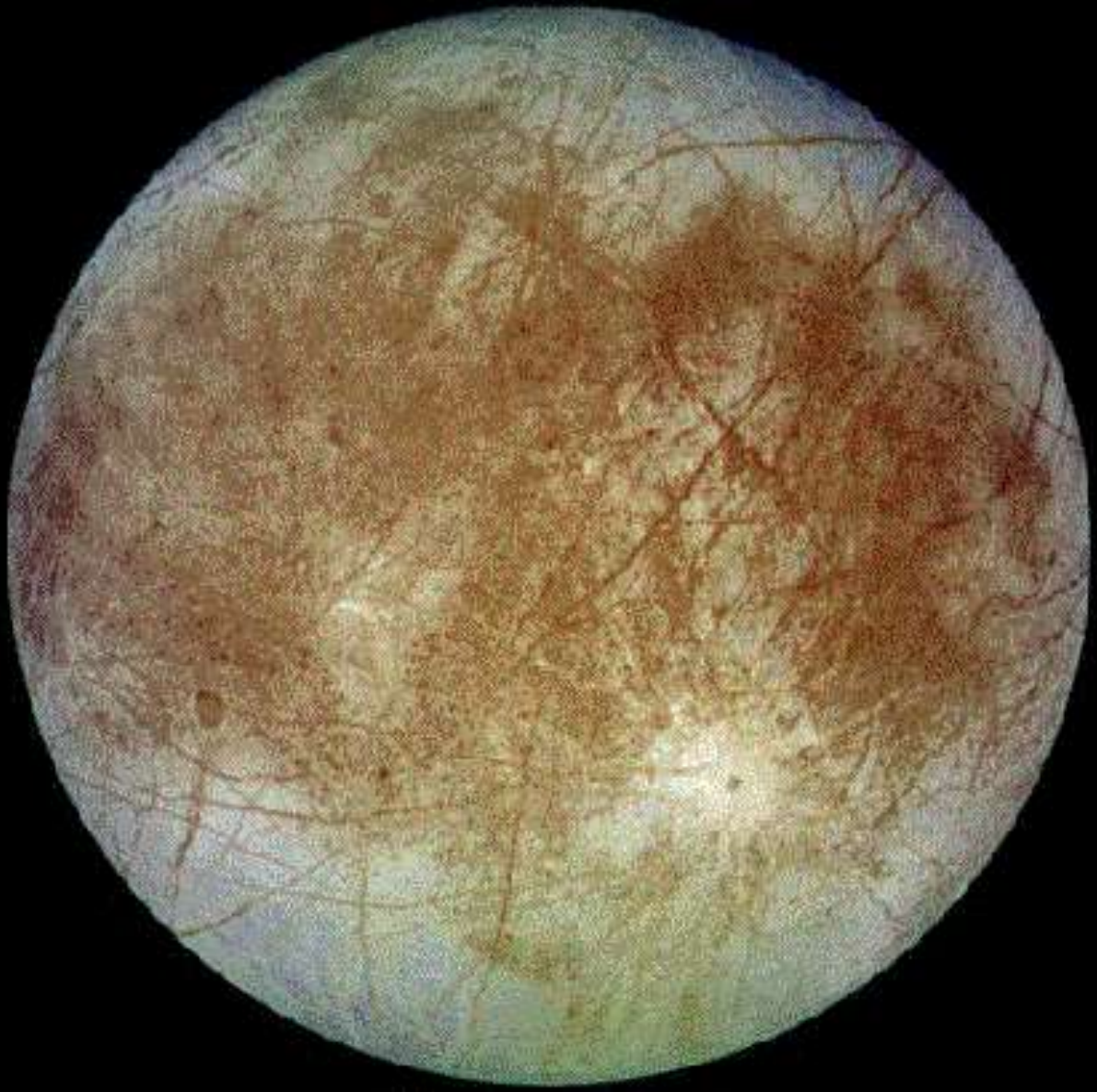
Mars Express Orbiter detects frozen carbon dioxide **and** water at the South Pole of Mars.

Signs of past **running water** in many Martian photographs

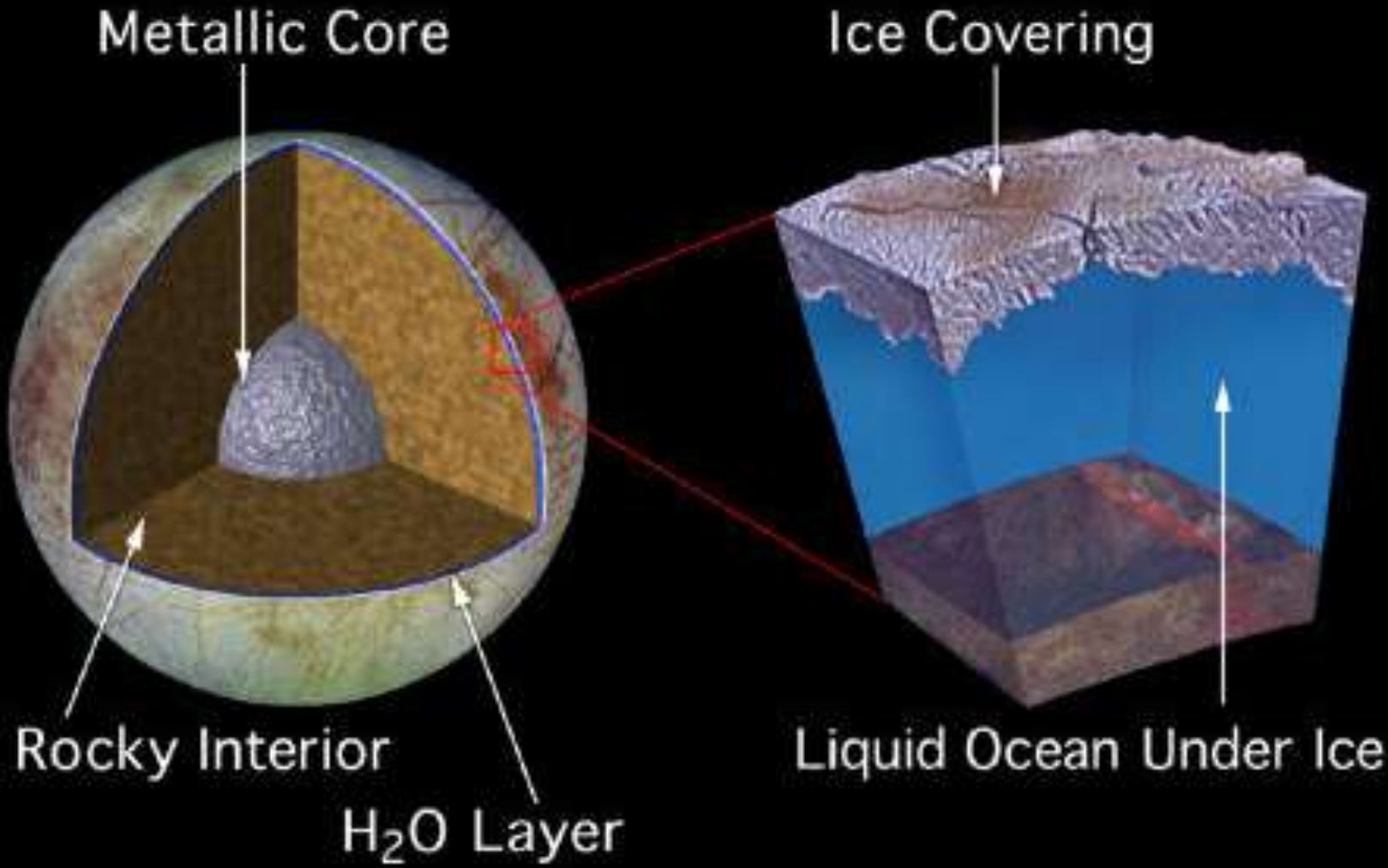




The moons of Jupiter

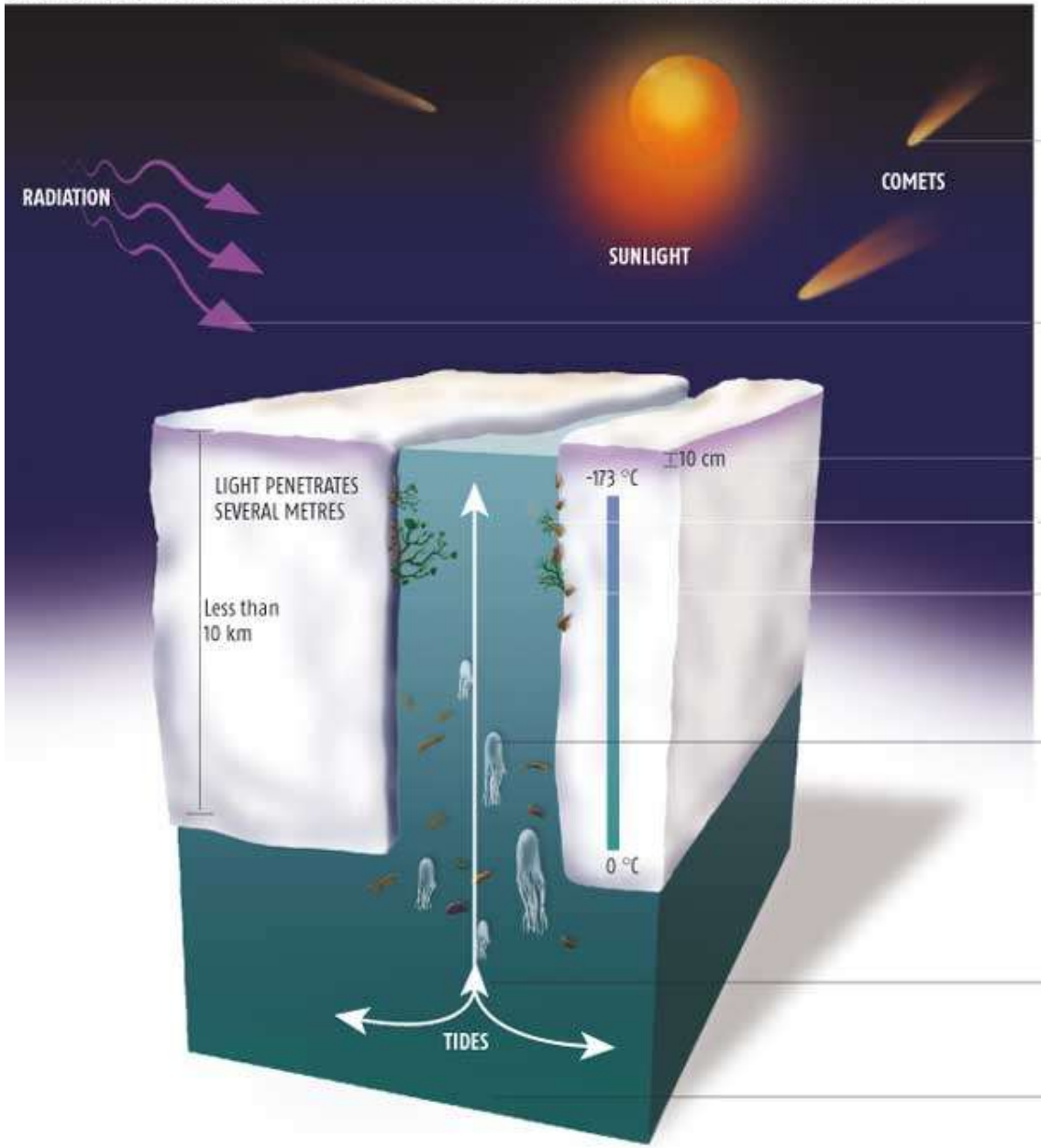


Inside Europa



IS THERE LIFE ON EUROPA?

If Europa's icy crust is thin enough, cracks would provide a habitat where life could thrive



Comets deliver organic molecules

Radiation from Jupiter's magnetosphere forms oxidants at surface that can be used as food source

Radiation danger

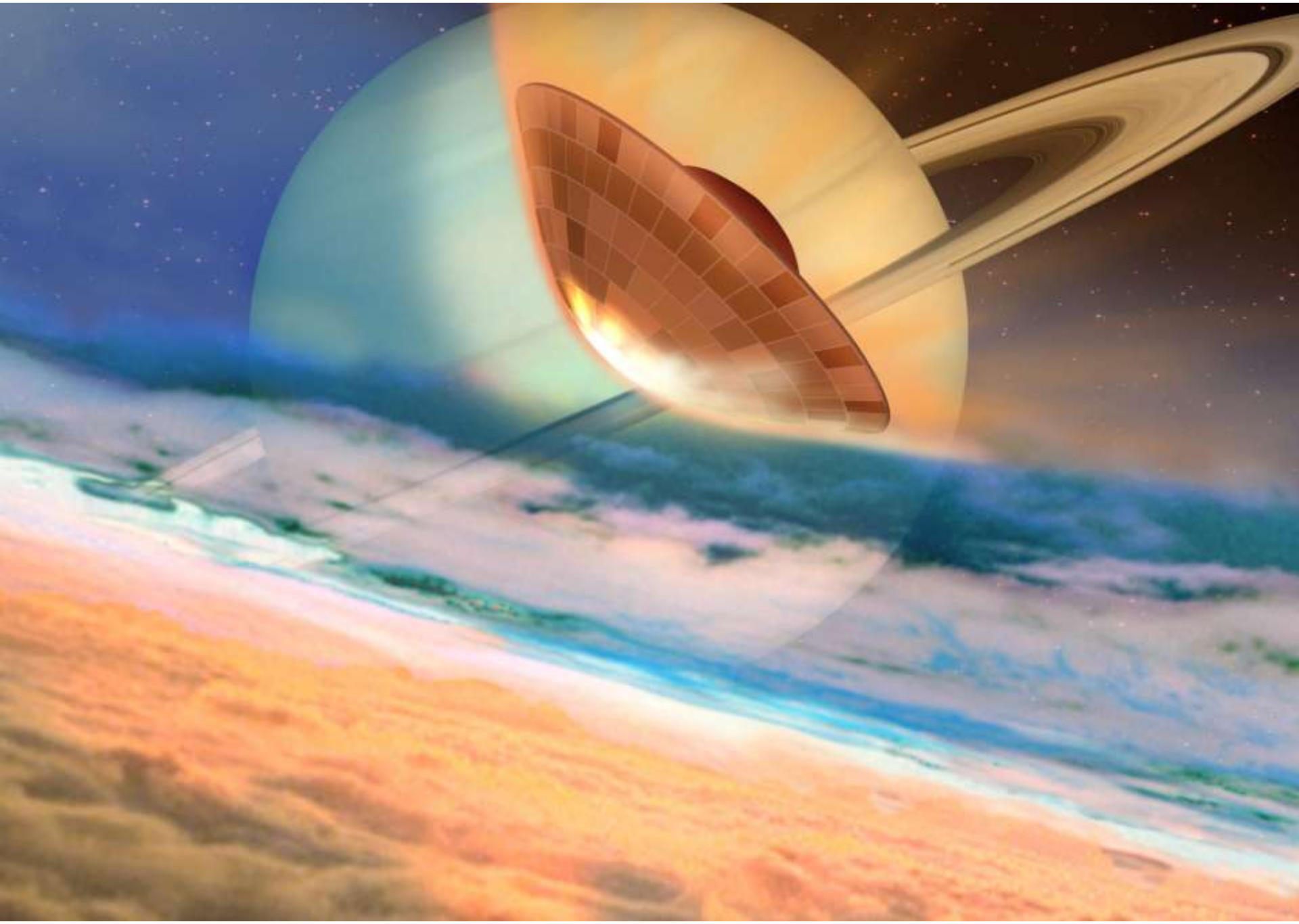
Photosynthetic plants take advantage of sunlight

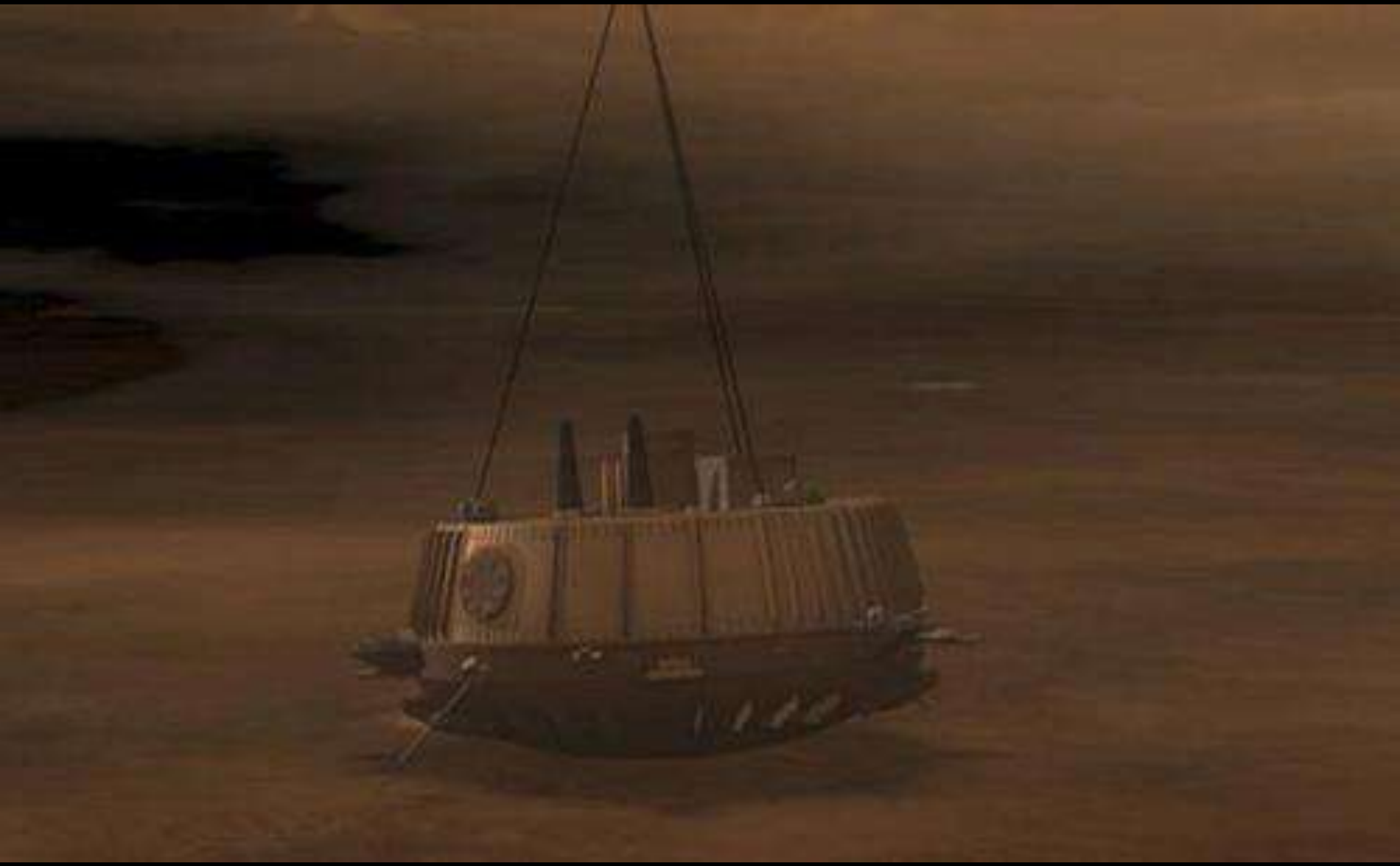
Clinging life forms use food brought down by current

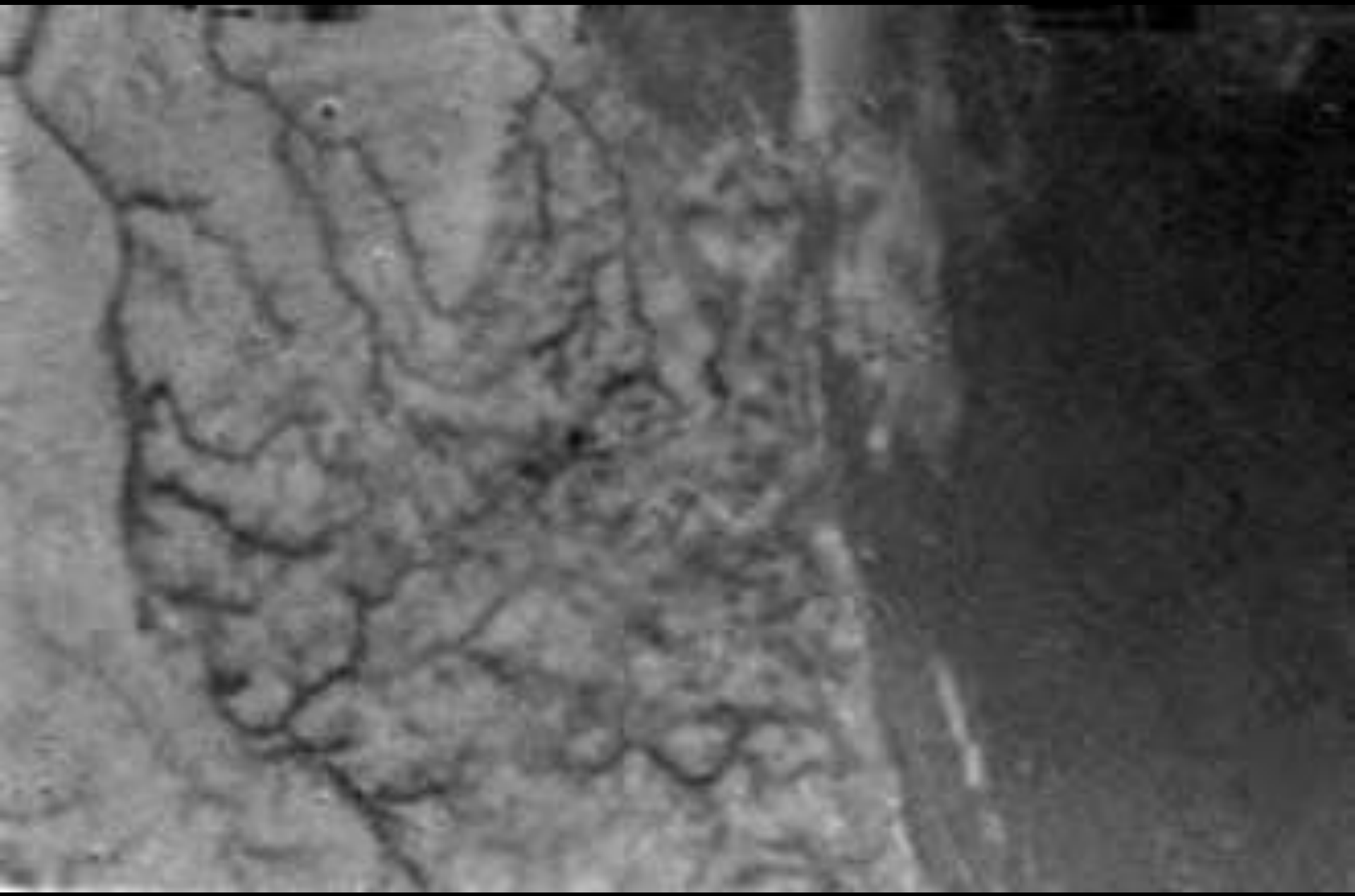
Floating life forms move up and down with the tides

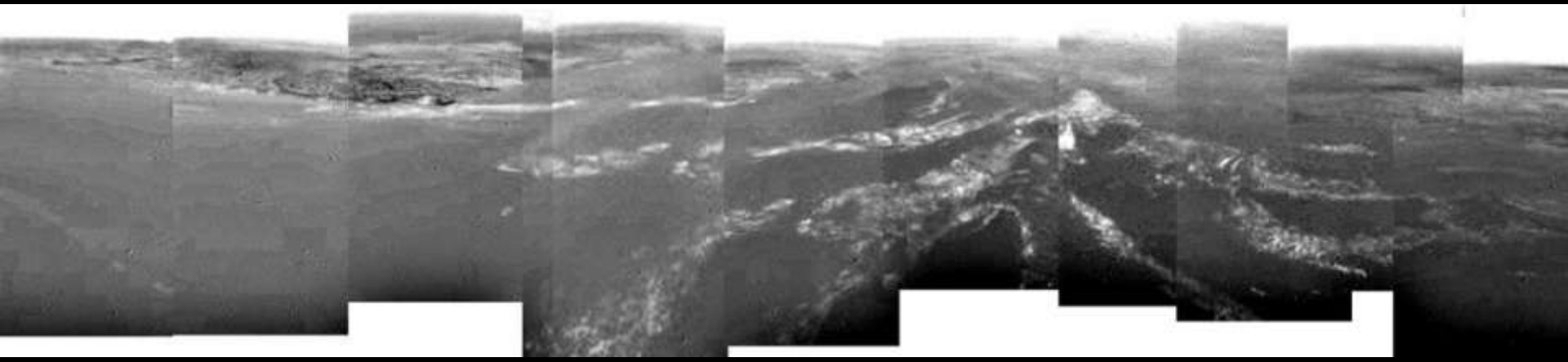
Strong daily tidal currents

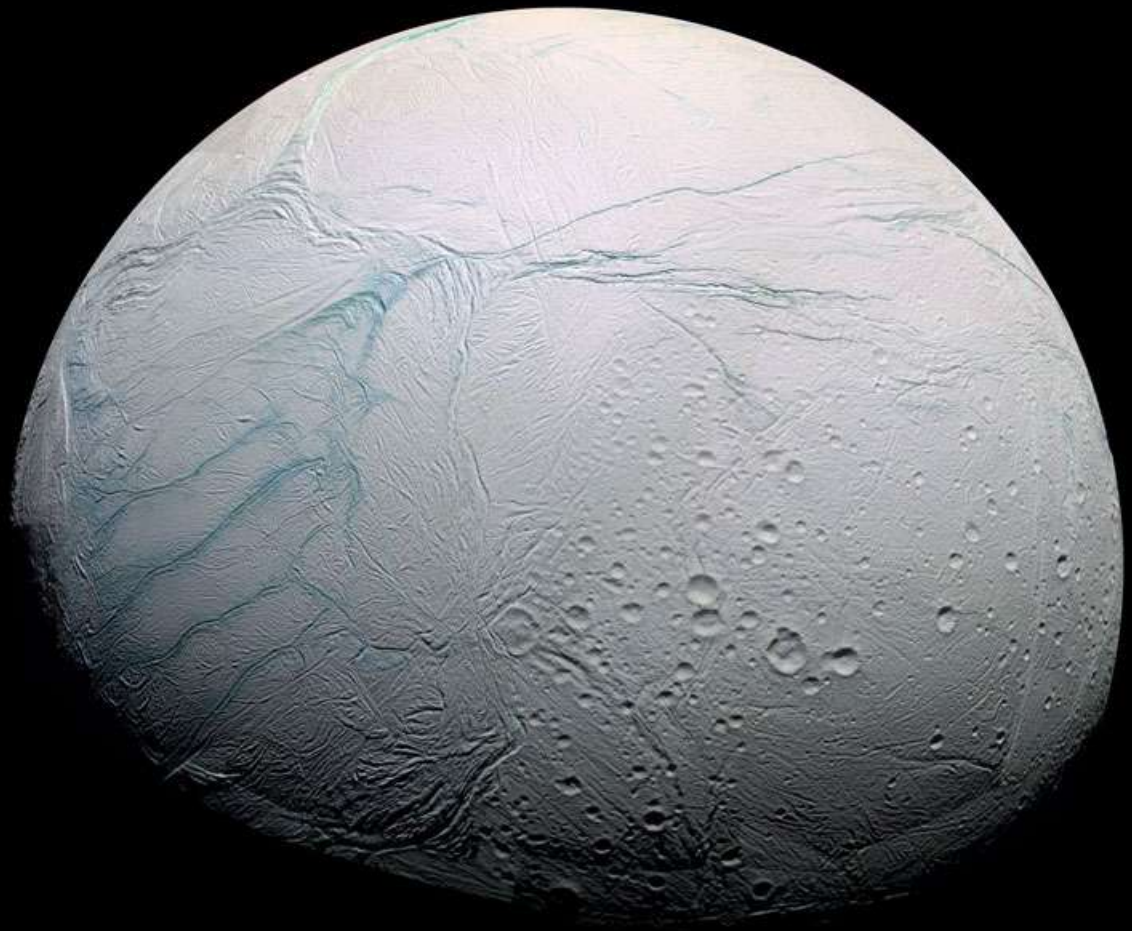
Relatively warm ocean

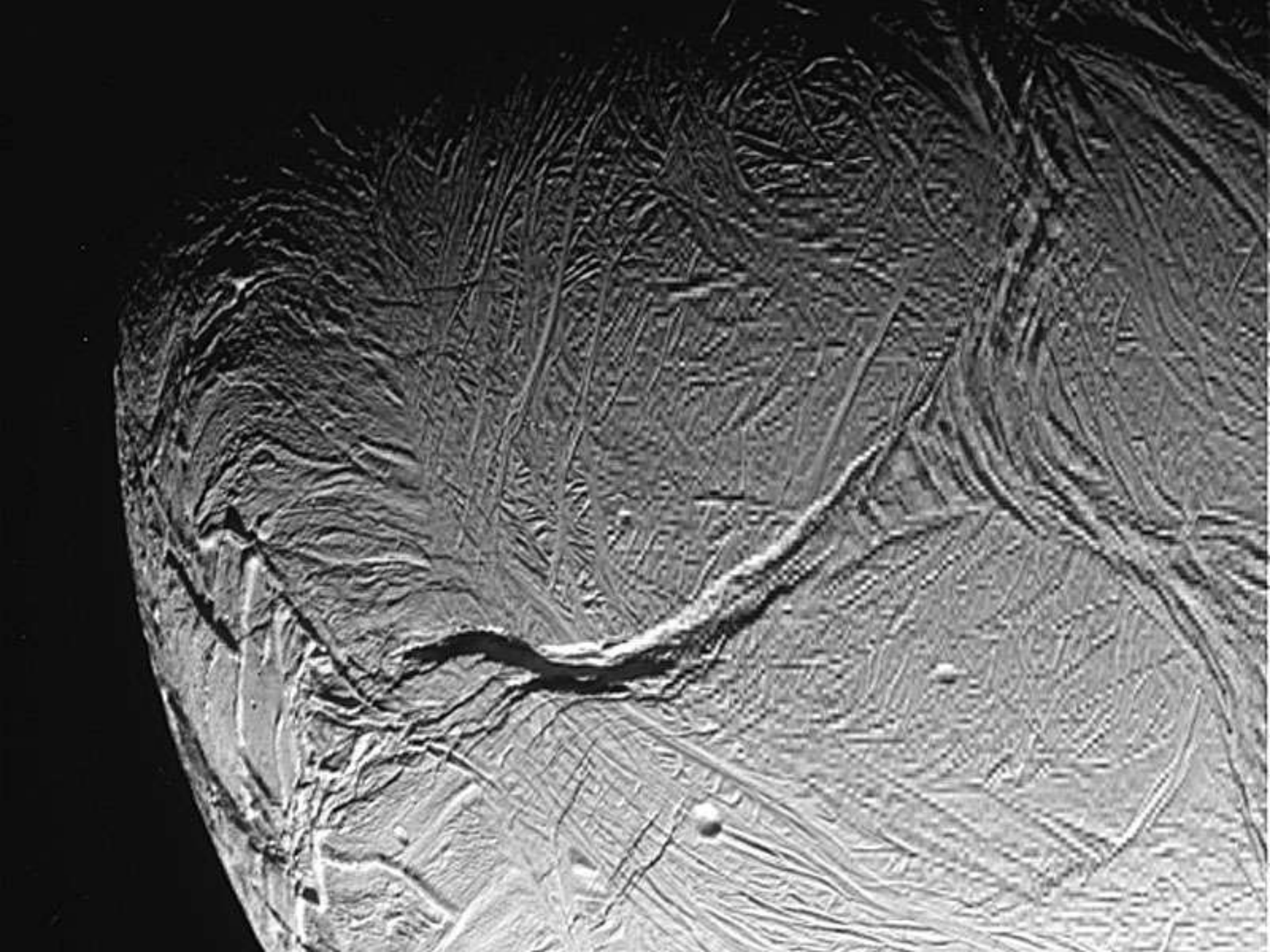


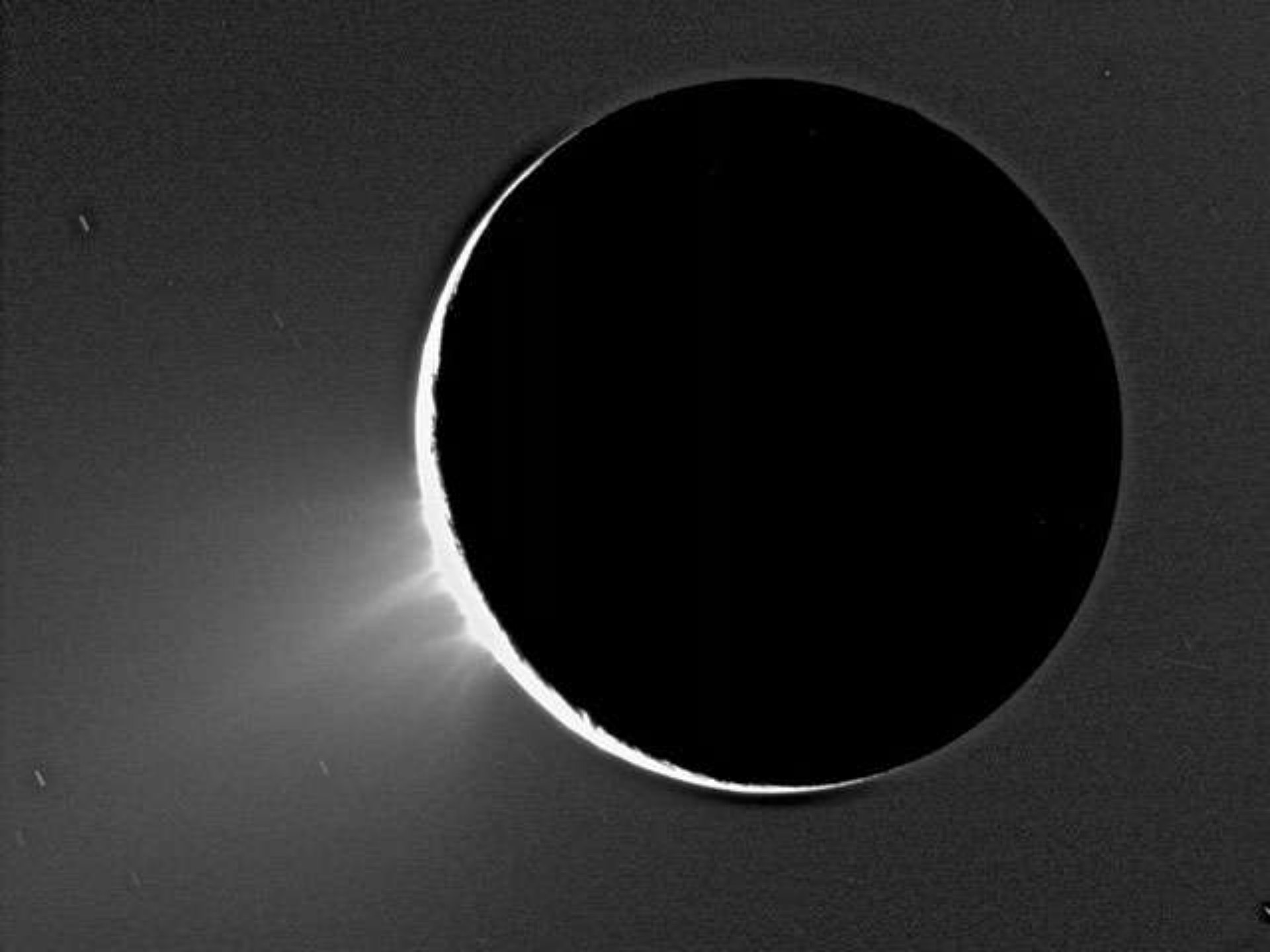








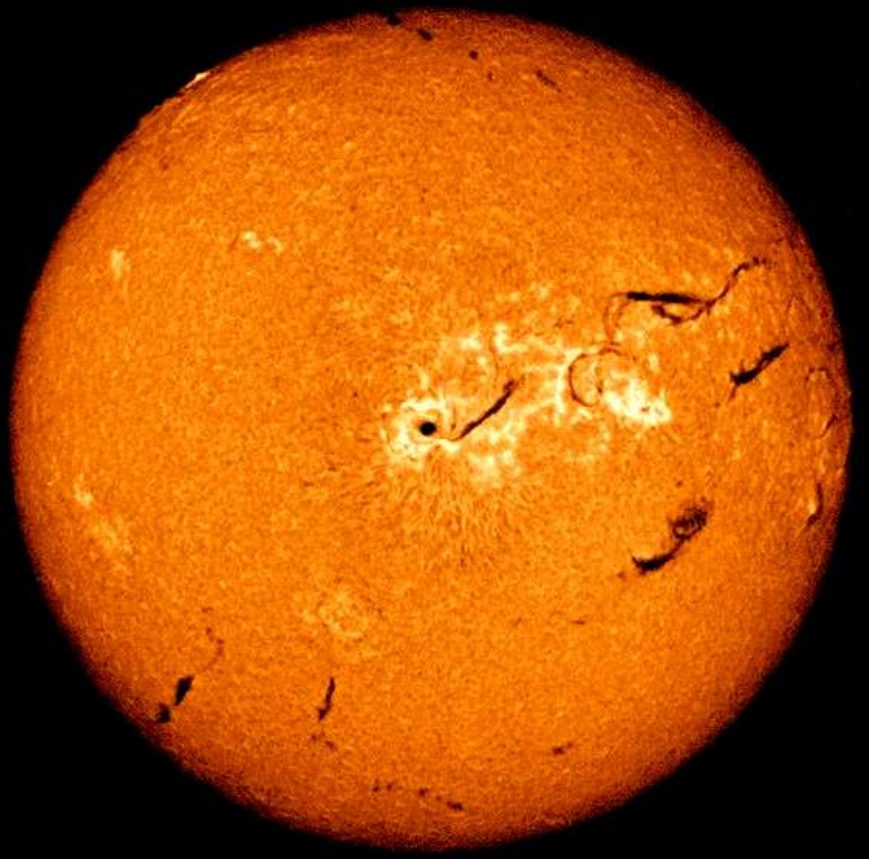




How can we detect planets around other stars?

This isn’t easy because:

- other stars (and their planets) are very far away
- planets don’t shine by themselves, they just reflect light from their star, so they get lost in the glare.

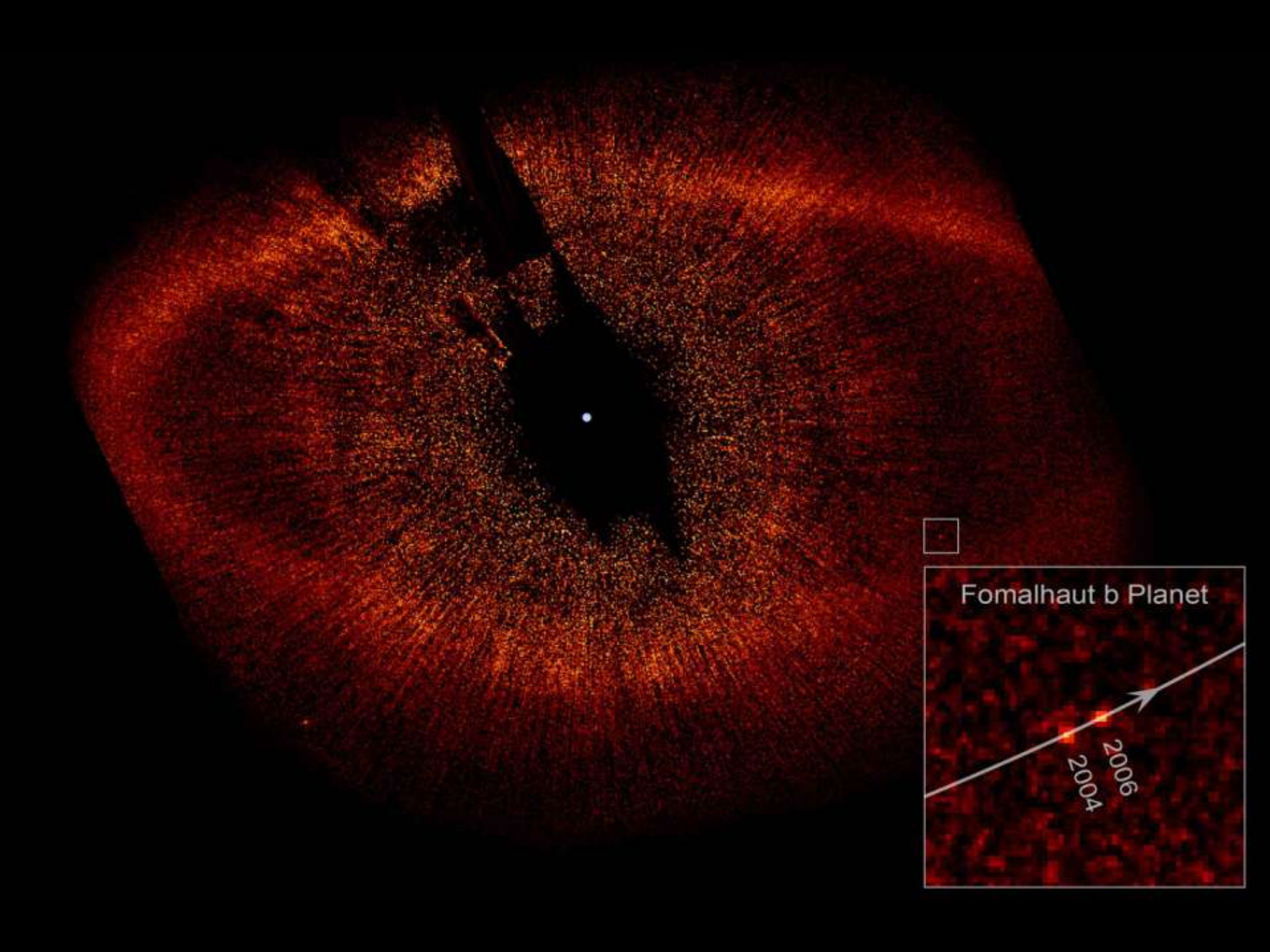


The distance from the Earth to the Sun is **150 million km**.

It takes sunlight more than **eight minutes** to travel this distance.

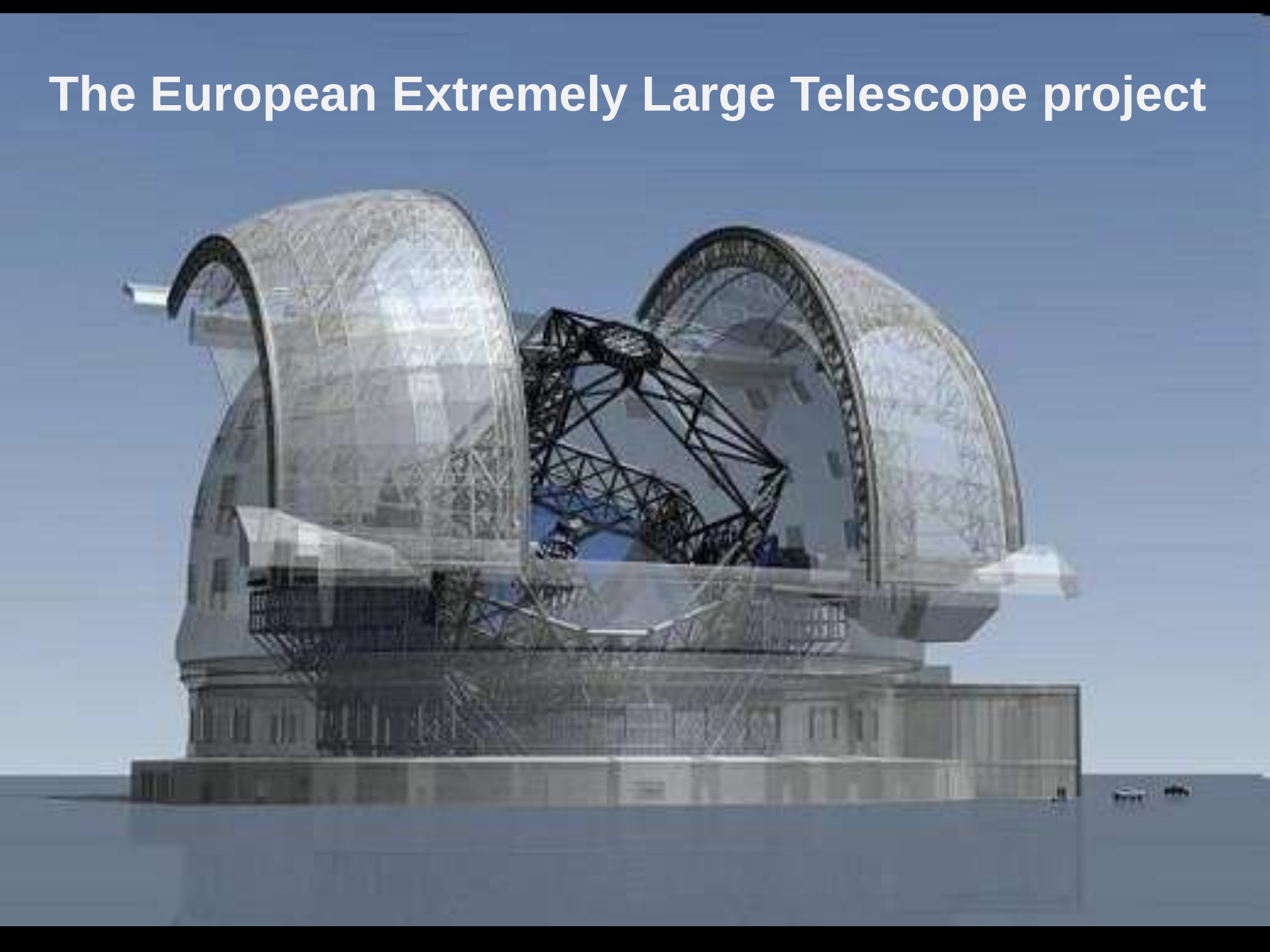
The light from the *next* nearest star, Alpha Centauri, takes more than **four years** to reach the Earth.

Exoplanets are 'drowned out' by their parent star. That makes them very hard to see directly with current telescopes (~10m mirrors)…


Fomalhaut b Planet
2006
2004


Todd Mason '05

The European Extremely Large Telescope project



The European Extremely Large Telescope project

42m mirror: to be completed by 2020

'Jupiter' at 30 l.y.

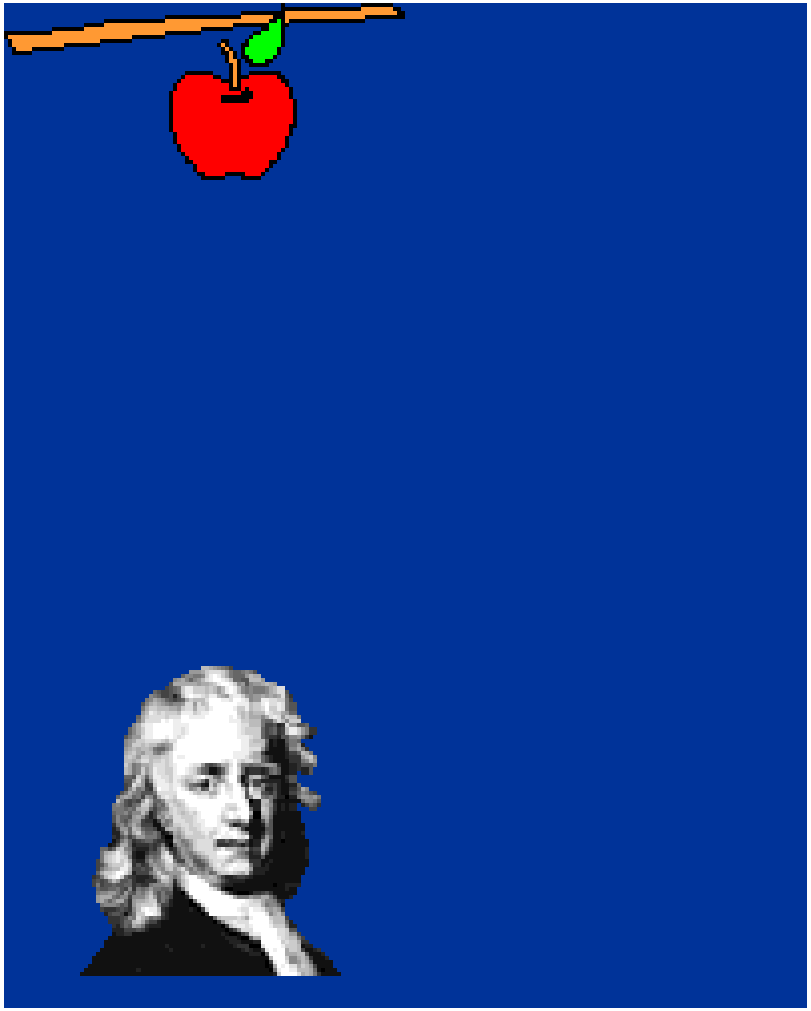
2. How can we detect planets around other stars?

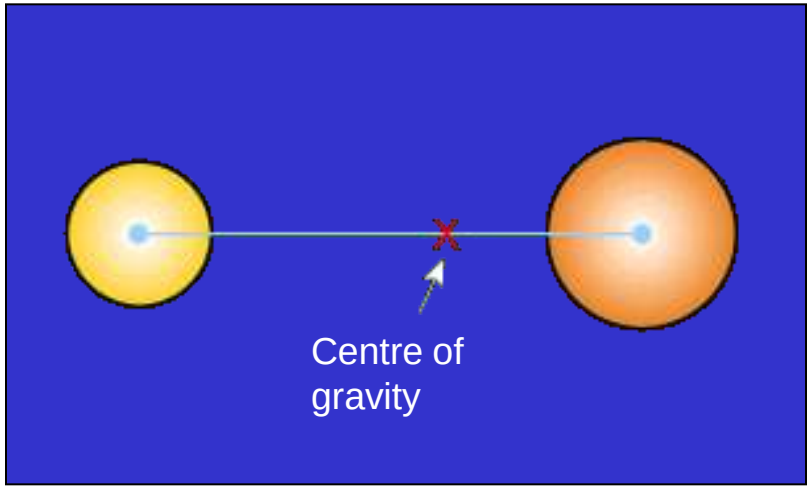
This isn't easy because:

- other stars (and their planets) are very far away
- planets don't shine by themselves, they just reflect light from their star, so they get lost in the glare.

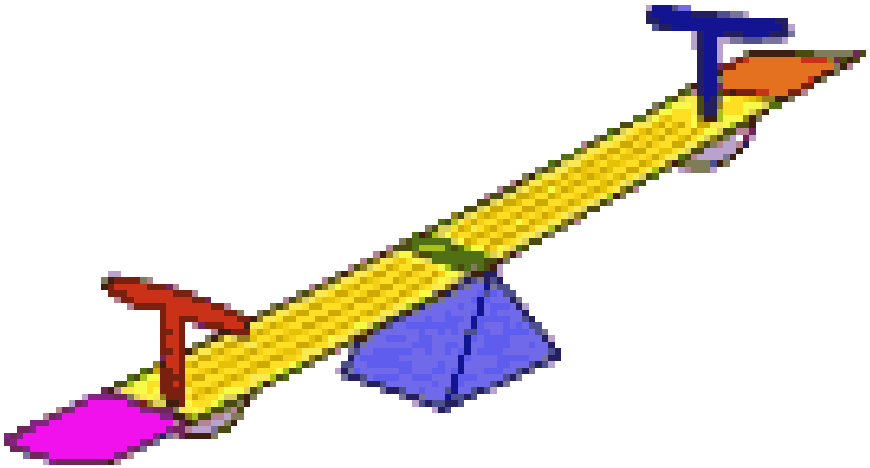
We can tell that planets are there by the effect they have on their star.

Planets cause their parent star to 'wobble'





Star + planet orbit about centre of gravity



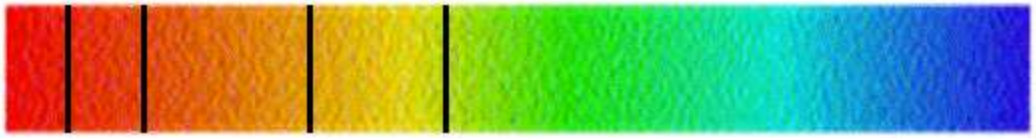
Star + planet orbit
about centre of gravity

Can see star 'wobble',
even when we can't see
the planet.

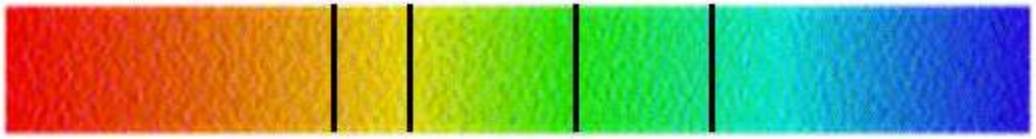
Star + planet orbit about centre of gravity

We can also see the motion of the star from its **spectral lines**.

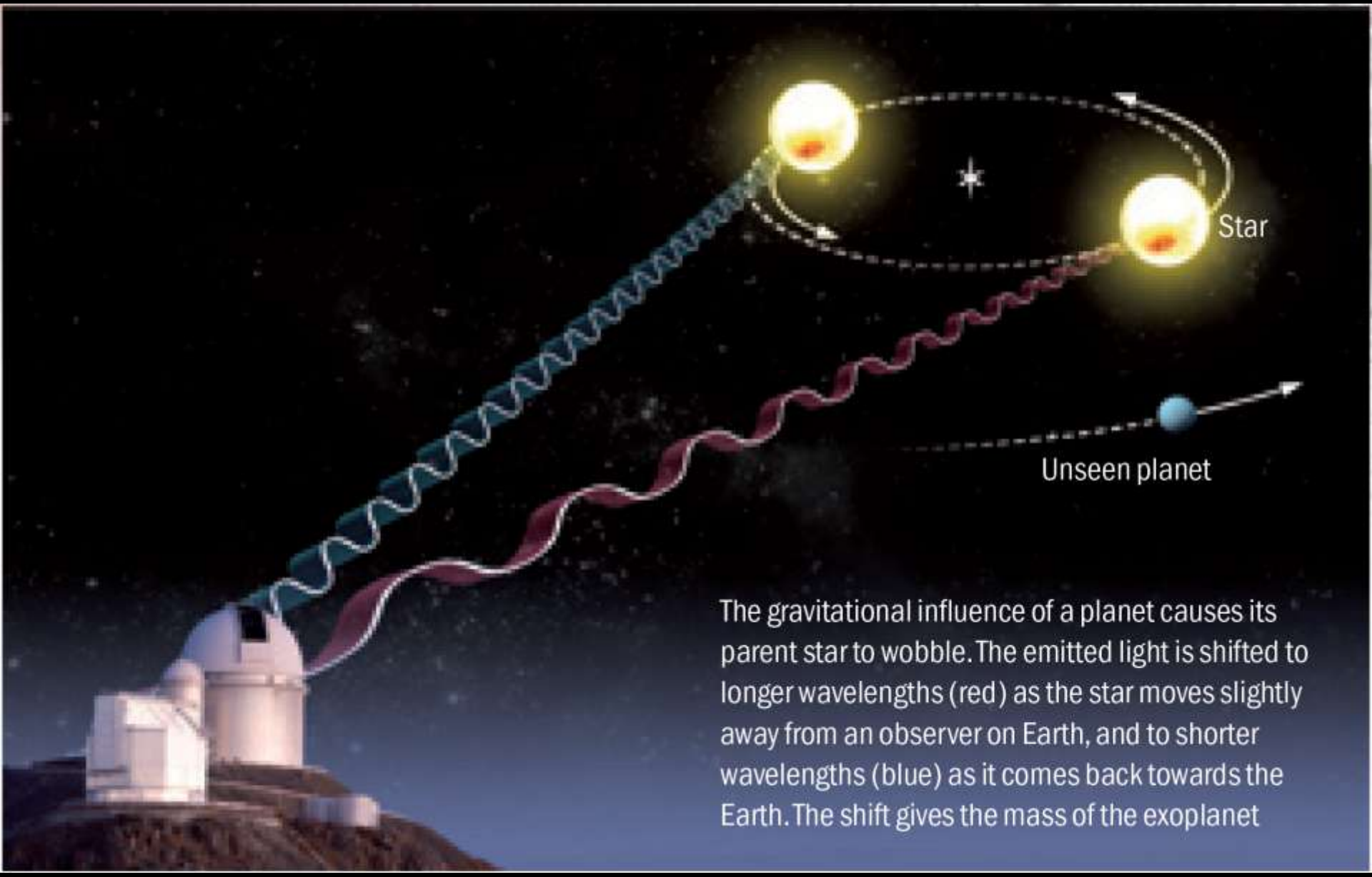
Direction to Earth



Star



Laboratory



The gravitational influence of a planet causes its parent star to wobble. The emitted light is shifted to longer wavelengths (red) as the star moves slightly away from an observer on Earth, and to shorter wavelengths (blue) as it comes back towards the Earth. The shift gives the mass of the exoplanet

In the past 16 years we have found many planets orbiting other stars in our galaxy…

3. Could some of those planets be like the Earth?

Most planets we've found so far are 'hot Jupiters':

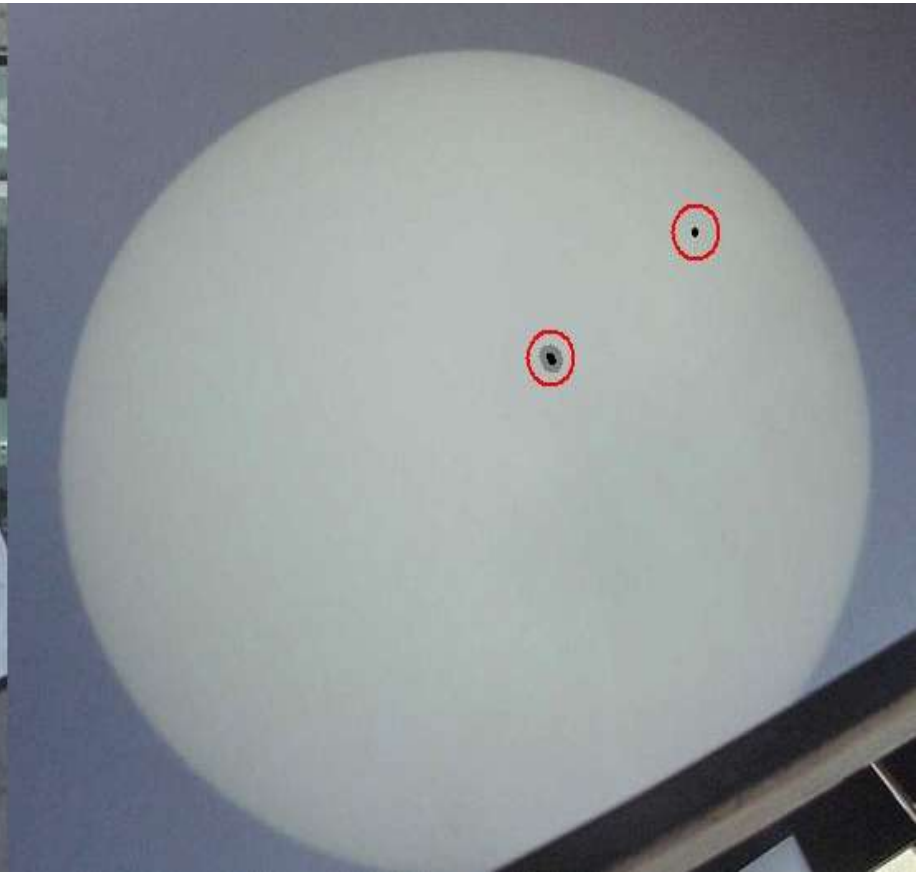
gas giants, much bigger and closer to their parent star than the Earth is to the Sun.

These are not good places to look for life like us:

no water,
no oxygen,
much too hot!

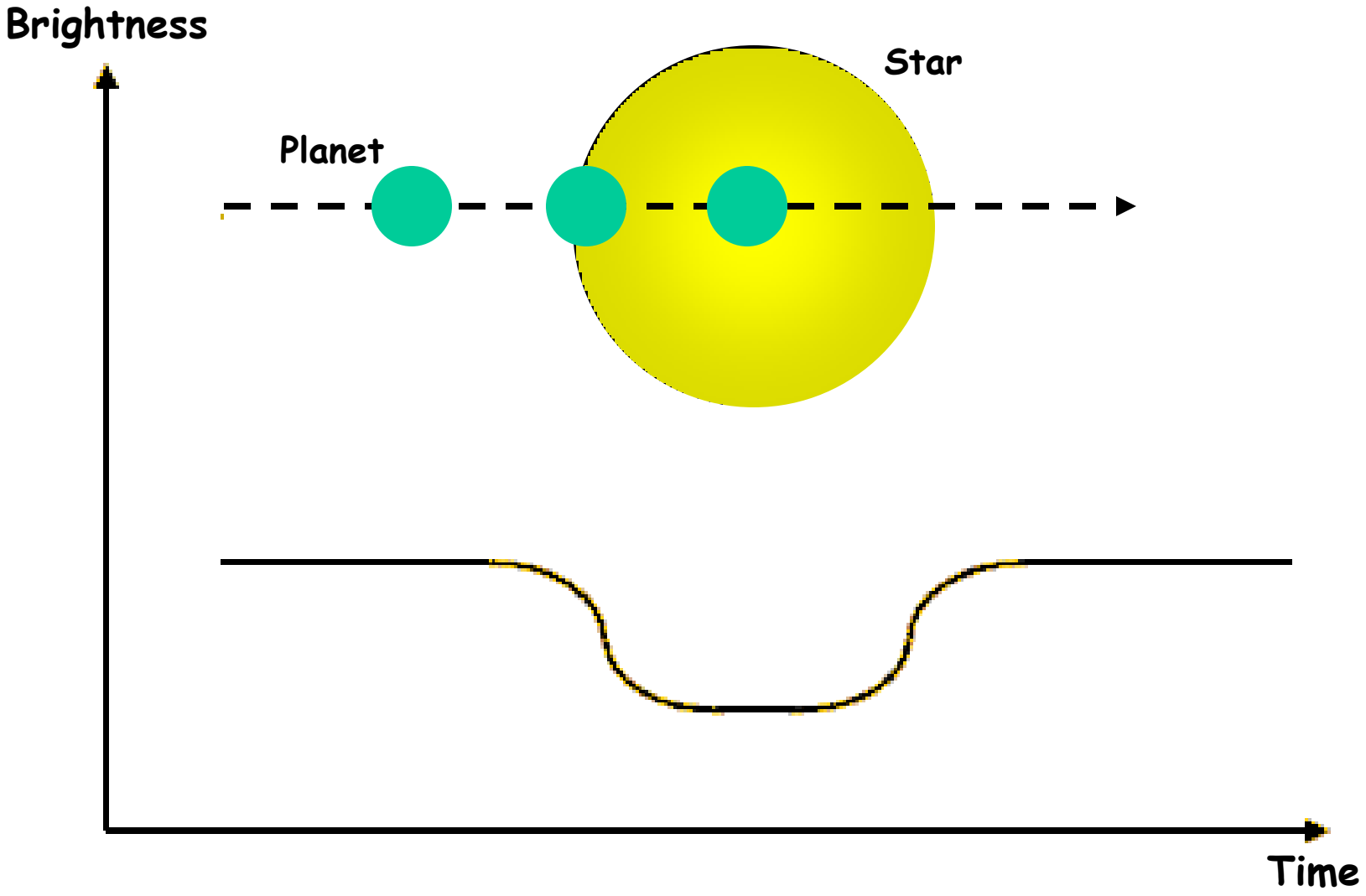
In the past 16 years we have found many planets orbiting other stars in our galaxy…

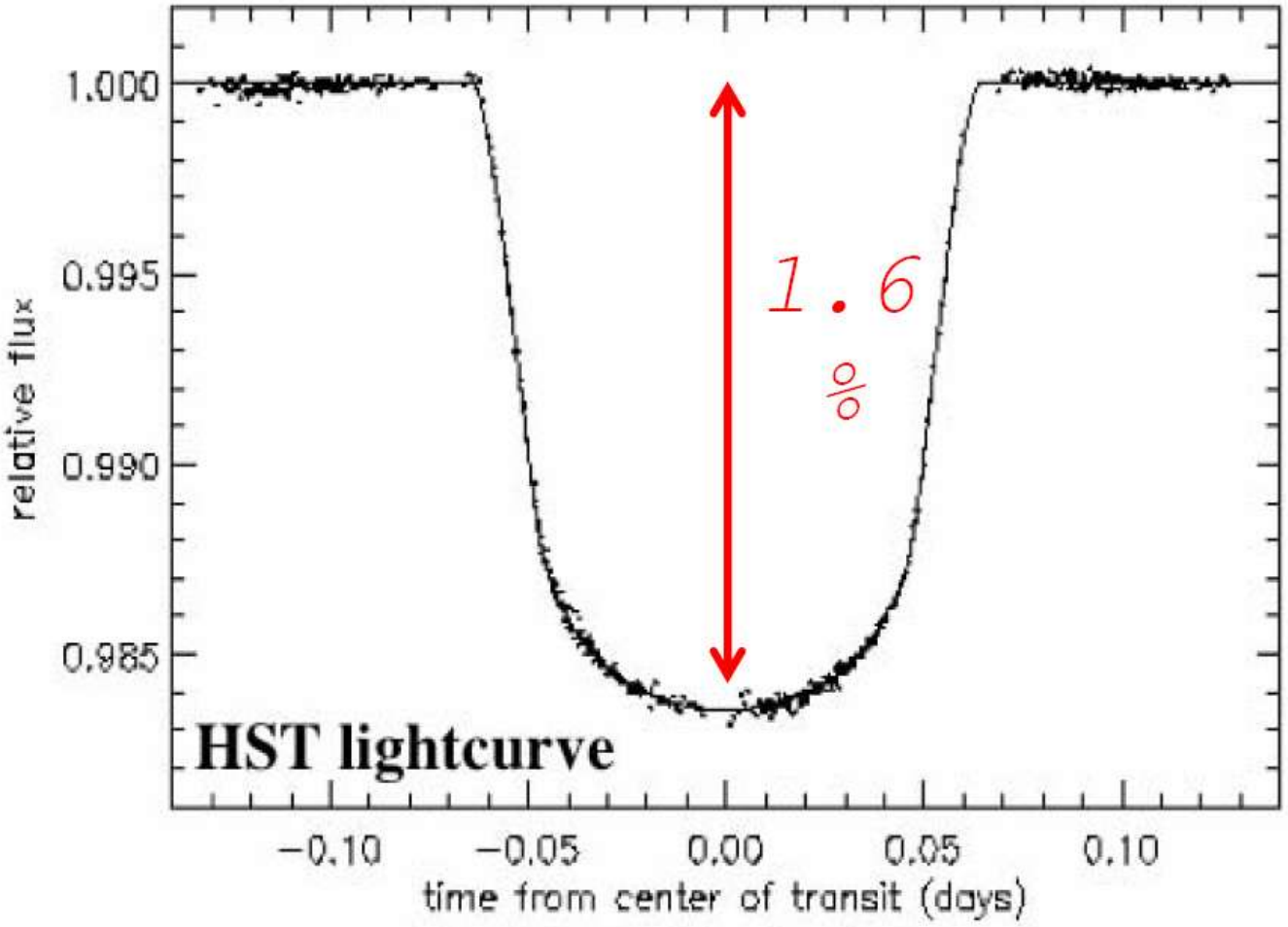
No Earth-like planets, yet?….



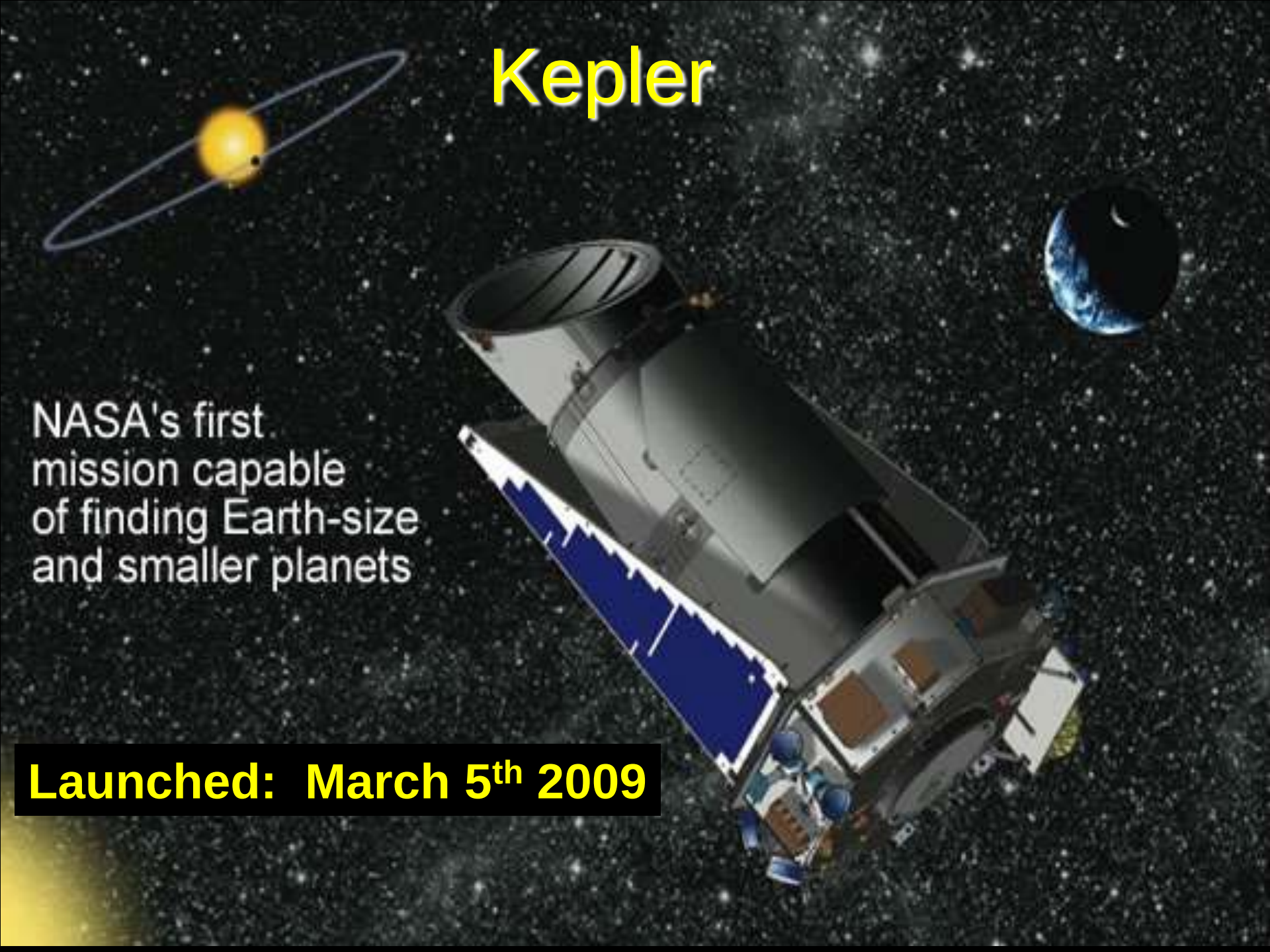
Transit of Mercury: May 7th 2003

Detecting exoplanets from transits

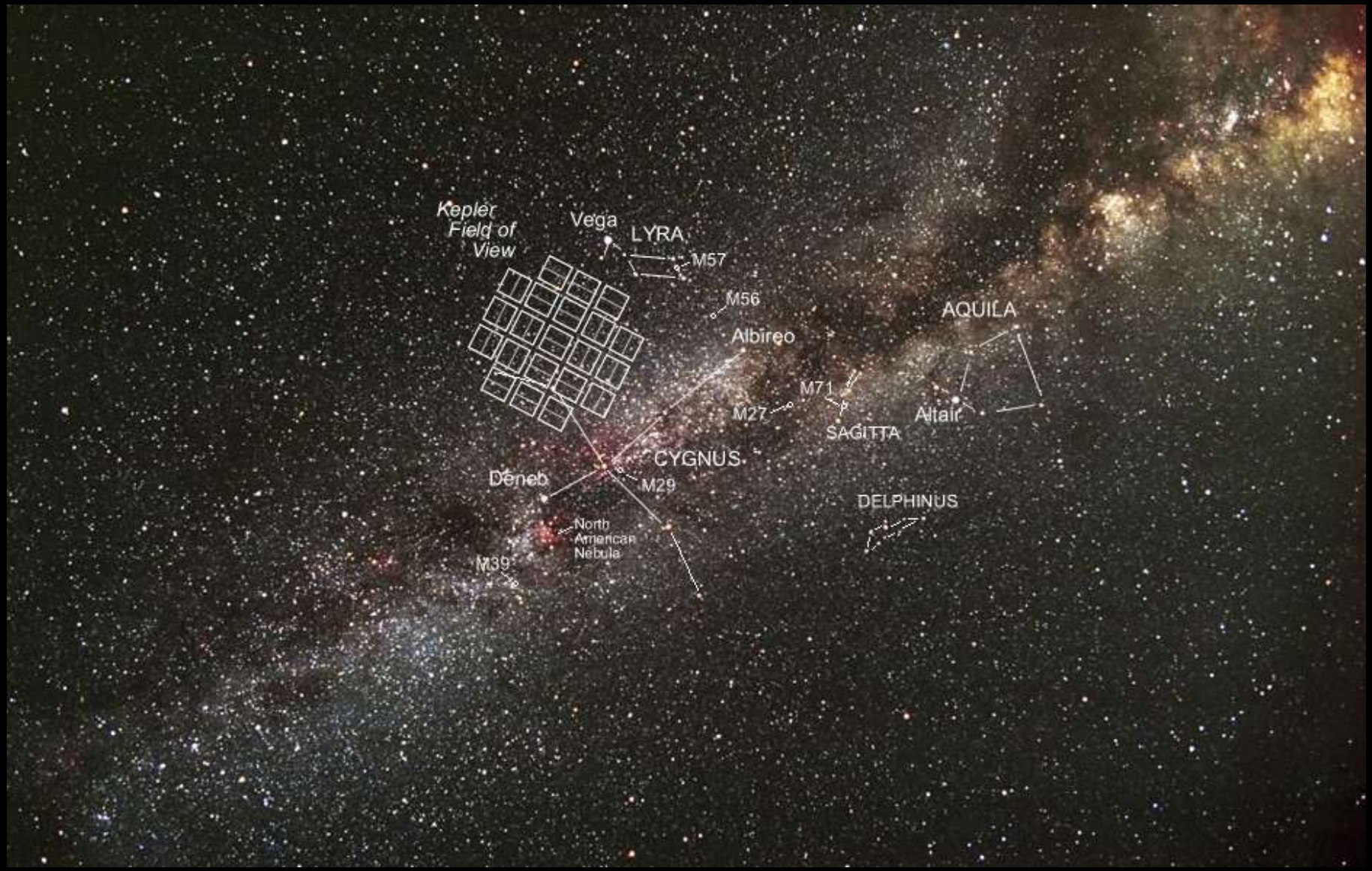



1.000
0.995
0.990
0.985
relative flux
1.6
%
HST lightcurve
−0.10
−0.05
0.00
0.05
0.10
time from center of transit (days)

Kepler

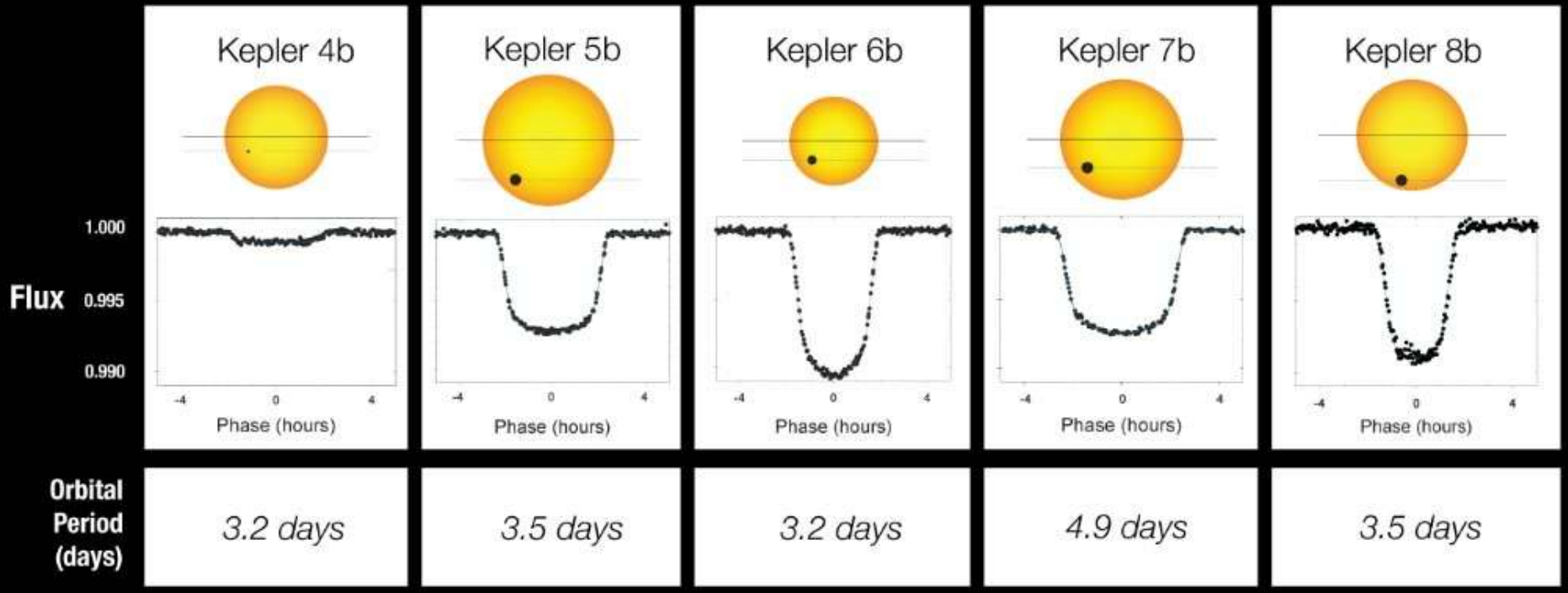


Launched: March 5th 2009

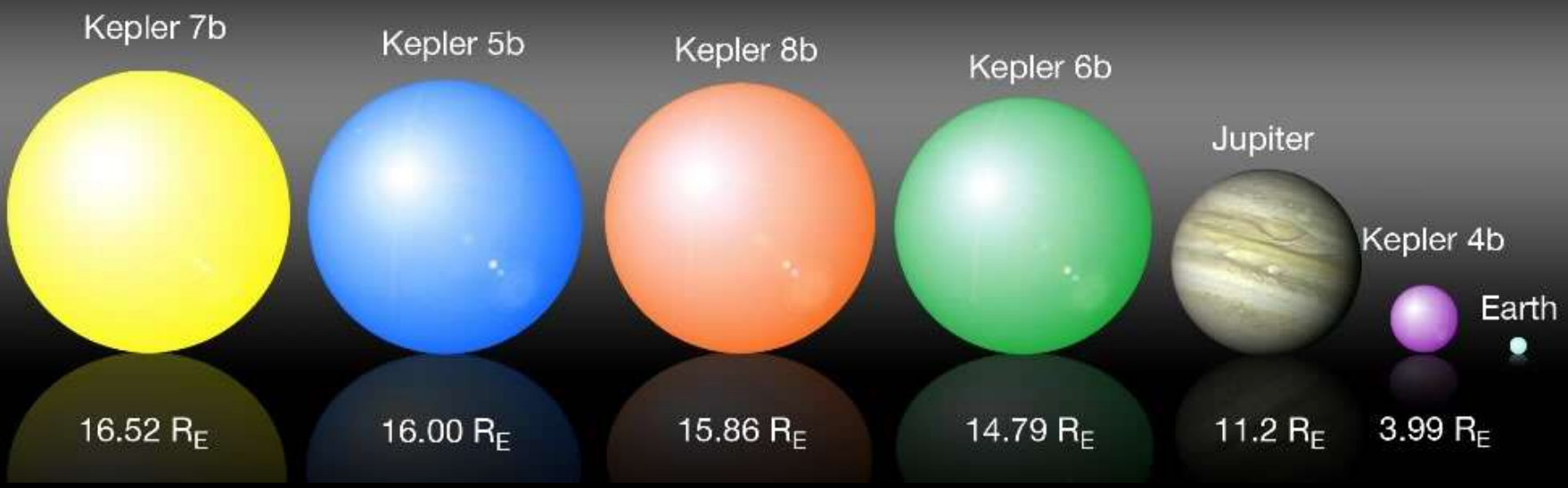

Kepler
Field of
View
Vega
LYRA
M57
M56
Albireo
AQUILA
M71
M27
SAGITTA
Altair
CYGNUS
Deneb
M29
DELPHINUS
North
American
Nebula
M39


BRIGHTNESS
TIME IN HOURS

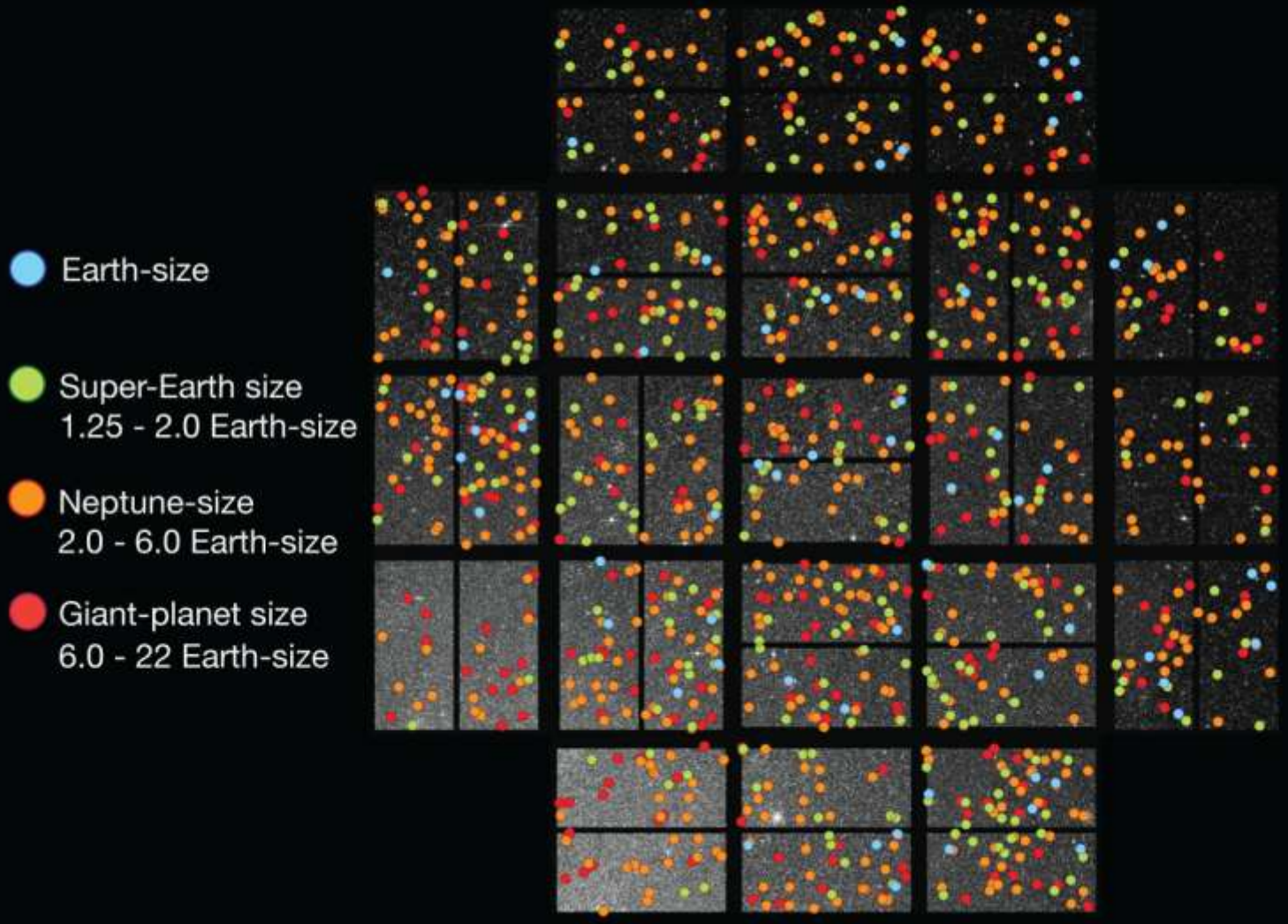
Transit Light Curves

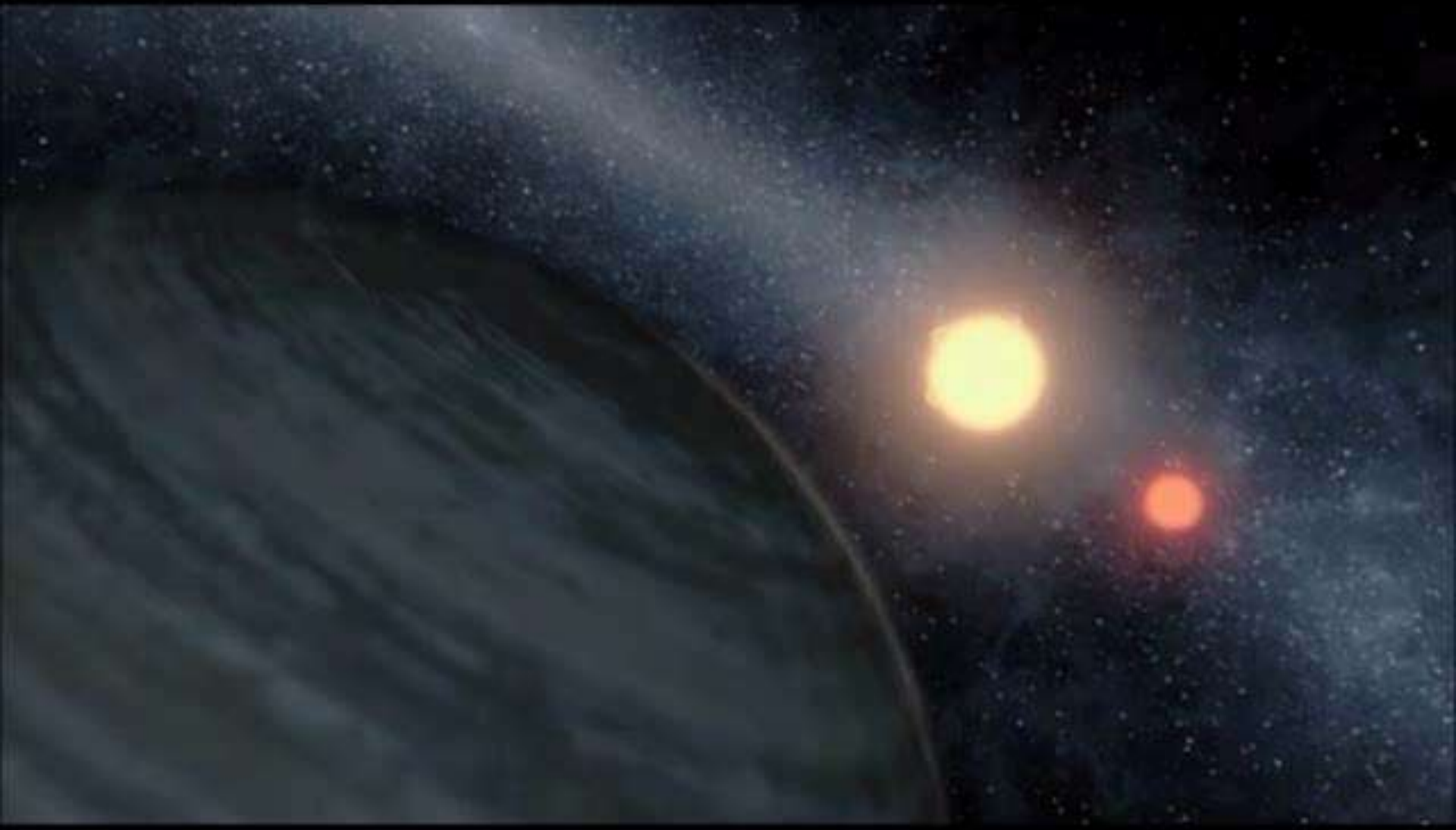


Planet Size

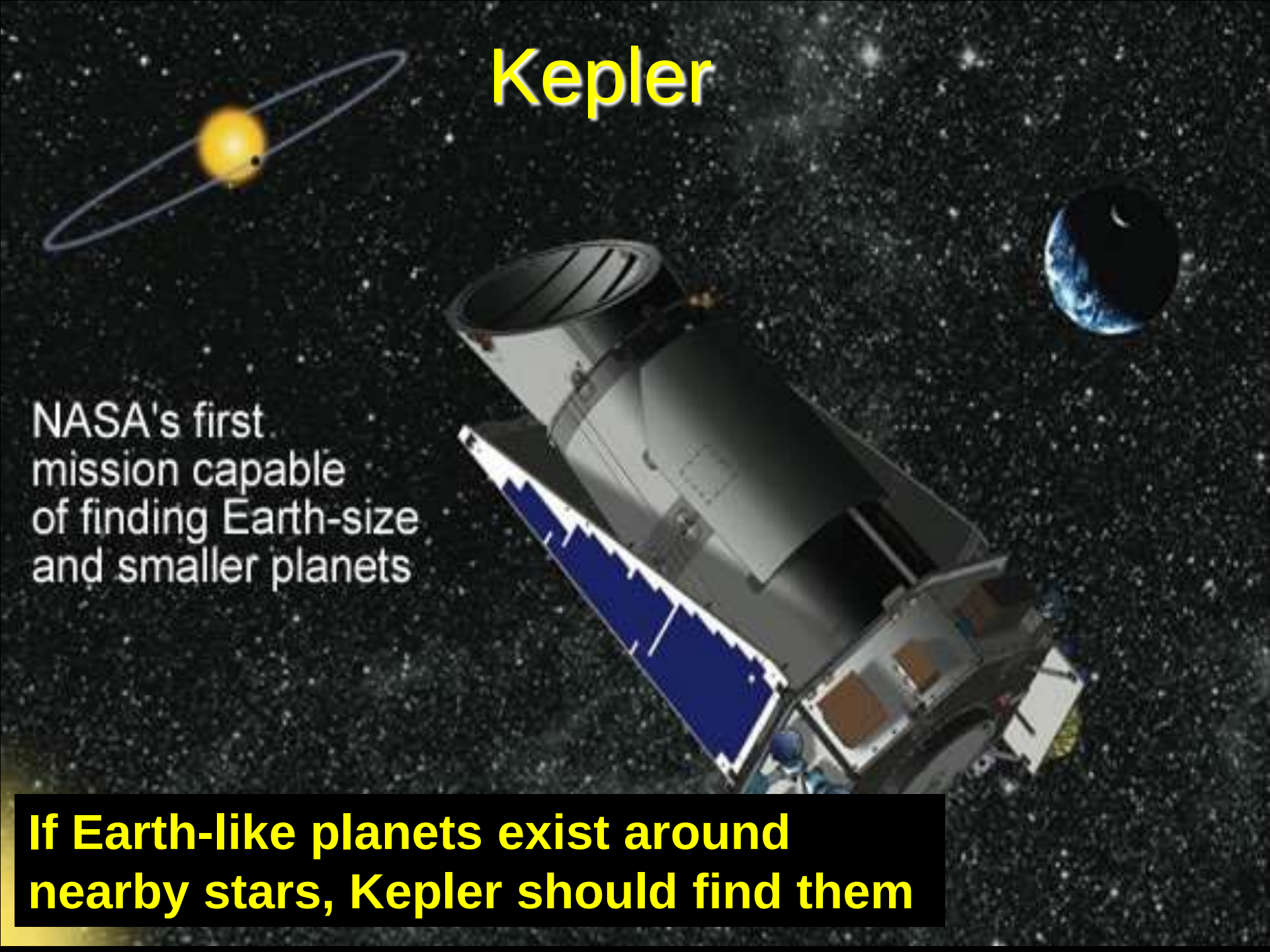

Kepler 7b
Kepler 5b
Kepler 8b
Kepler 6b
Jupiter
Kepler 4b
Earth
16.52 R_E
16.00 R_E
15.86 R_E
14.79 R_E
11.2 R_E
3.99 R_E

Locations of Kepler Planet Candidates





Kepler

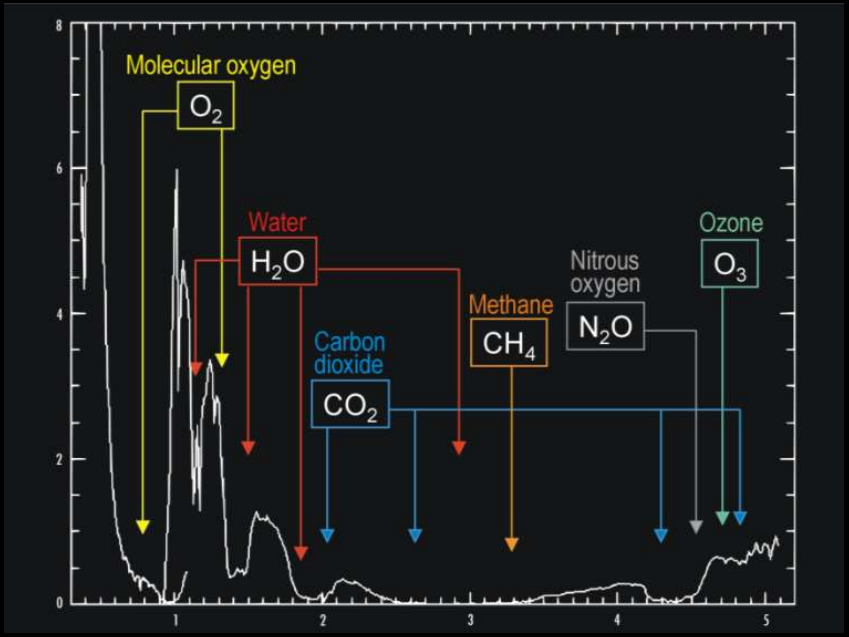


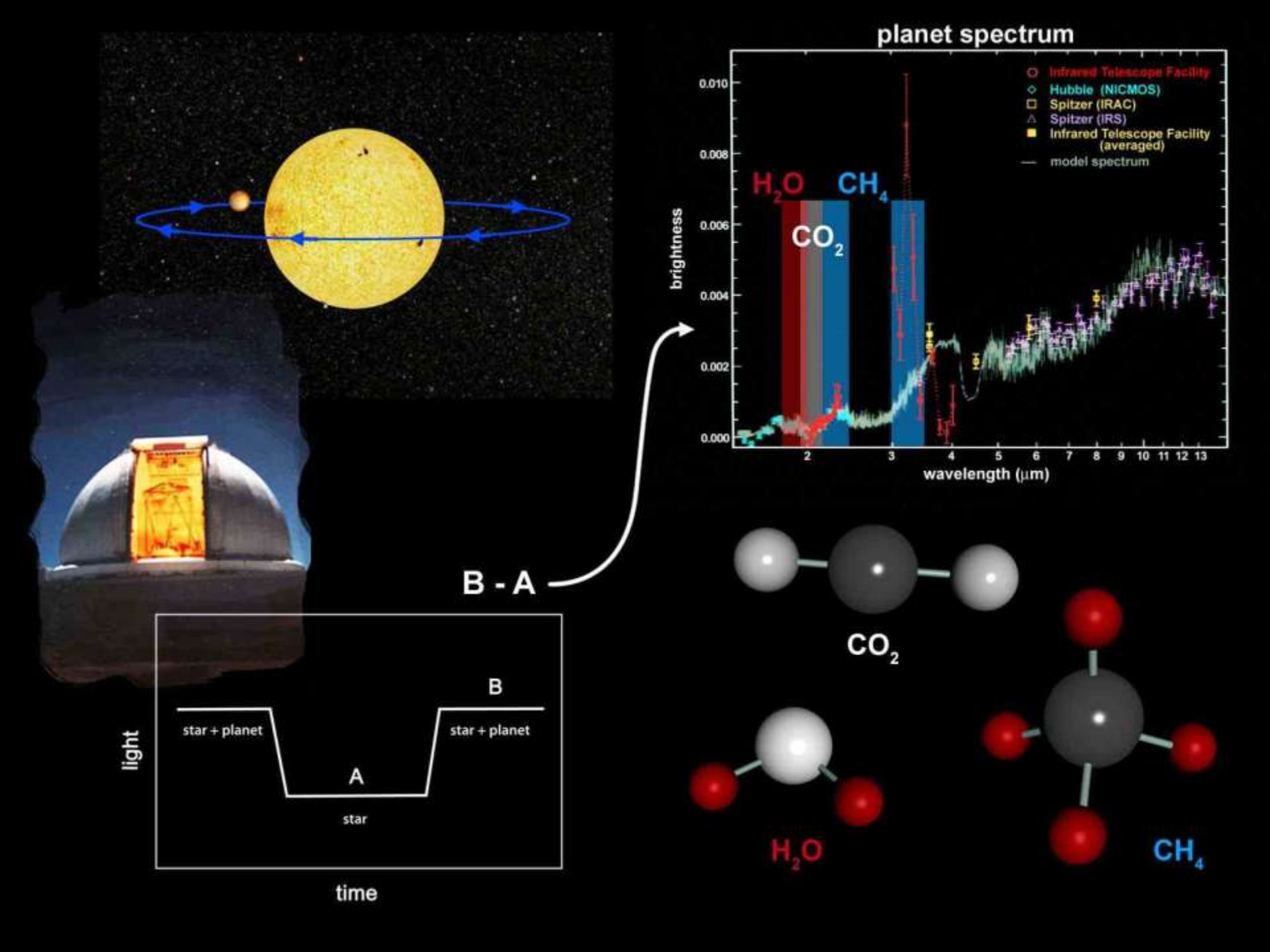
If Earth-like planets exist around nearby stars, Kepler should find them


Kepler-22 System
Habitable Zone
Solar System
Mercury
Venus
Earth
Mars
Kepler-22b

Could there be ET life like us on those planets?

Finding water, carbon dioxide, and especially **oxygen** would be a very big clue, but we really don’t know!




planet spectrum
Infrared Telescope Facility
Hubble (NICMOS)
Spitzer (IRAC)
Spitzer (IRS)
Infrared Telescope Facility (averaged)
model spectrum
H2O
CH4
CO2
brightness
0.010
0.008
0.006
0.004
0.002
0.000
2
3
4
5
6
7
8
9
10
11
12
13
wavelength (μm)
B - A
B
star + planet
star + planet
A
star
light
time
CO2
H2O
CH4

Could there be ET life like us on those planets?

Finding water, carbon dioxide, and especially **oxygen** would be a very big clue, but we really don't know!

If life *does* exist, what would it look like?

How would this depend on the type of planet and star?...