

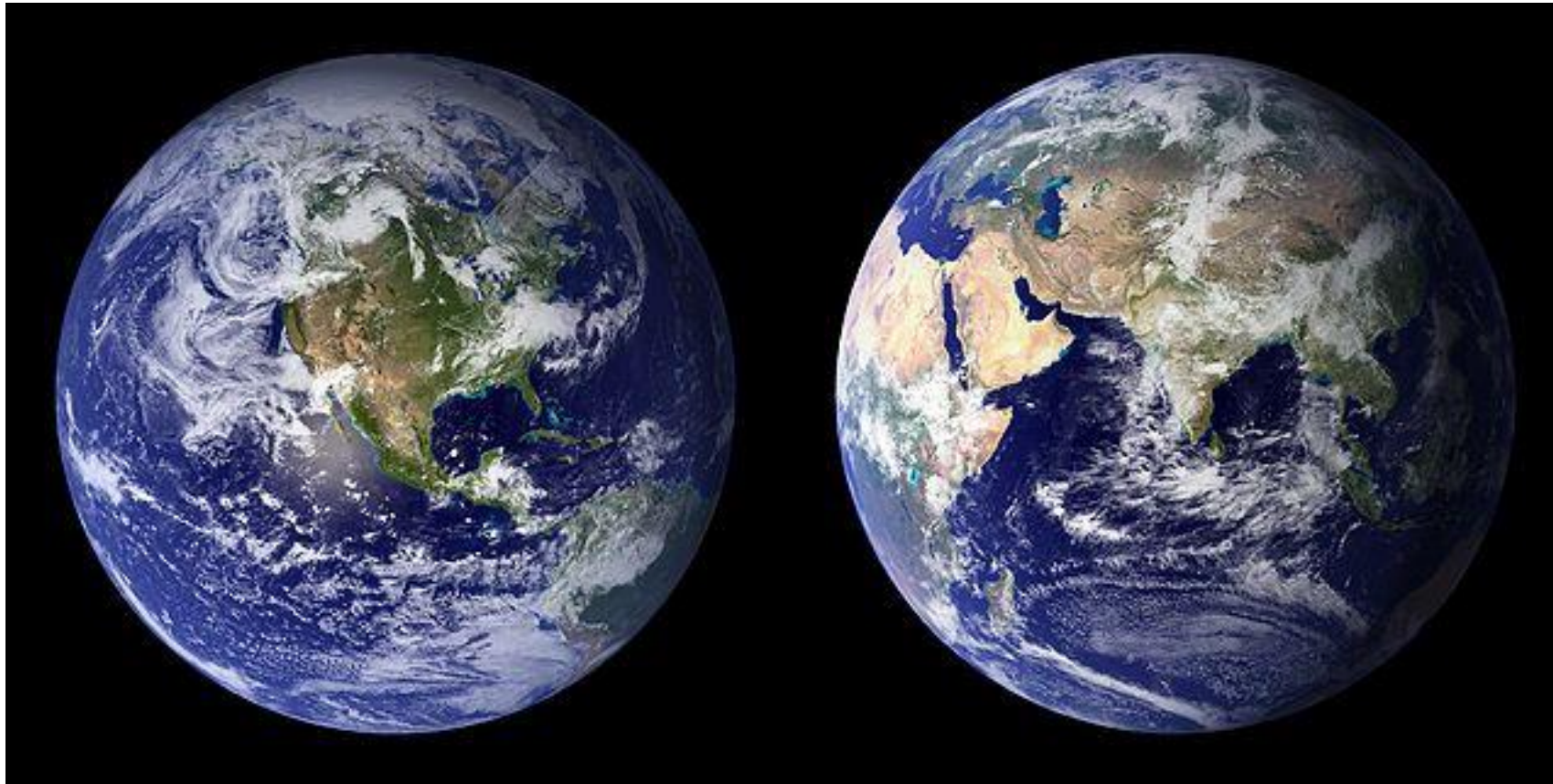
The search for life in the universe

Week 17

Water is **essential** for life

- Photosynthesis cannot happen without water
- Your body wouldn't be able to dissolve solutes
- Metabolic processes cannot happen:
 - Molecules could not grow or be broken down which is essential to life

The origin of water on Earth



Just over
71% of the
planet's
surface is
water

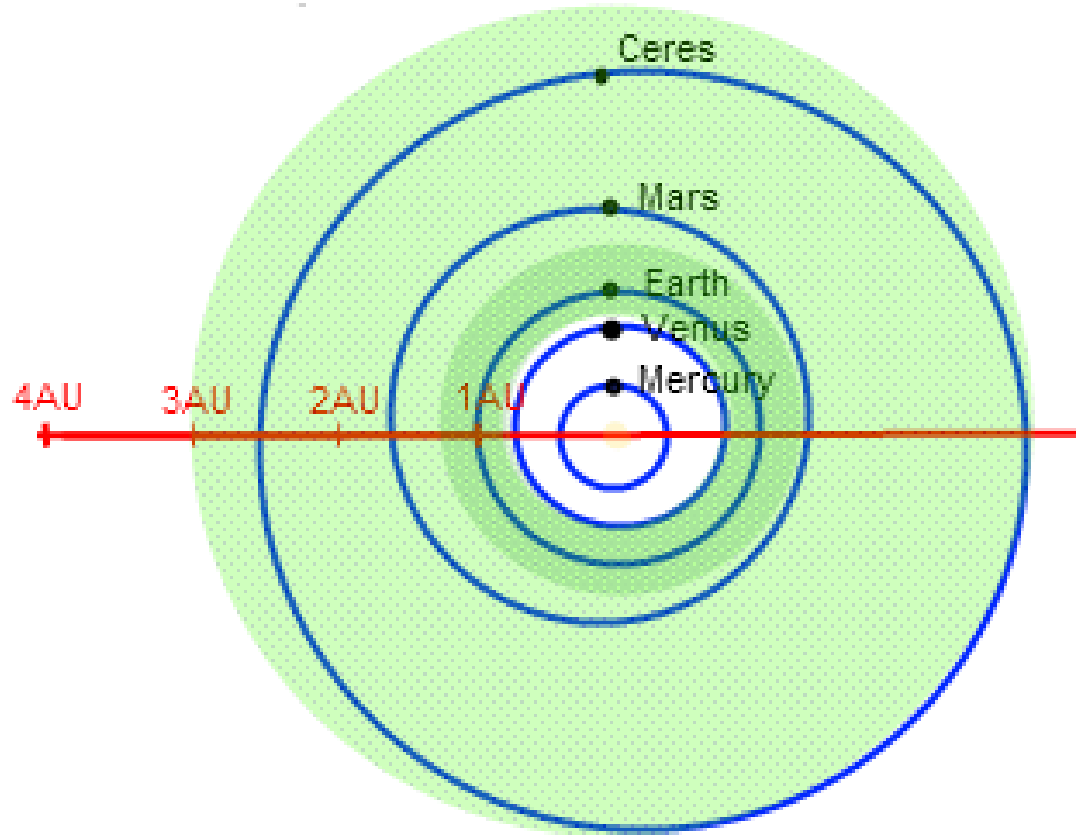
The origin of water on Earth

- From the solar system:
 - Ice from comets colliding with the planet.
 - Trans-Neptunian objects
 - Water-rich meteoroids from the outer reaches of the asteroid belt.
- Inside the Earth:
 - Hydrated minerals in the Earth's rocks
 - Water vapour in volcanic explosions fell as rain
 - Scientists currently believe that most of the Earth's water was already present

The 'Goldilocks zone'

- The **circumstellar habitable zone (CHZ)** is the range of orbits around a star within which a planet's surface will have liquid water.
- A number of factors affect the CHZ:
 - Temperature.
 - Air pressure.
 - Greenhouse effects of the different planets' atmospheres.
 - Size of the star which the planet orbits.
 - Temperature of the star.

The 'Goldilocks zone'



The dark green section is the limit of the CHZ for our solar system

The lighter green section shows the range where 'super earth' sized planets could support life if their atmospheric greenhouse effects were very strong.

Life on Mars

- Mars sits in the Goldilocks zone for part of its orbit.
- BUT only about 30% of the land is low lying enough for the atmospheric pressure to be high enough for liquid water to exist

CHZ planets beyond our solar system

- The Kepler space probe data reports:
- There are around 40 billion CHZ planets in orbit around either 'sun-like' stars or red dwarves in our galaxy, the milky way
- 11 billion are orbiting 'sun-like' stars in the milky way
- These are called **exoplanets (extra-solar planets)**

Exoplanets

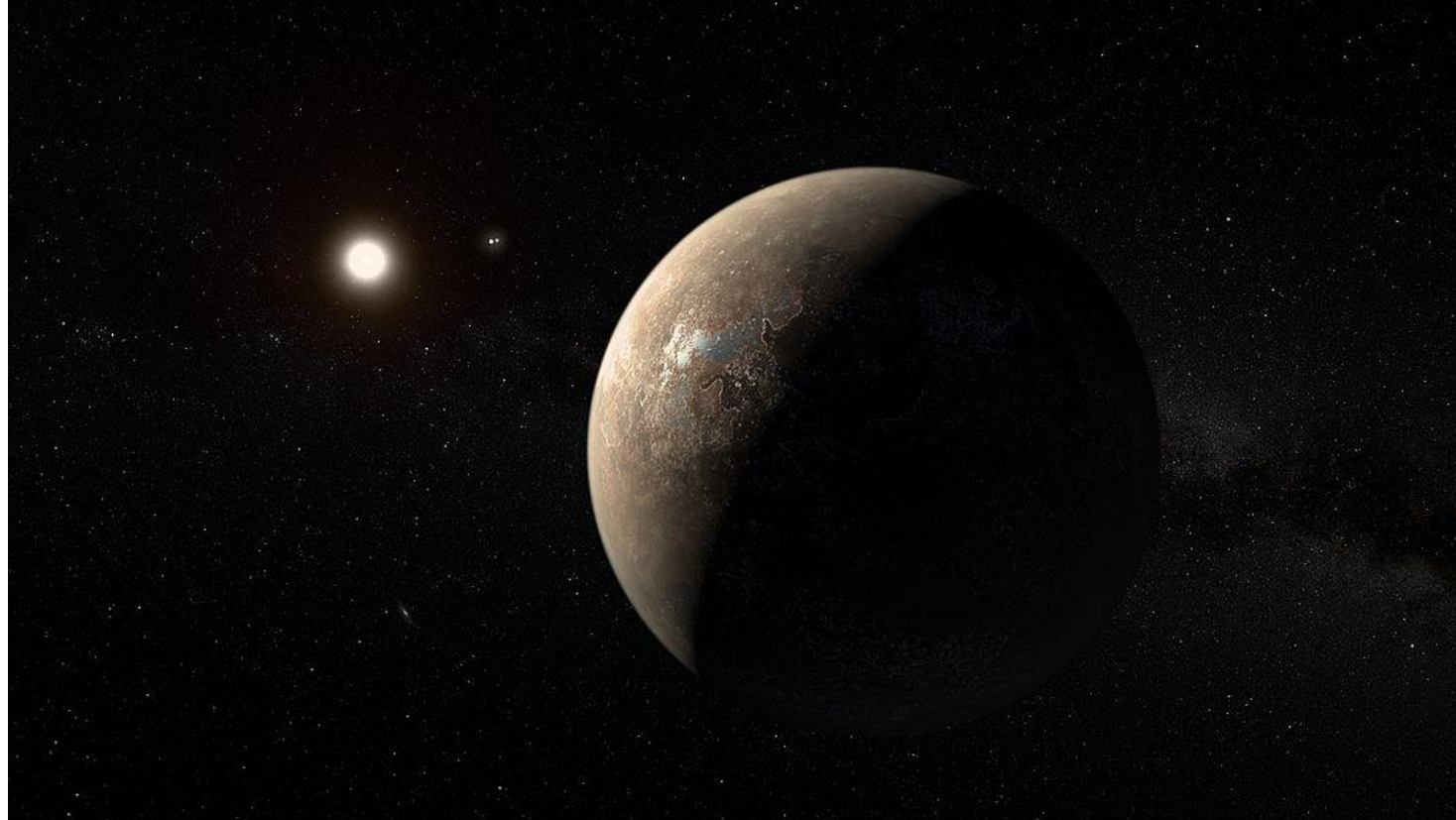
- Confirmed first in 1988, since then it's confirmed that there are:
 - 3,565 exoplanets in 2,675 planetary systems
 - 602 multiple planetary systems

Exoplanets

The **High Accuracy Radial velocity Planet Searcher (HARPS)** at La Scilla observatory in Chile has discovered over 130 exoplanets to date

The **Kepler space telescope** launched in 2009 has found over 3000 exoplanets. Kepler is in heliocentric orbit and trails behind the Earth in its path around the sun

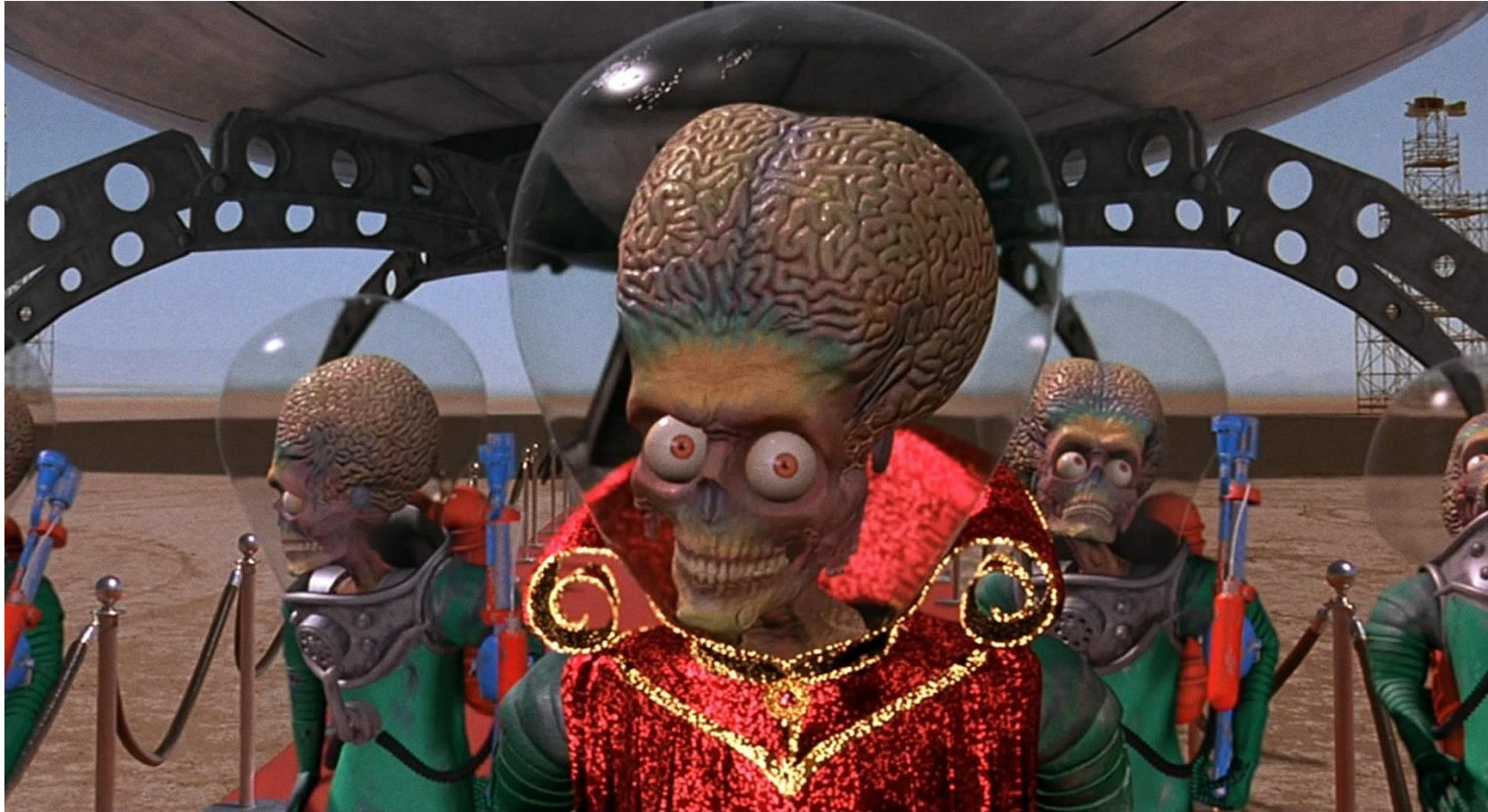
Proxima Centauri b



Proxima centurai b is an exoplanet orbiting the nearest star to us – proxima centurai (a red dwarf star) in the CHZ zone.

It was discovered in August 2016 and is 4.2 light years or 1.8 parsecs from Earth.

But is there intelligent life out there???



But is there intelligent life out there???

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

The **Drake equation** tells us the probability of developed civilizations existing in the Milky way

- The number of developed civilizations, N , is equal to the product of:
- (i) the average rate of star formation, R^* , in our galaxy,
- (ii) the fraction of formed stars, f_p , that have planets,
- (iii) the average number of planets per star, n_e , that can potentially support life,
- (iv) the fraction of those planets, f_l , that actually develop life,
- (v) the fraction of planets bearing life on which intelligent, civilized life, f_i , has developed,
- (vi) the fraction of these civilizations that have developed communications, f_c , i.e., technologies that release detectable signs into space.
- (vii) the length of time, L , over which such civilizations release detectable signals,

SETI – the Search for Extra-Terrestrial Intelligence



SETI – what are the aliens sending out?

- Many universities have SETI research programmes.
- **Radio waves** are not blocked by the Earth's atmosphere.
- Therefore radio telescopes are widely used to gather waves from space and are analysed to try and find patterns in the static.
- **Optical (light)** messages are difficult to detect.
- **Technosignatures** are also looked for.
- **Gamma-wave bursts** are not detectable on Earth as our atmosphere blocks them.

SETI – why haven't we met up yet?

- Is life in the universe rare? – the 'rare Earth' hypothesis
- Have we just not found them yet?
- Are our SETI methods good enough?
- Would the public be told anyway?

SETI – What have we sent out?

- The first high power TV broadcast was Hitler opening the 1936 Olympic Games in Berlin.
- That signal is still travelling away from Earth at the speed of light and will be the first thing detected followed by all other TV
- So over the course of 80 years aliens will receive an array of information starting from Hitler to Keeping up with the Kardashians – great!

SETI – The breakthrough message.

- In 2015 a competition was announced to design a message from mankind to be sent out into space.
- The winning entry will be decided by a committee of scientists and politicians

SETI – The implications.

- If intelligent life was discovered and contact made
- What do you think??????