Exoplanets

Planets in orbit around other stars

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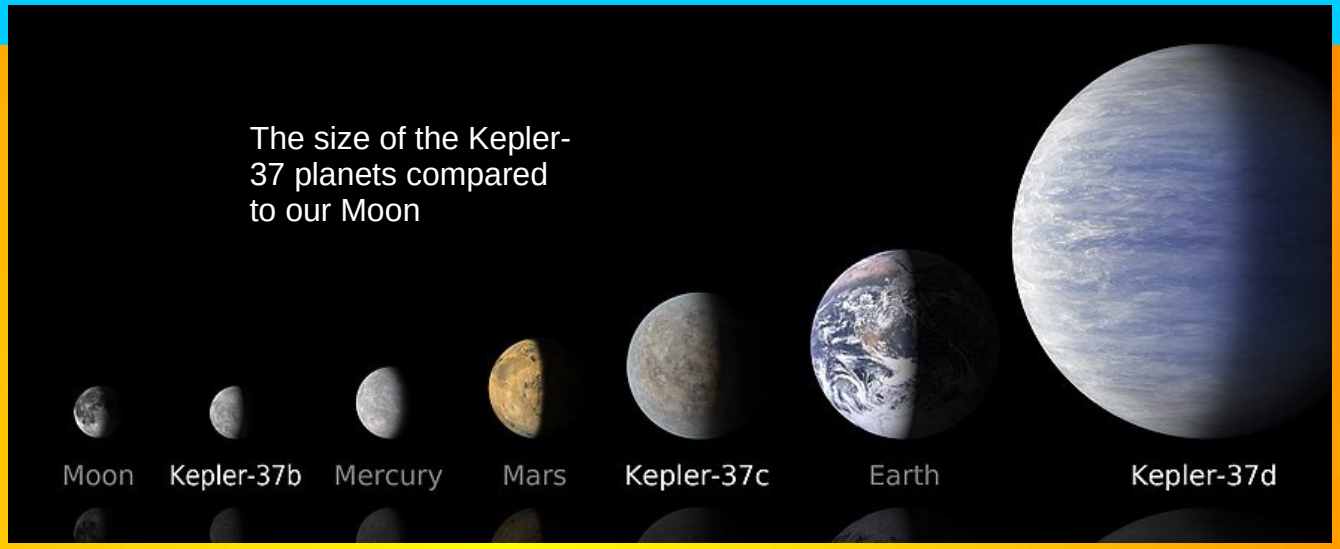
- **Images from NASA and Wikipedia**

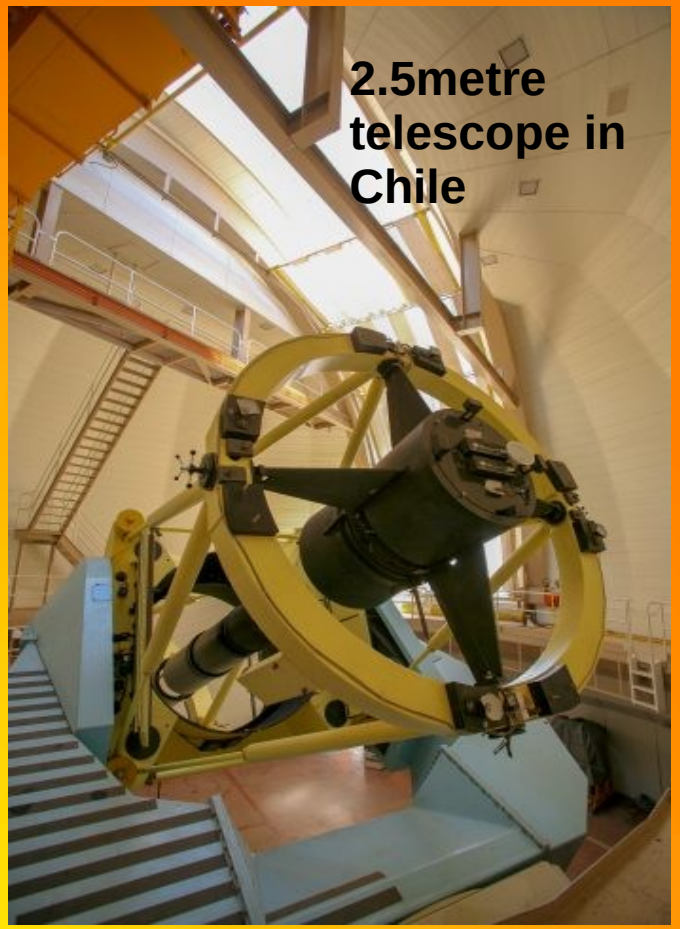
How many stars have planets?

- The first confirmed exoplanet was announced in 1992. As of 1 May 2025, there are 5,889 exoplanets in 4,395 planetary systems.
- 986 stars have been detected with more than one planet - our sun has 8 plus a number of other objects such as Pluto.
- All exoplanets detected so far are within the Milky Way.
- Extragalactic planets, exoplanets in other galaxies, may also exist, but the evidence is so far indirect.



What's the problem?

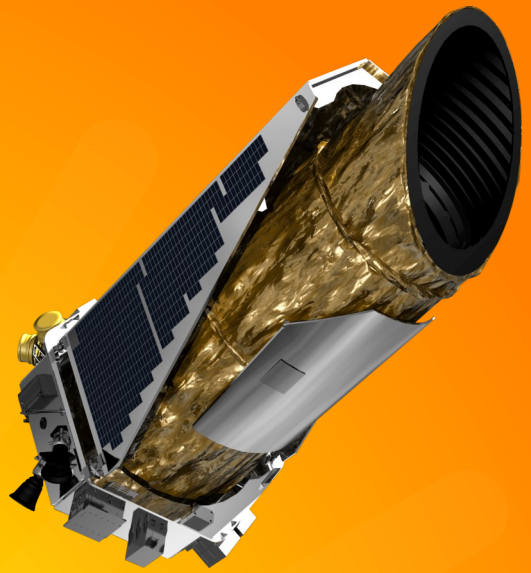
- In two words, ***Earth's Atmosphere***
- Earth-bound telescopes can't see objects in orbit around other stars, even the nearest ones, because of atmospheric distortion
- Even so, the first crude image of a planetary disc was made in 1984 from Chile with a 2.5m telescope
- It wasn't until the first space telescopes were launched in 1990 that real progress could be made
- We are now identifying planetary systems very quickly.



2.5metre telescope in Chile

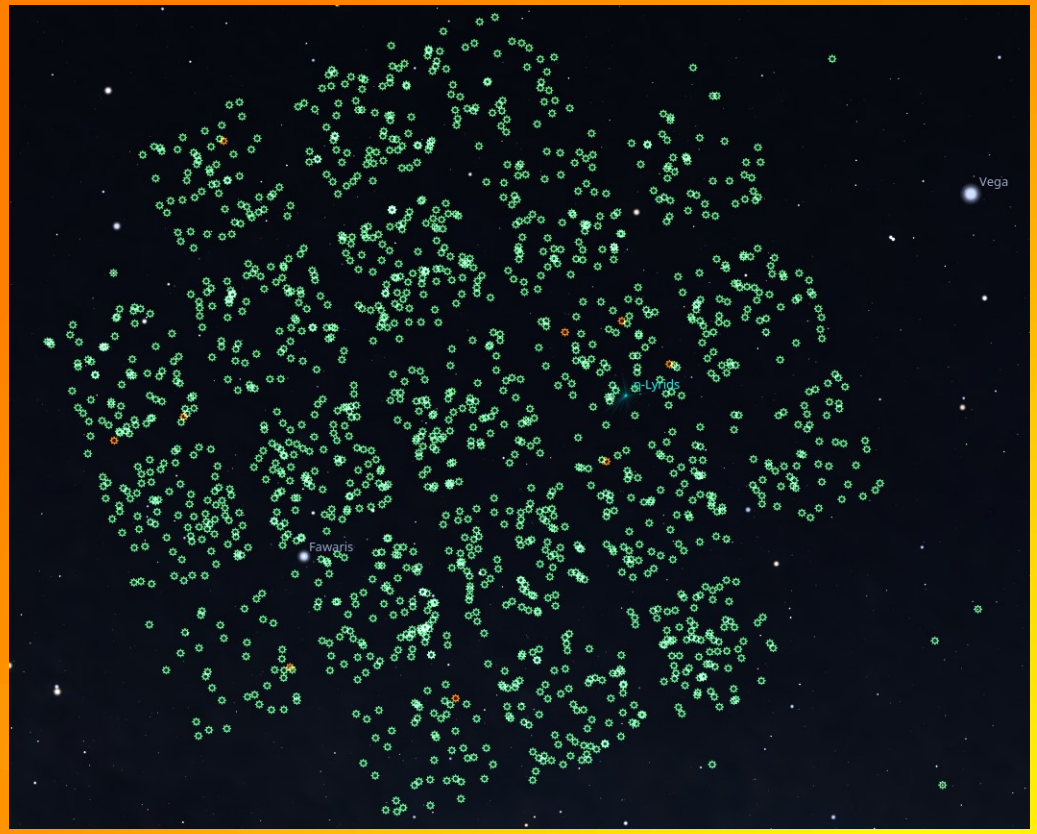
The Kepler space telescope

- The Kepler space telescope was launched by NASA in 2009 to discover Earth-sized planets orbiting other stars.
- The spacecraft was launched into an Earth-trailing heliocentric orbit.
- It surveyed part of our region of the Milky Way to find exoplanets and estimate how many of the billions of stars in the Milky Way have planets.
- Kepler's only instrument was a photometer that monitored the brightness of 150,000 main sequence stars in a fixed field of view.



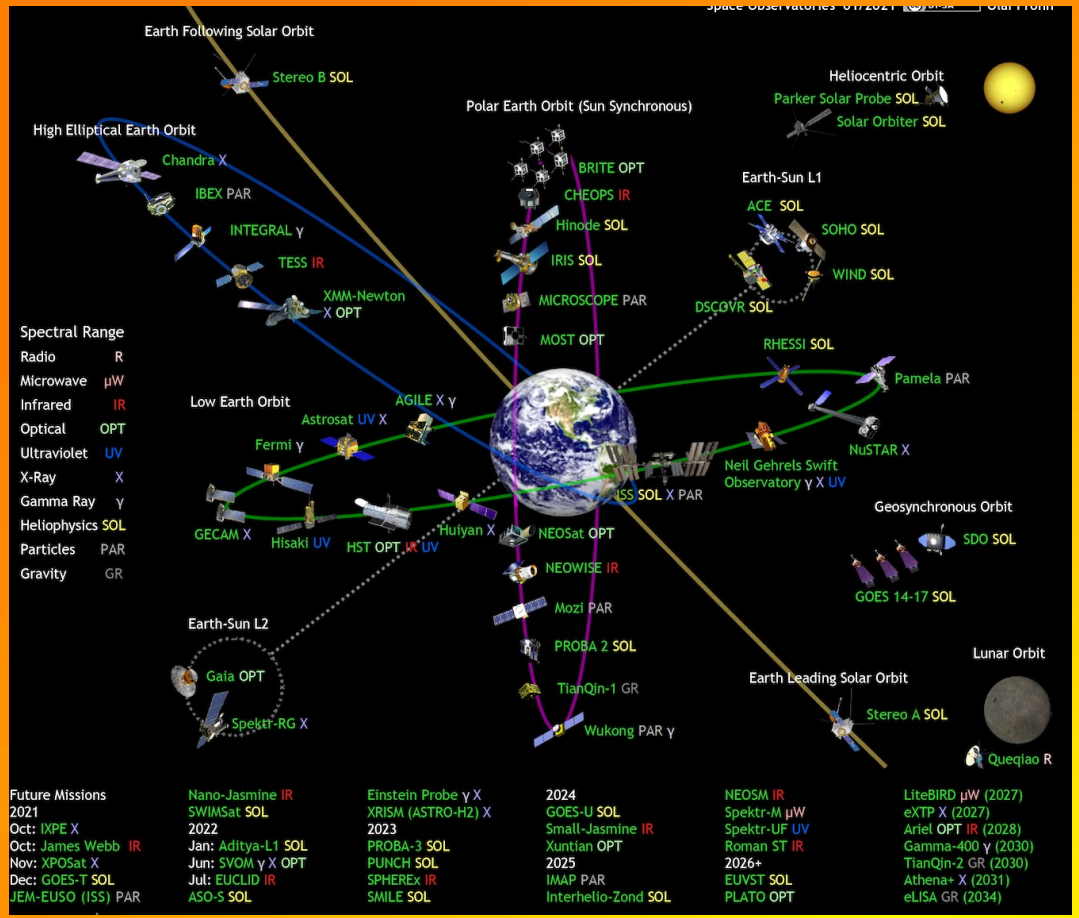
- Kepler observed 530,506 stars, and had detected 2,778 confirmed planets as of June 16, 2023. After nine and a half years of operation, the telescope's reaction control system fuel was depleted and it was “retired” from service.

The “Kepler patch” of sky



- This is a Stellarium screenshot. Each green ring shows a star with at least one planet.
- The area shown is a small patch of the sky near Vega, in the constellation Lyra, that was first explored by Kepler K1.
- It could only find stars with planets orbiting in line with the telescope.
- The number of stars with planets around them is astonishing.
- There are many more planets in the universe than there are stars!

More Space telescopes

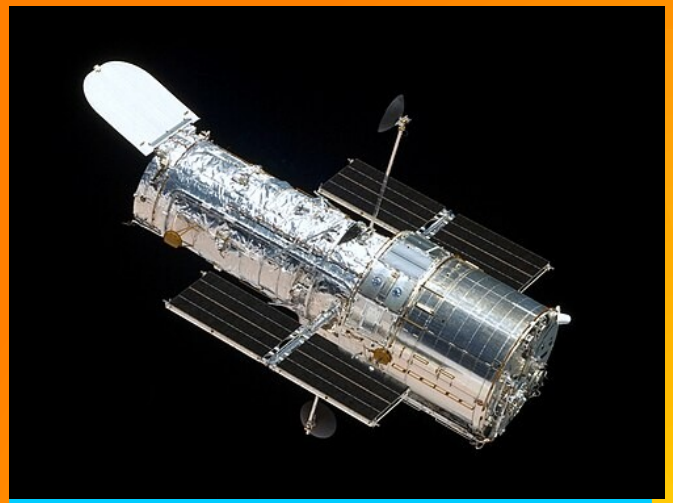


There are amazing numbers of space telescopes in orbit around us. This image shows only the active ones - there have now been about 130 in all.

Wikipedia has details of all of them - 11 x particle and graviton: 2 x Radio wave: 4 x Microwave: 14 x Infrared: 15 x Visible light: 23 x UV: 43 x X-ray: 18 x Gamma-ray.

Most have now gone out of service, some have crashed and burned in the atmosphere.

Hubble and JWST telescopes



The Hubble Space Telescope (HST) was launched into low Earth orbit in 1990 and is still in operation. It is one of the largest, a vital research tool for astronomy.

The James Watt Space Telescope (JWST) is designed to conduct infrared astronomy.

It is equipped with high-resolution and high-sensitivity instruments, allowing it to view objects too old, distant, or faint for the Hubble Space Telescope.

It is in orbit around Earth's L2 Lagrange point.

The mirror of the JWST

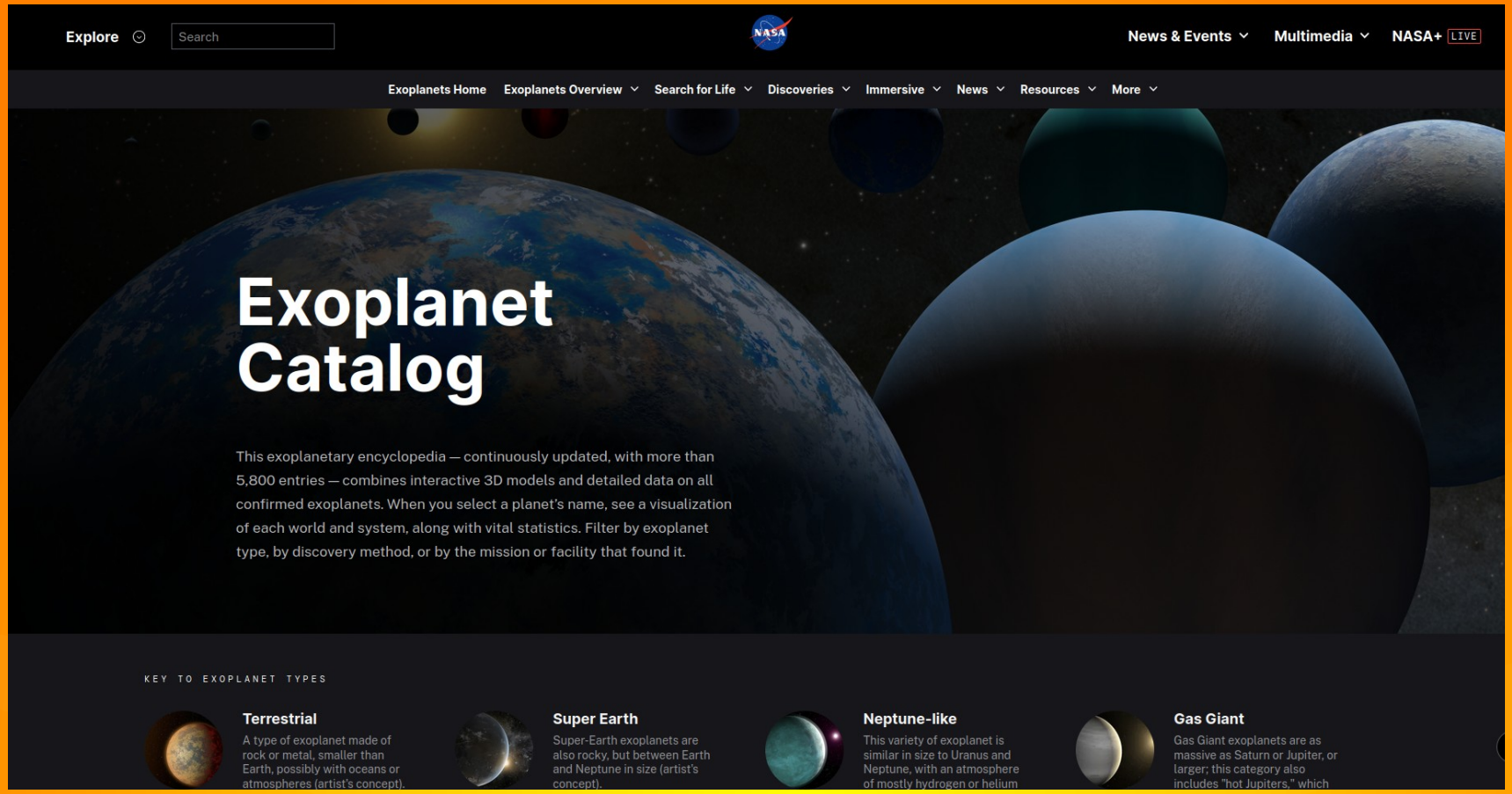
Direct imaging

Planets are extremely faint light sources compared to stars, and what little light comes from them tends to be lost in the glare from their parent star. So it is very difficult to tell them apart from their host star.

Planets orbiting far enough from stars to be resolved reflect very little starlight, so planets are detected through their thermal emission instead. It is easier to obtain images when the planetary system is near to us, and when the planet is especially large, far away from its parent star, and hot; images have then been made in the infrared, where the planet is brighter than it is at visible wavelengths.

Coronagraphs are used to block light from the star, while leaving the planet visible. Direct imaging of an *Earth-like* exoplanet needs extreme optothermal stability.

NASA Exoplanet Catalogue



Stellarium and the Exoplanets

- The Stellarium program keeps updating itself with the latest confirmed exoplanet discoveries. Full data on each planetary system can be displayed. Here, for example, is an extract from the data display for Kepler-9, a faint star 2000 light-years away in Libra, discovered in 2010:
- Star name: Kepler-9 / planetary system / Magnitude: 13.90
- Planet Name: Orbital period / Mass / Radius / Inclination
- Kepler-9b 19.24 days / 0.14J / 0.7 J / 89.0 deg
- Kepler-9c 38.99 days / 0.09J / 0.7J / 89.2 deg
- Kepler-9d 1.59 days / 0.02J / 0.1J / unknown

List of Nearest Stars

- https://en.wikipedia.org/wiki/List_of_nearest_stars

Designation		Distance (ly)[7]	Constellation	Stellar class	Mass	Magnitude		Notes and additional references
System	Name					App.	Abs.	
Solar System	Sun (Sol)$	0.0000158	N/A	G2V[6]	1	−26.74#	4.85	eight recognized planets and more dwarf planets
Alpha Centauri	Proxima Centauri	4.2465 ±0.0003	Cen*	M5.5Ve	0.122	11.09	15.53	flare star, one confirmed planet (b, 2016, and two candidate planets, (d, 2022)[9][10] and (c, 2019)[11][12]
	Rigil Kentaurus	4.3441 ±0.0022		G2V[6]	1.079	0.01#	4.38	one directly imaged habitable-zone planet candidate (Candidate 1) (2021)
	Toliman			K1V[6]	0.909	1.34#	5.71	planet b refuted in 2015
Barnard's Star		5.9629 ±0.0004	Oph*	M4.0Ve	0.144	9.53	13.22	flare star, largest-known proper motion,[14] four confirmed planets (d, b, c, and e)[15][16]
Luhman 16	A§	6.5029 ±0.0011	Vel*	L8±1[17]	0.032	10.7 J	14.2 J	nearest brown dwarfs
	B§			T1±2[17]	0.027			
WISE 0855−0714&		7.430 ±0.041	Hya*	Y4	0.003-0.010	25.0 J	28.2 J	sub-brown dwarf
Wolf 359 (CN Leonis)		7.8558 ±0.0013	Leo*	M6.0V[6]	0.090	13.44	16.55	flare star, has 1 candidate & 1 refuted planet[20][21]
Lalande 21185		8.3044 ±0.0007	UMa*	M2.0V[6]	0.390	7.47	10.44	two known planets (2019, 2021)[22]
Alpha Canis Majoris	Sirius (A)$	8.7094 ±0.0054	CMa*	A1V[6]	2.063	−1.46#	1.42	brightest star in the night sky
	B‡			DA2[6]	1.018	8.44	11.34	
Gliese 65 (Luyten 726–8)	A (BL Ceti)	8.724 ±0.012	Cet*	M5.5Ve	0.102	12.54	15.40	flare star (Archetypal member), has 1 candidate planet[23]
	B (UV Ceti)			M6.0Ve	0.100	12.99	15.85	
Ross 154 (V1216 Sagittarii)		9.7063 ±0.0009	Sgr*	M3.5Ve	0.17	10.43	13.07	flare star

Why bother?

- Good question! Many countries are working to find more exoplanets. The costs are huge. What do you think?

  + Most people have an inner drive to find out things.

  - All these planets are far out of our reach.

  + Only for now - maybe in future we can get there.

  - We're wrecking our own planet right now.

  + Sure - but it won't last for ever anyway. Nor will we!

  - Who are we to be thinking about colonising the Galaxy?

  + Can any other lifeforms can think in the ways we do. Is that valuable?

  +/- Spinoffs, advances in technology.