

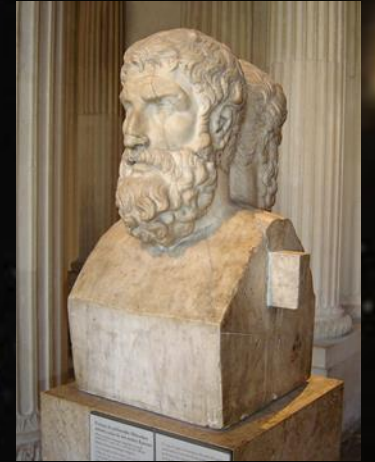


Exobolygók



Arisztotelész:
Csak egy világ, a miénk, a földi létezik.

Epikurosz:
„Fontos tudni, hogy végtelen számú világ van, s közülük némelyek hasonlóak ehhez a mi világunkhoz, mások nem hasonlók.”



Giordano Brunó
A csillagok is Napok, és körülöttük lehetnek bolygók is.

A Naprendszer megismerése során változott a bolygó fogalma



Jelentősebb felfedezések: 1787 Uránusz

1801 Ceres 1802 Pallas 1804 Juno

1807 Vesta 1845 Astraea

1846 Neptunusz ...

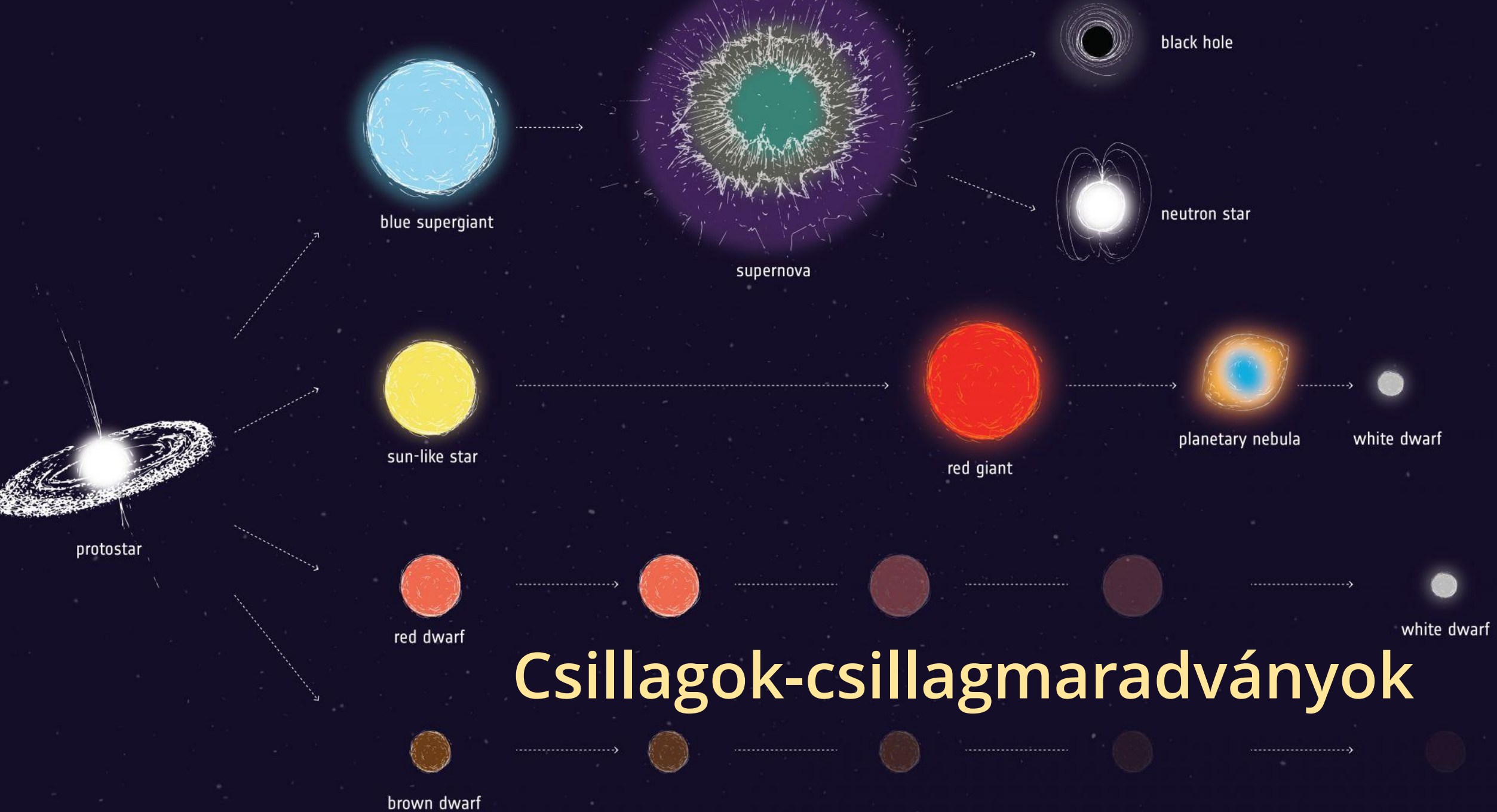
1930 Plútó ...

2005 Eris ...

• Exobolygók definiálása

Naprendszeren kívüli bolygó, csillag vagy csillagmaradvány körül kering

A felső tömeghatár: 13 Jupiter tömeg
Ennél nagyobb tömegnél beindul a deutérium termonukleáris fúziója, és ezt már barna törpének nevezzük.



Csillagok-csillagmaradványok

Égitestek méret szerint

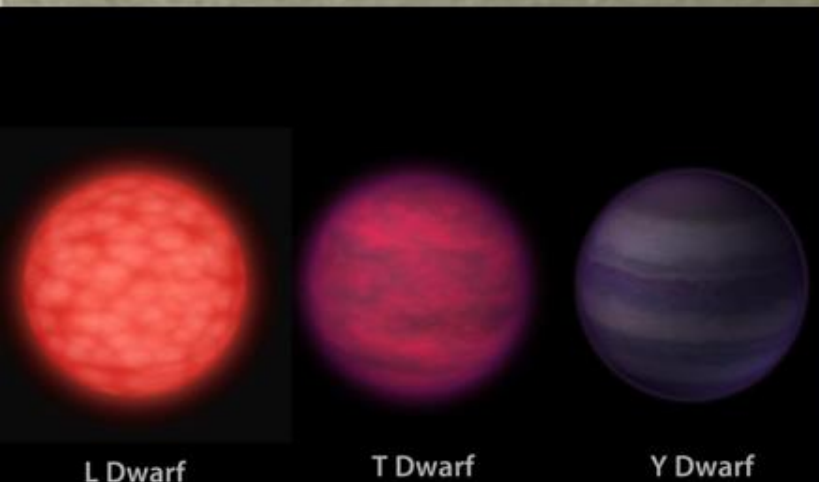
Sun

Low Mass Star

Brown Dwarf

Jupiter

Earth



L Dwarf

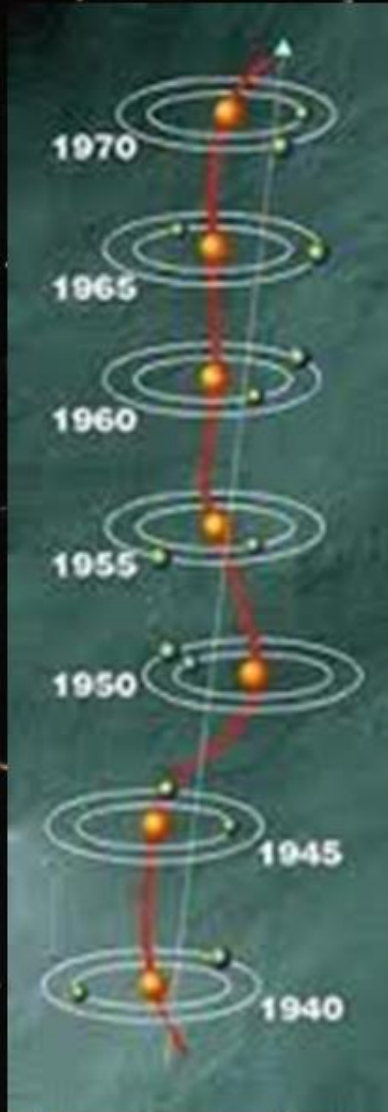
T Dwarf

Y Dwarf

Az első(?) felfedezés

Peter van de Kamp 1938-tól vizsgálta a Barnard csillagot (legnagyobb sajátmozgású csillag)
1963-ban bejelentette egy exobolygó felfedezését

Később ez a hír tévesnek bizonyult!





PSR B1257 +12 b, c, d

Az első exobolygókat pulzár
körül találták 1991-ben.

51 Pegasi b, az első Naphoz hasonló csillag körül felfedezett exobolygó (1995)



TEMPERATURE

51 Pegasi b has a temperature of **1000C°/1800F°**.



ORBITAL PERIOD

51 Pegasi b orbits its host star **every 4 days**.



DISTANCE FROM EARTH

51 Pegasi b is **50 light-years** from Earth.

PLANET COMPARISON

51 Pegasi b



Jupiter



51 Pegasi b is **47% less massive**, but **50% larger** than Jupiter.

STAR COMPARISON

51 Pegasi

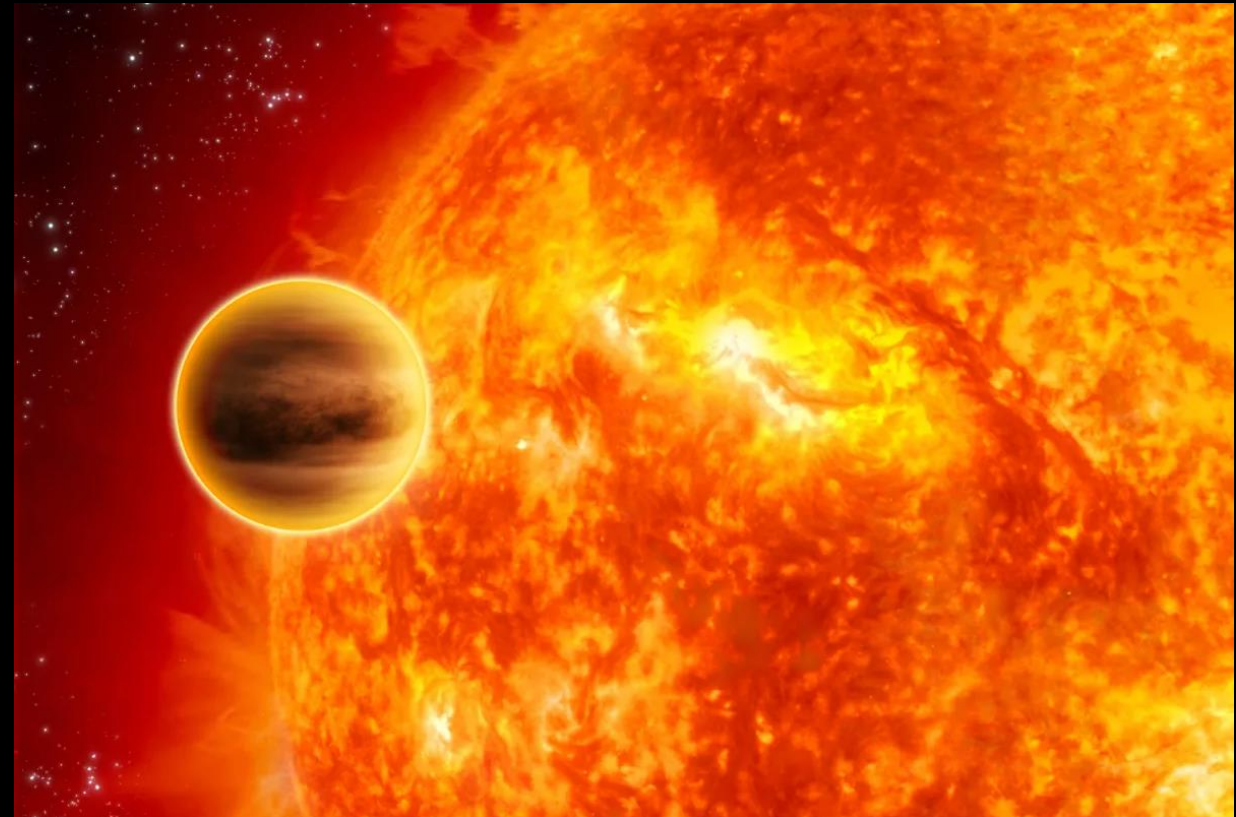
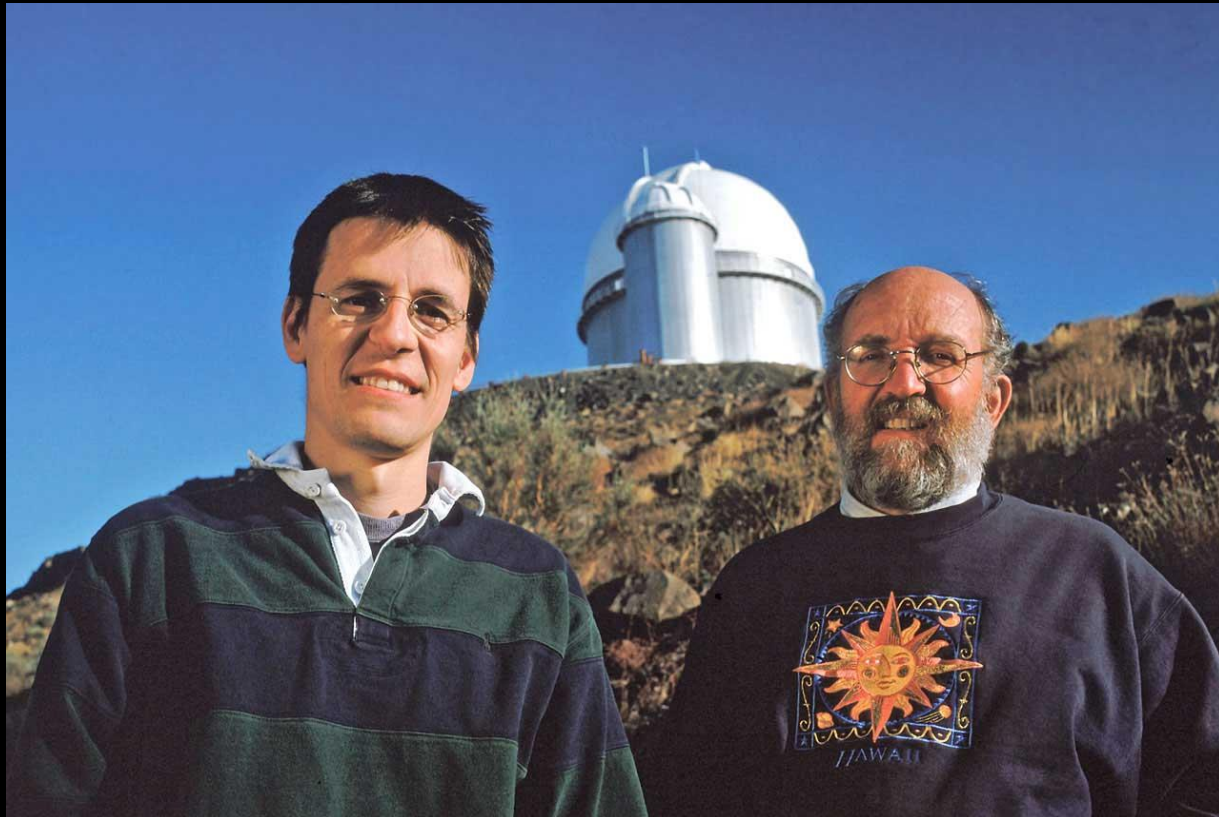


Our sun



51 Pegasi is **11% more massive** and **23% larger** than our sun.

Fizikai Nobel-díj 2019-ben exobolygófelfedezésért (Didier Queloz, Michel Mayor)



Exoplanet Detection Methods Visualized

Simple Telescope



A twinkling star caused by atmospheric effects

Pulsar Timing

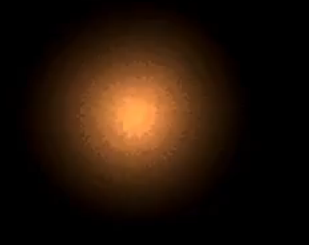
[5]



Pulsar Frequency by Radio
[orbit • mass]

Radial Velocity

[511]



Star Motion by Doppler Effect
[orbit • mass]

Transit

[1,137]



Star Brightness by Eclipse
[orbit • radius • atmosphere]

Stars appear to twinkle with many colors as observed by the naked eye or simple telescopes.

Precise instruments were required to remove this atmospheric effect and reveal planets.

Since 1992 we know of over 1,800 planets around other stars detected by six main methods.

Astrometry

[1]



Star Motion by Imaging
[orbit • mass]

Microlensing

[26]



Star Brightness by Lensing
[orbit • mass]

Direct Imaging

[35]



Planet Brightness by Imaging
[orbit • radius • atmosphere]



Exobolygó-felfedező módszerek:

- Radiális sebességmérés (spektroszkópia)
- Fotometriai módszer (tranzit)
- Direkt leképezés (képalkotás)
- Gravitációs mikrolencse módszer
- Asztrometriai módszer

5 Ways to Find a Planet

WATCHING FOR WOBBLE

Radial Velocity
630 planets discovered

SEARCHING FOR SHADOWS

Transit
2717 planets discovered

TAKING PICTURES

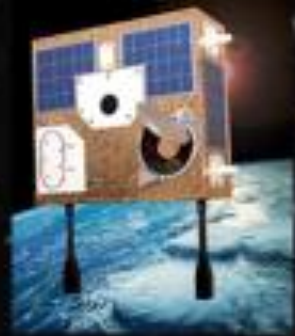
Direct Imaging
44 planets discovered

LIGHT IN A GRAVITY LENS

Gravitational Microlensing
44 planets discovered

MINISCULE MOVEMENTS

Astrometry
1 planet discovered

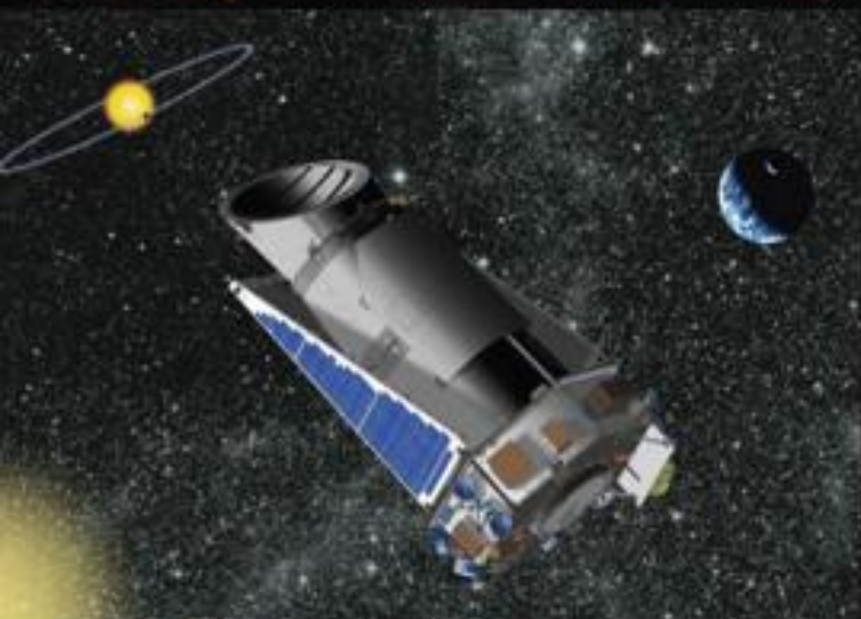


MOST

Exobolygókereső űrtávcsövek

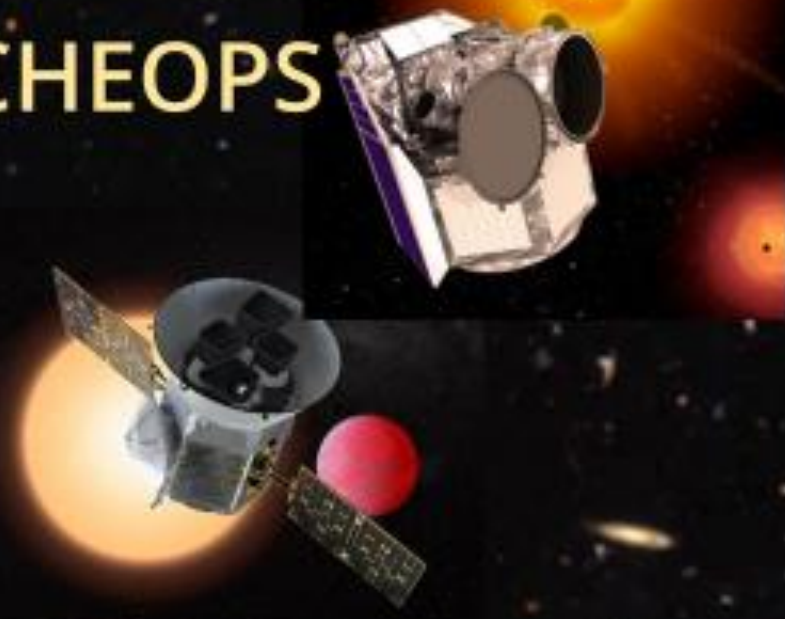


COROT

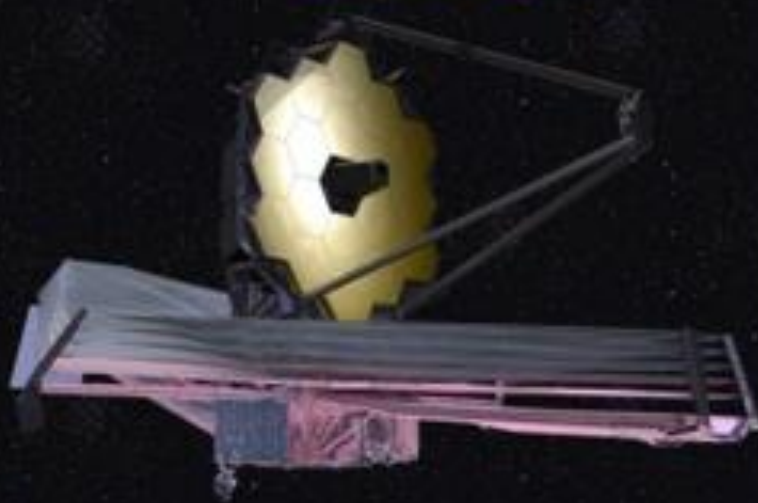


• Kepler

CHEOPS



TESS



James Webb

Subaru, japán 8 m-es távcső (Hawaii)



HATNet, HATSouth,

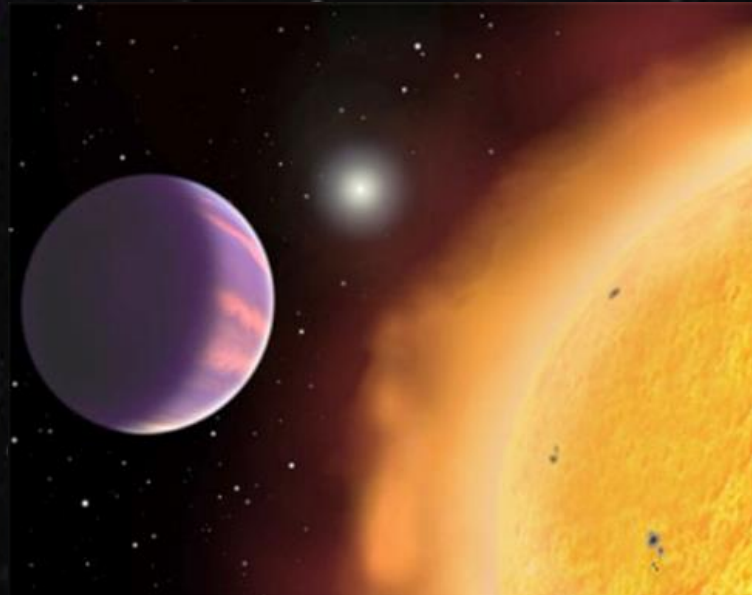
Hungarian-made Automated Telescope Network,
Magyar Automatikus Távcsőhálózat

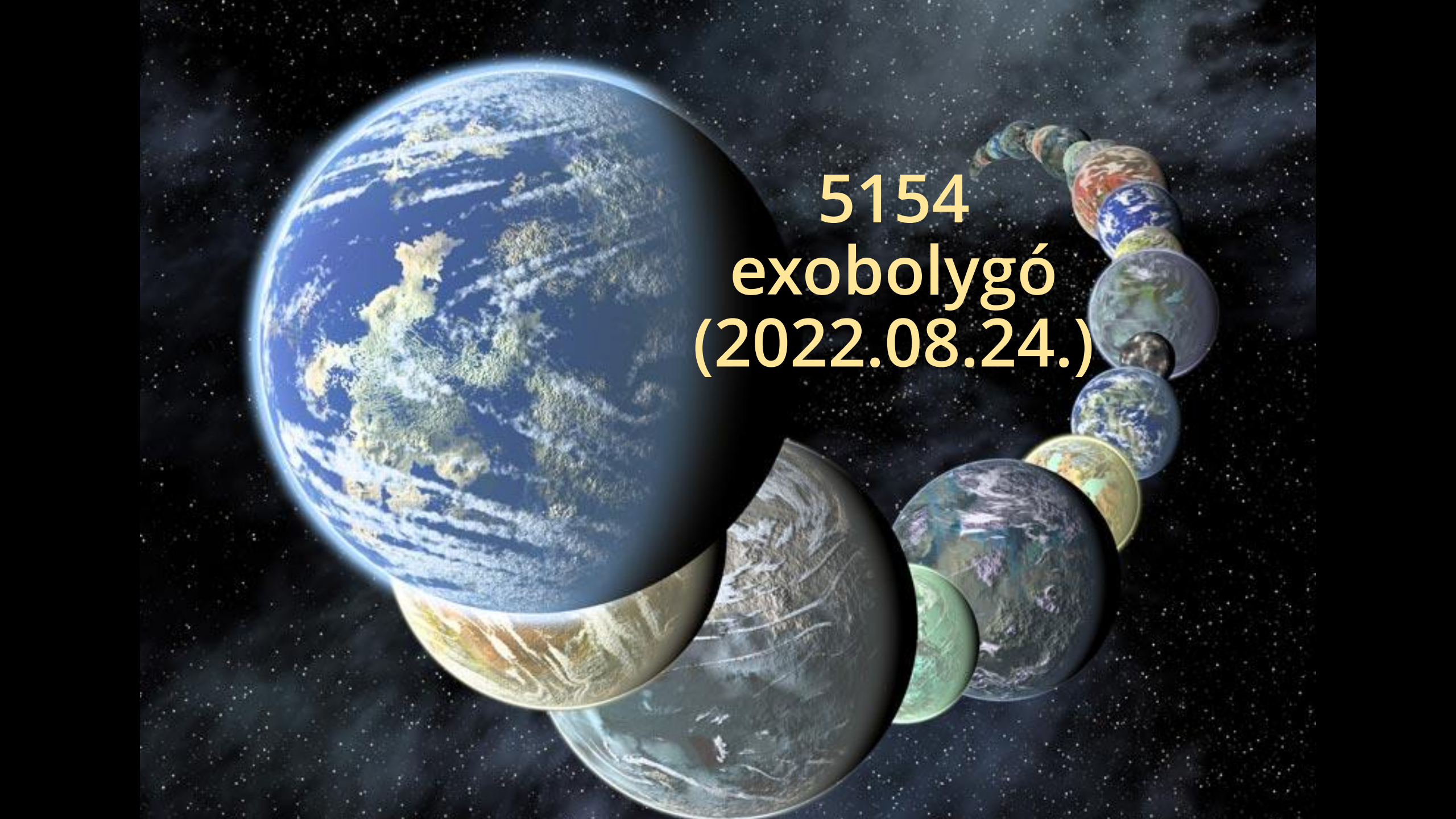
143 exobolygófelfedezés (70 az északi égboltról, 73 a déli égboltról)

<http://hatnet.org/>

<http://hatsouth.org/>

Az első magyar felfedezésű exobolygó,
HAT-P-1b, fél Jupiter tömegű,
4,5 napos periódusú
(2006, Bakos Gáspár)



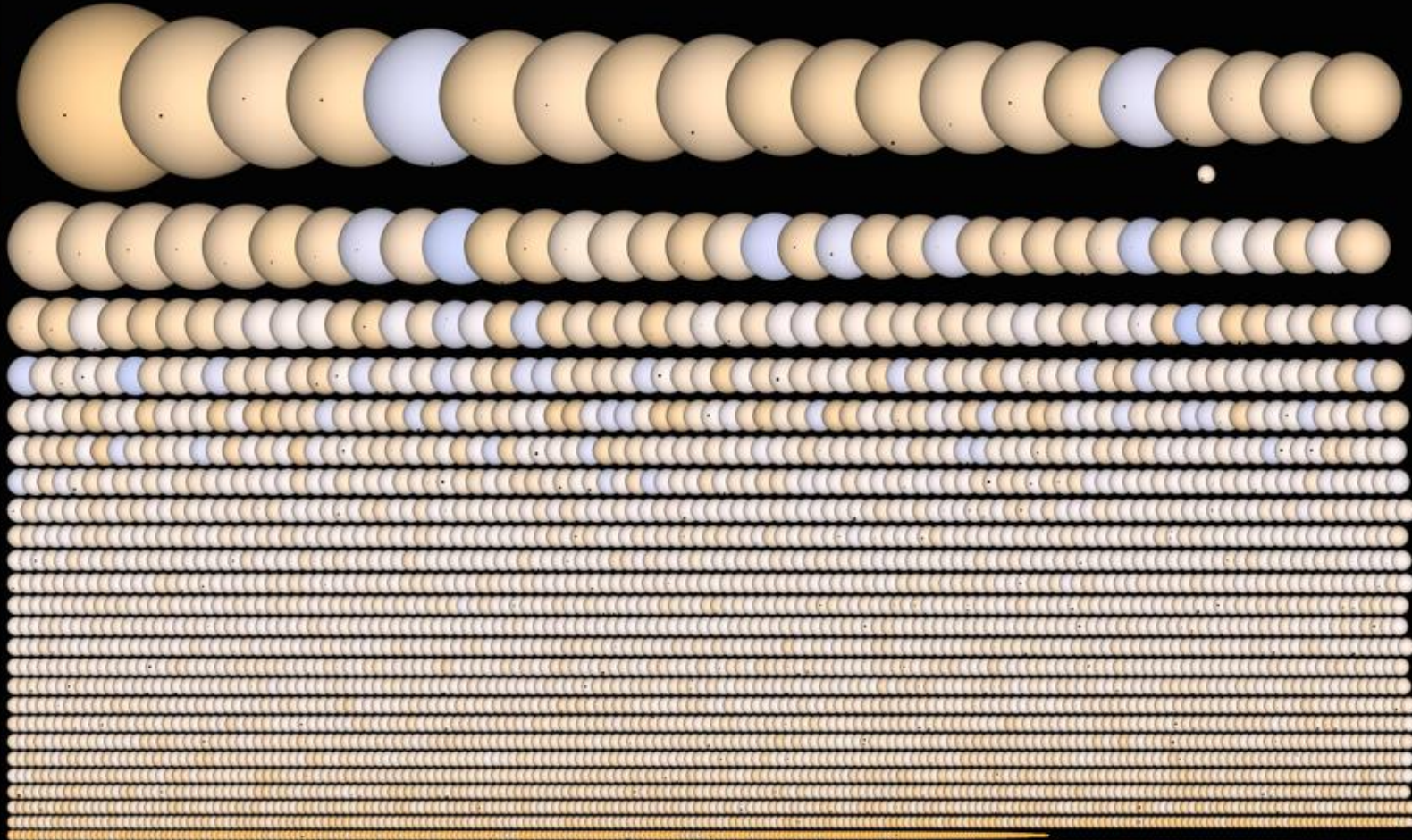


5154
exobolygó
(2022.08.24.)

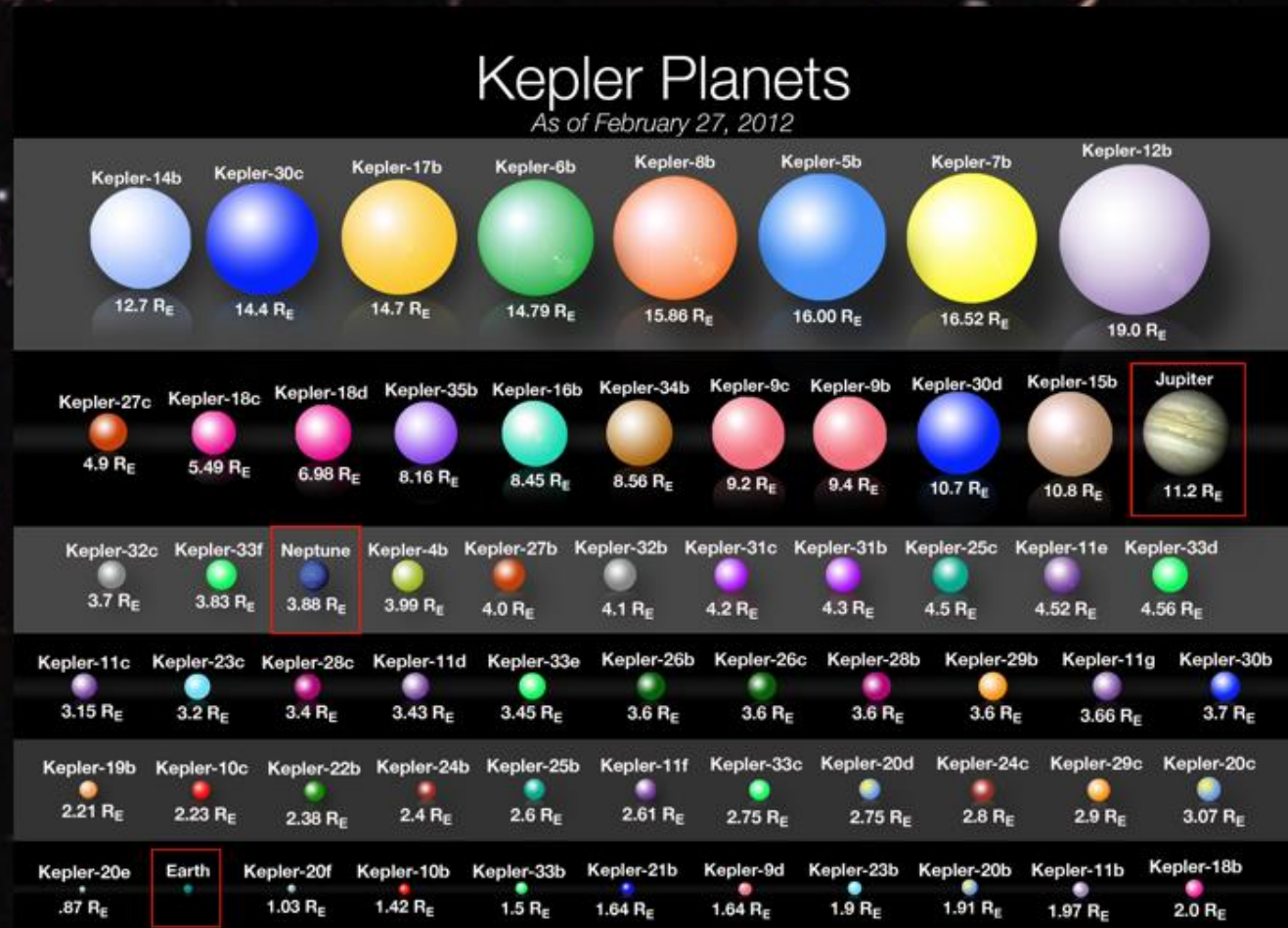
A legtöbb csillagnak vannak bolygókísérői, így csak a mi galaxisunkban milliárdnyi exobolygó lehet.



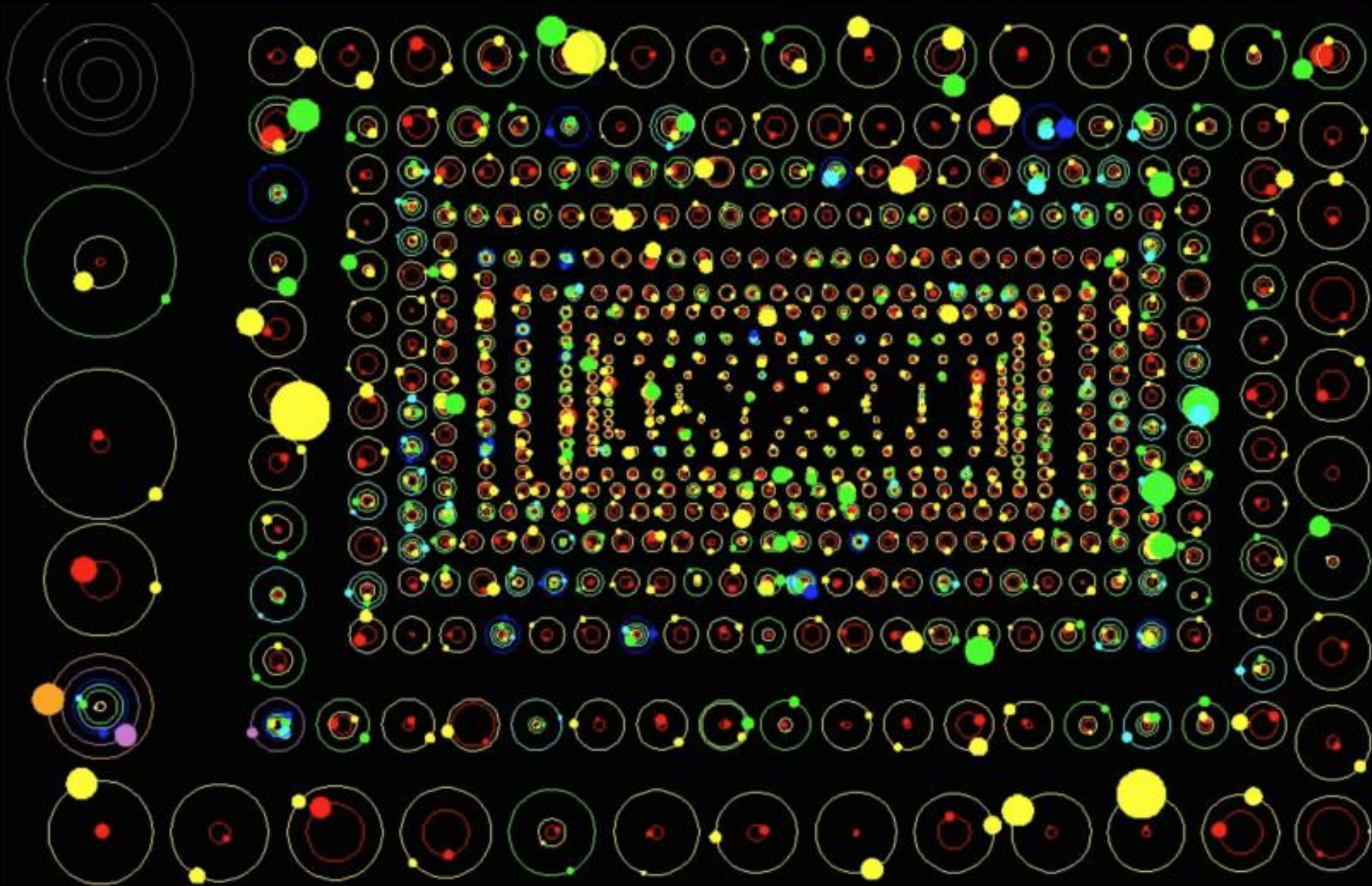
Exobolygók mindenféle csillag körül



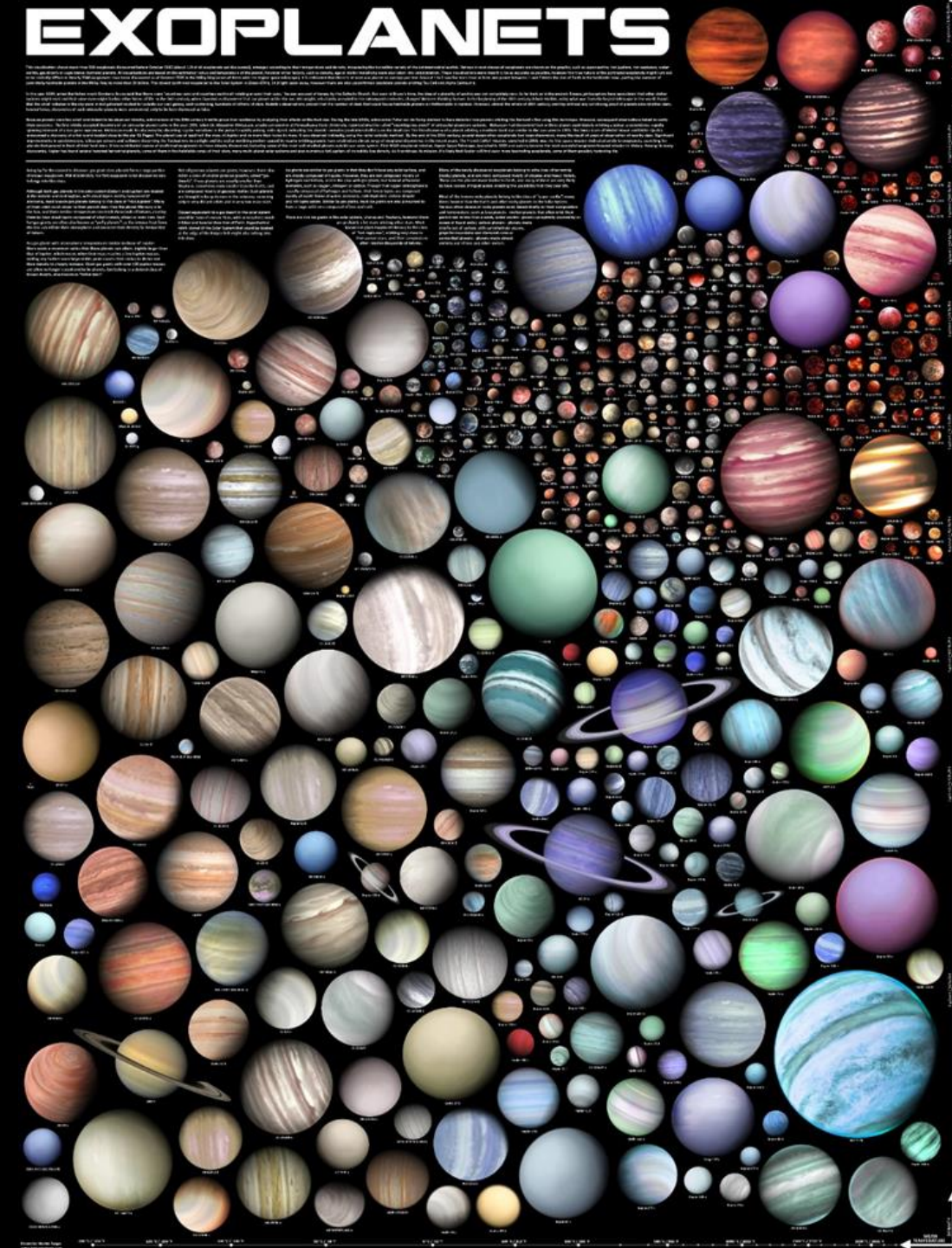
Exobolygók minden méretben



Változatos exobolygópályák

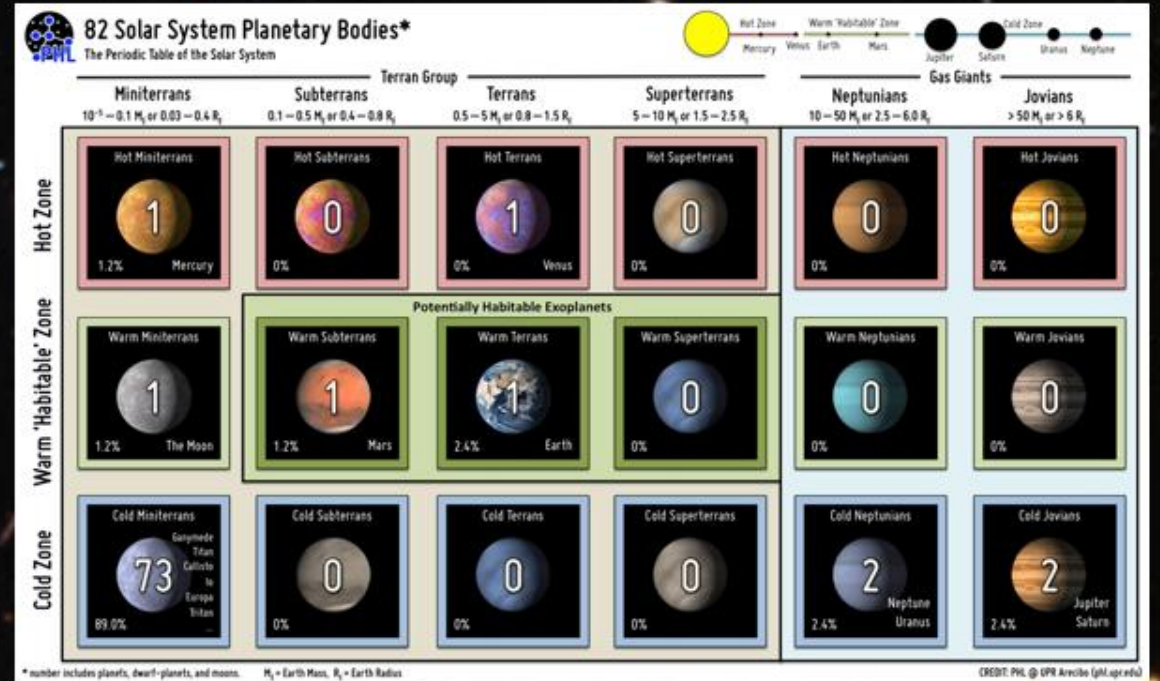
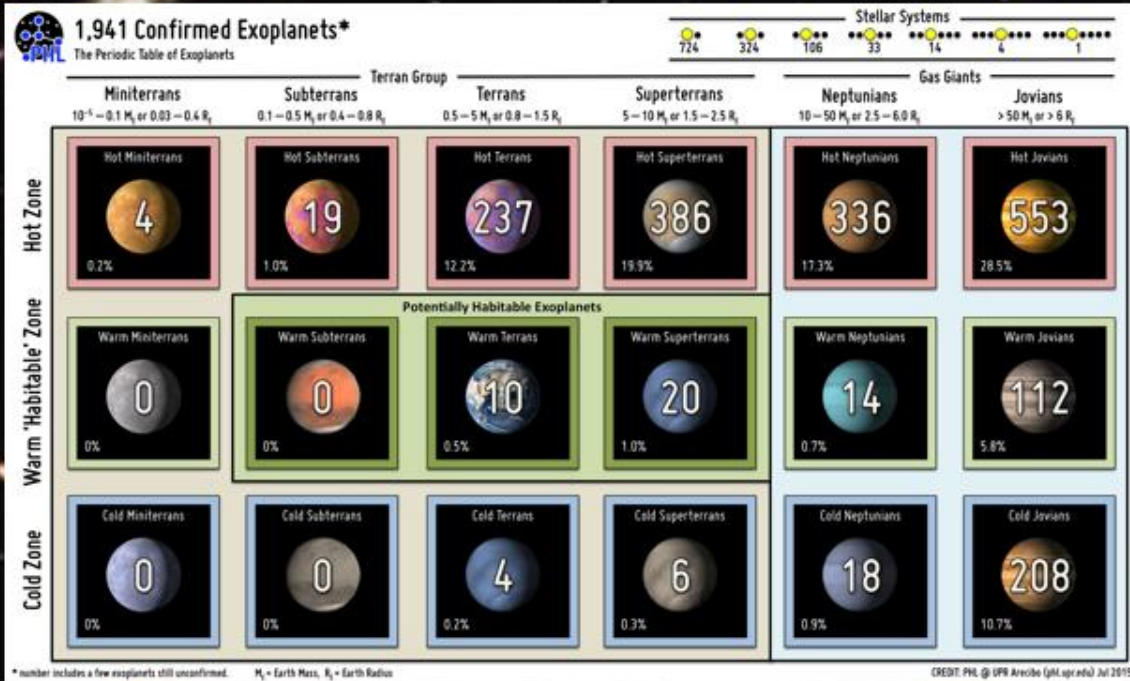


EXOPLANETS

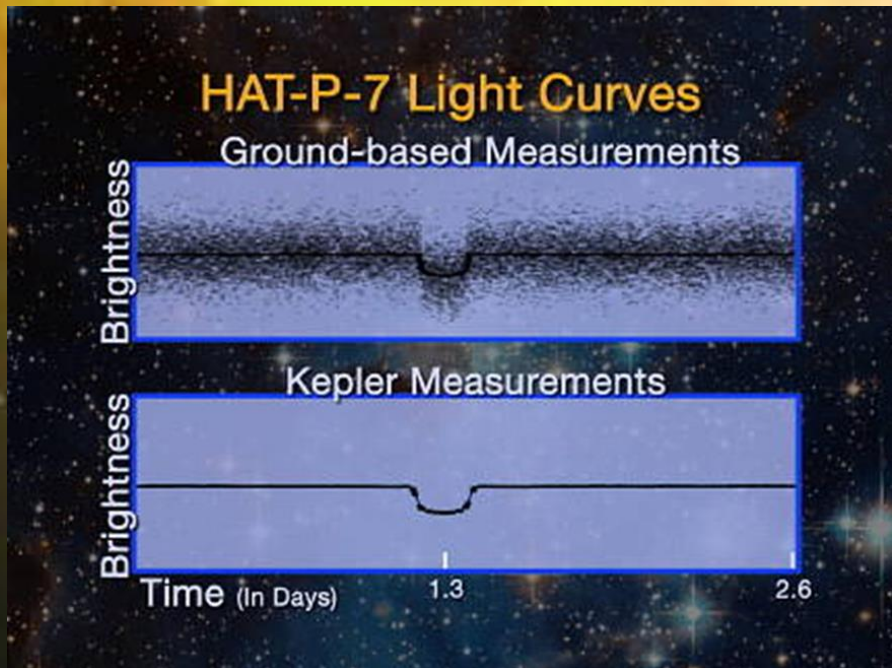
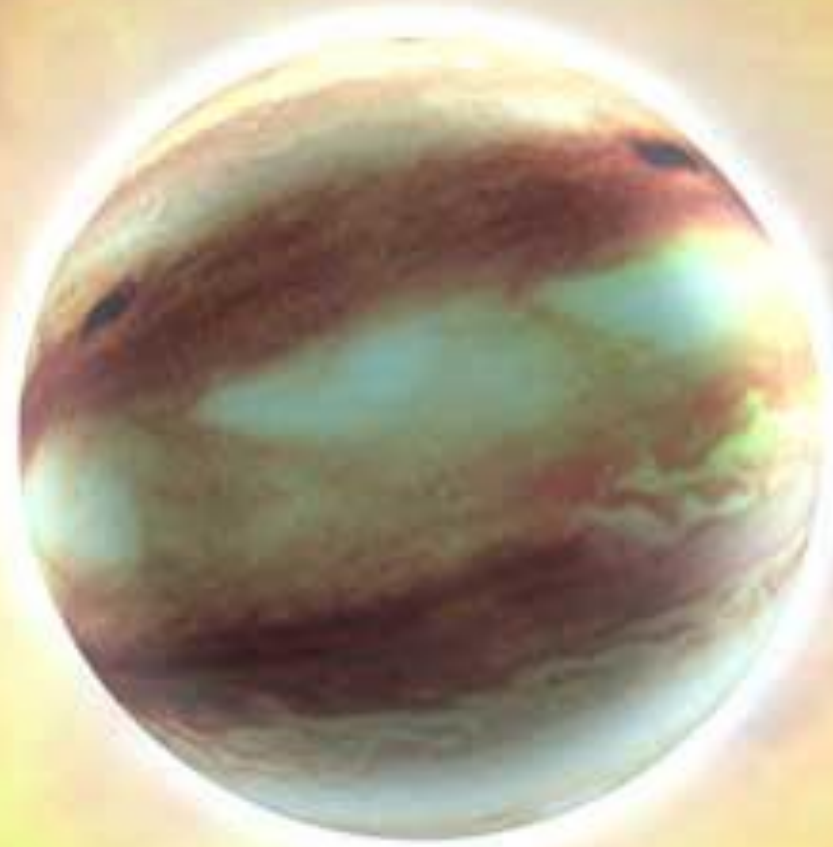


Az exobolygók sokszínű világában mindenféle bolygóra találunk példát, köztük olyan különlegesekre is, amelyek nincsenek a Naprendszerben, például a forró-Jupiterek vagy a szuperföldek.

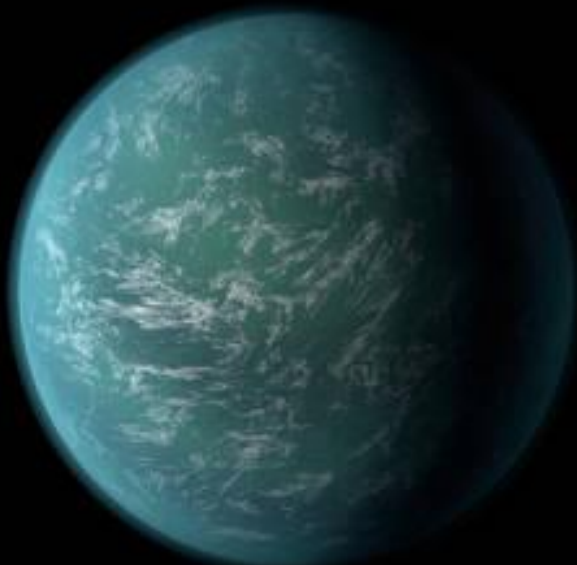
Az exobolygók „periódusos rendszere”, összehasonlítva a Naprendszer égitesteivel



Kepler-2b, HAT-P-7b egy „forró Jupiter”



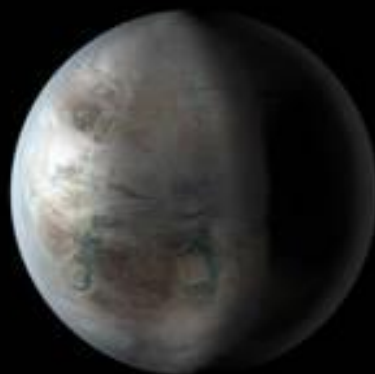
Szuperföldek



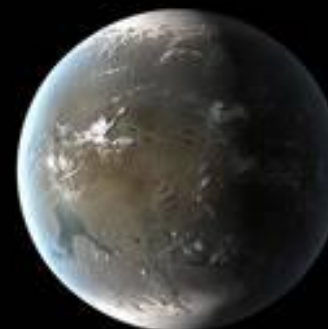
Kepler-22b



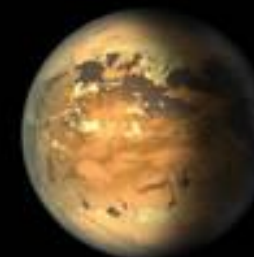
Kepler-69c



Kepler-452b



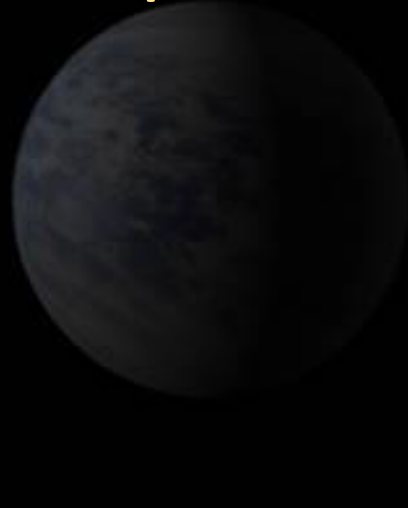
Kepler-62f



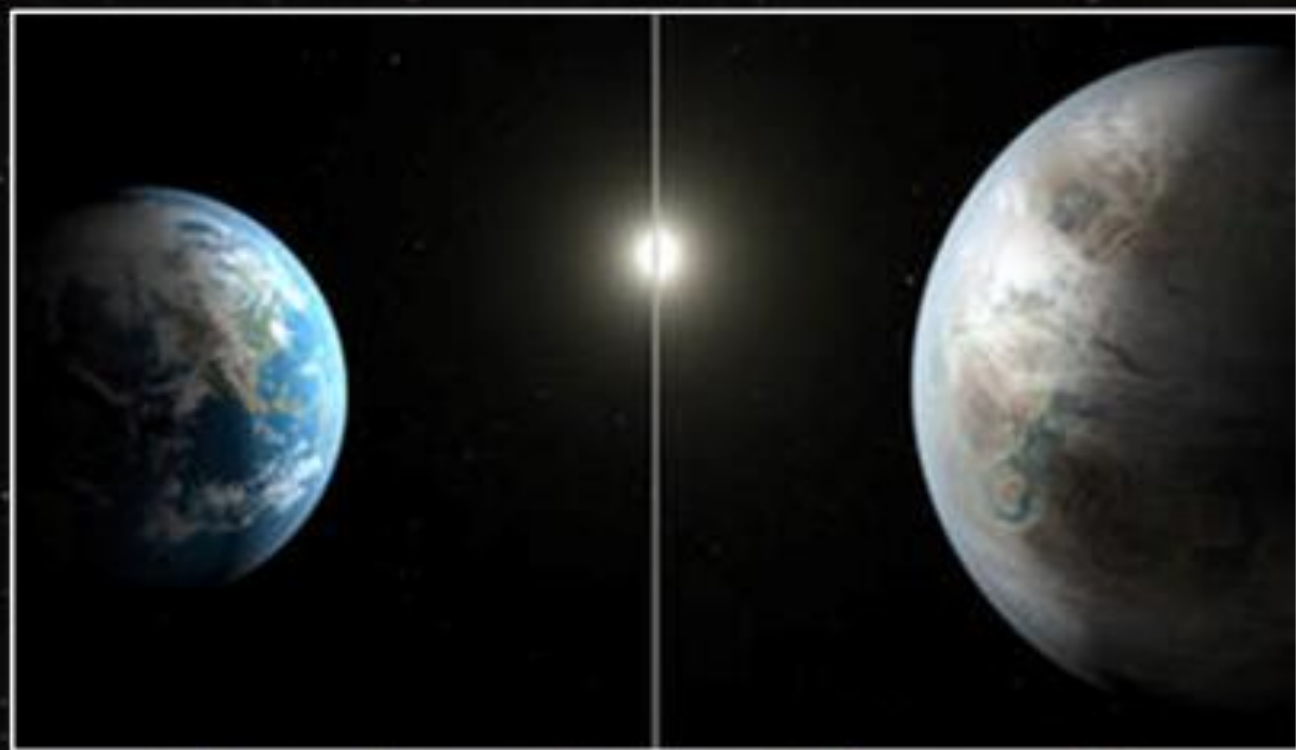
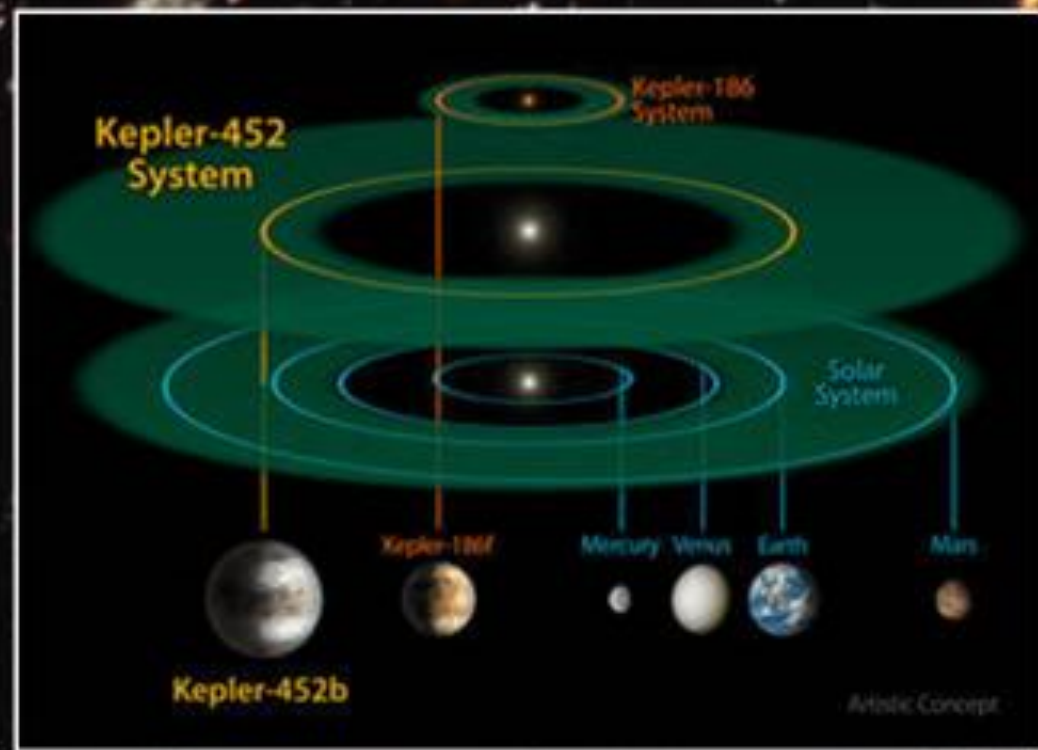
Kepler-186f



Föld



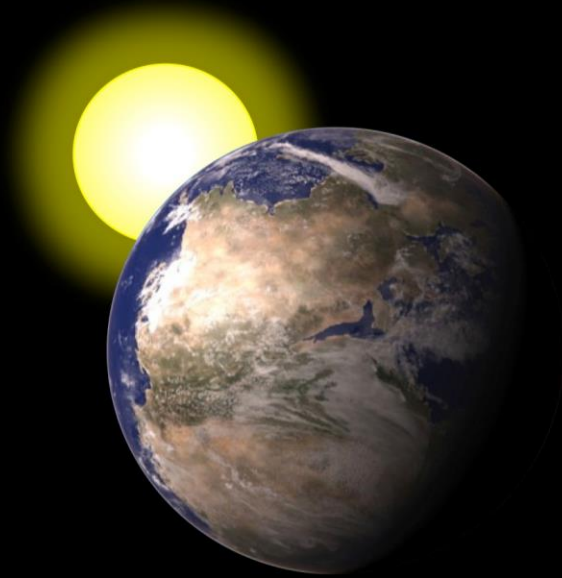
Föld ikertestvérének keresése, Kepler-452b



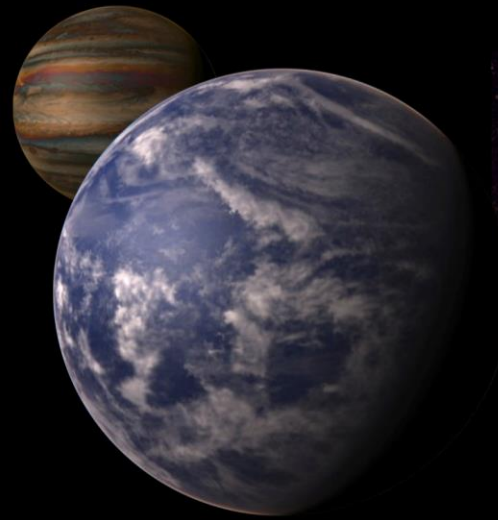
Egyedül vagyunk?



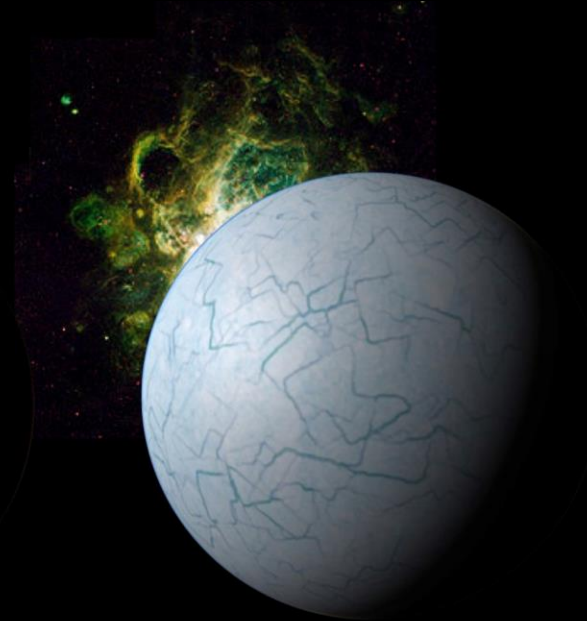
Lakható helyek az Univerzumban



Planets

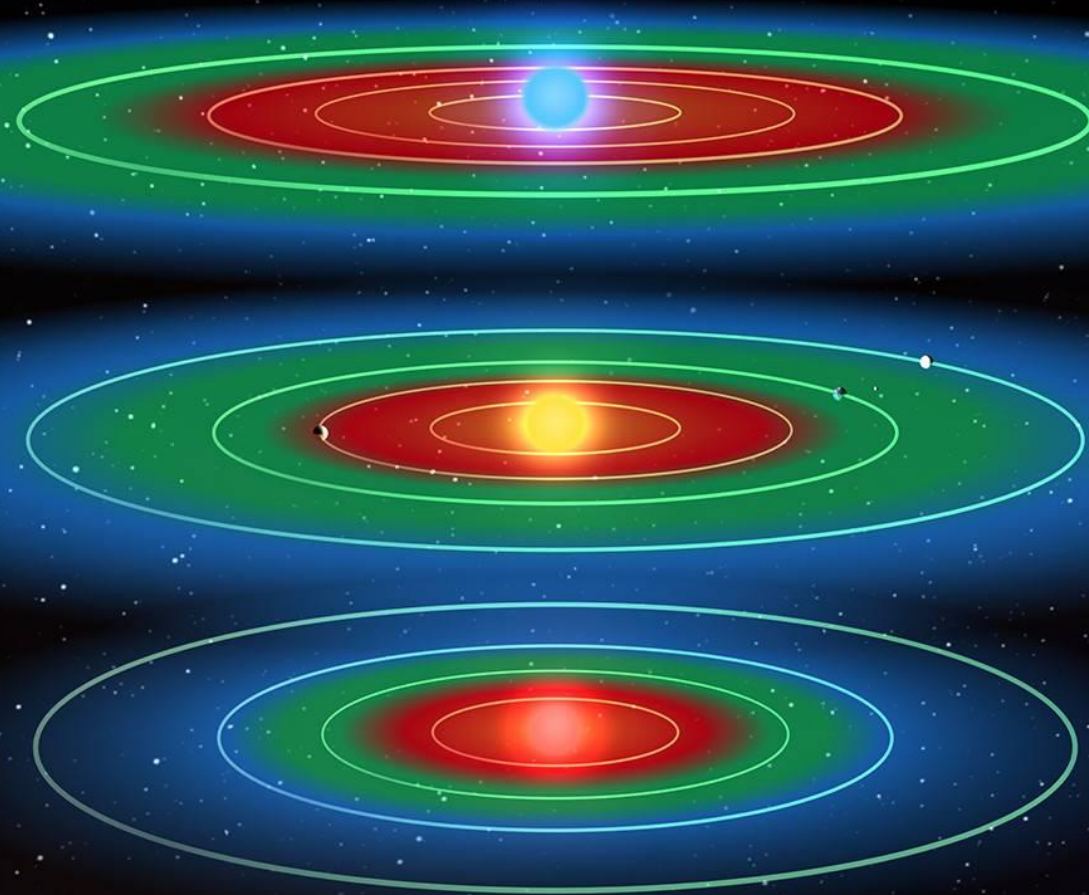


Moons



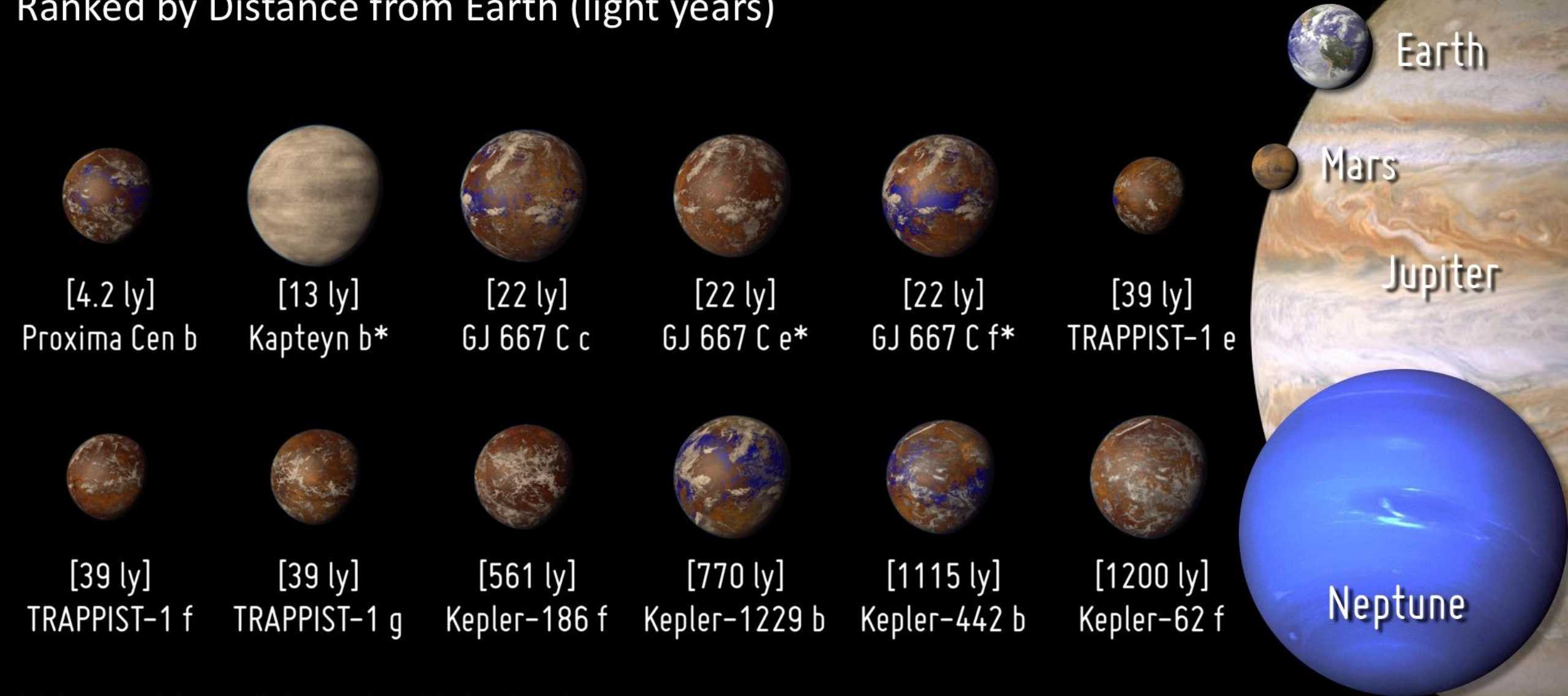
Nomads

Lakhatósági zóna különböző típusú csillagok körül



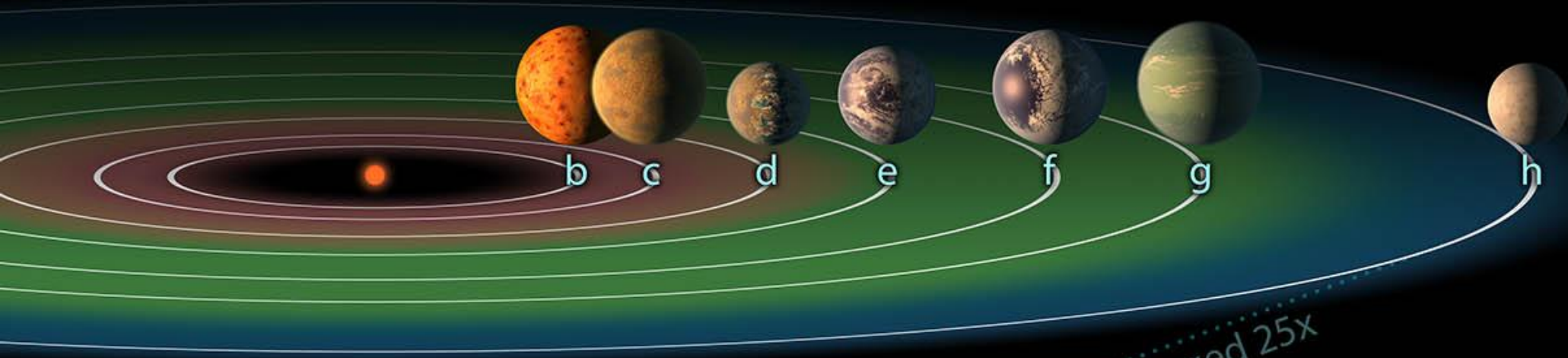
Potentially Habitable Exoplanets

Ranked by Distance from Earth (light years)

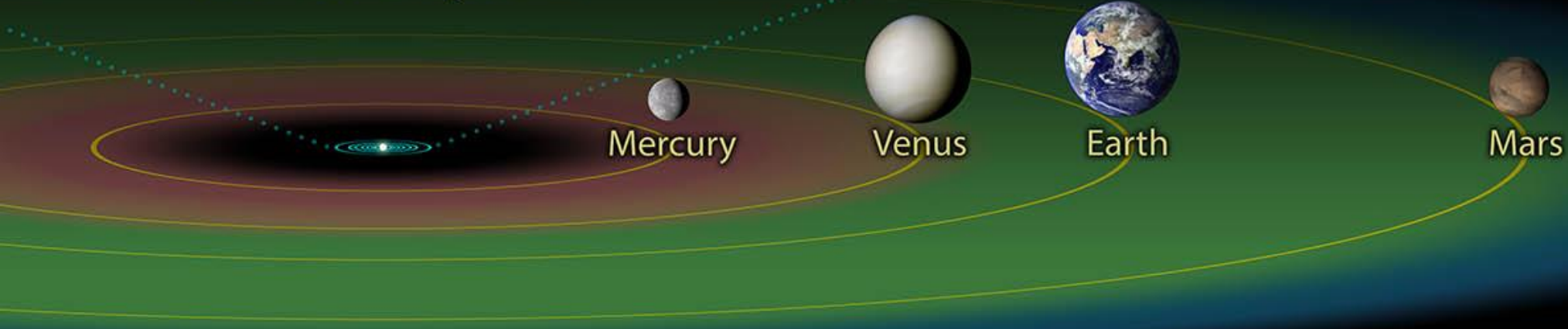


Artistic representations. Earth, Mars, Jupiter, and Neptune for scale.
Distance is between brackets. Planet candidates indicated with asterisks.

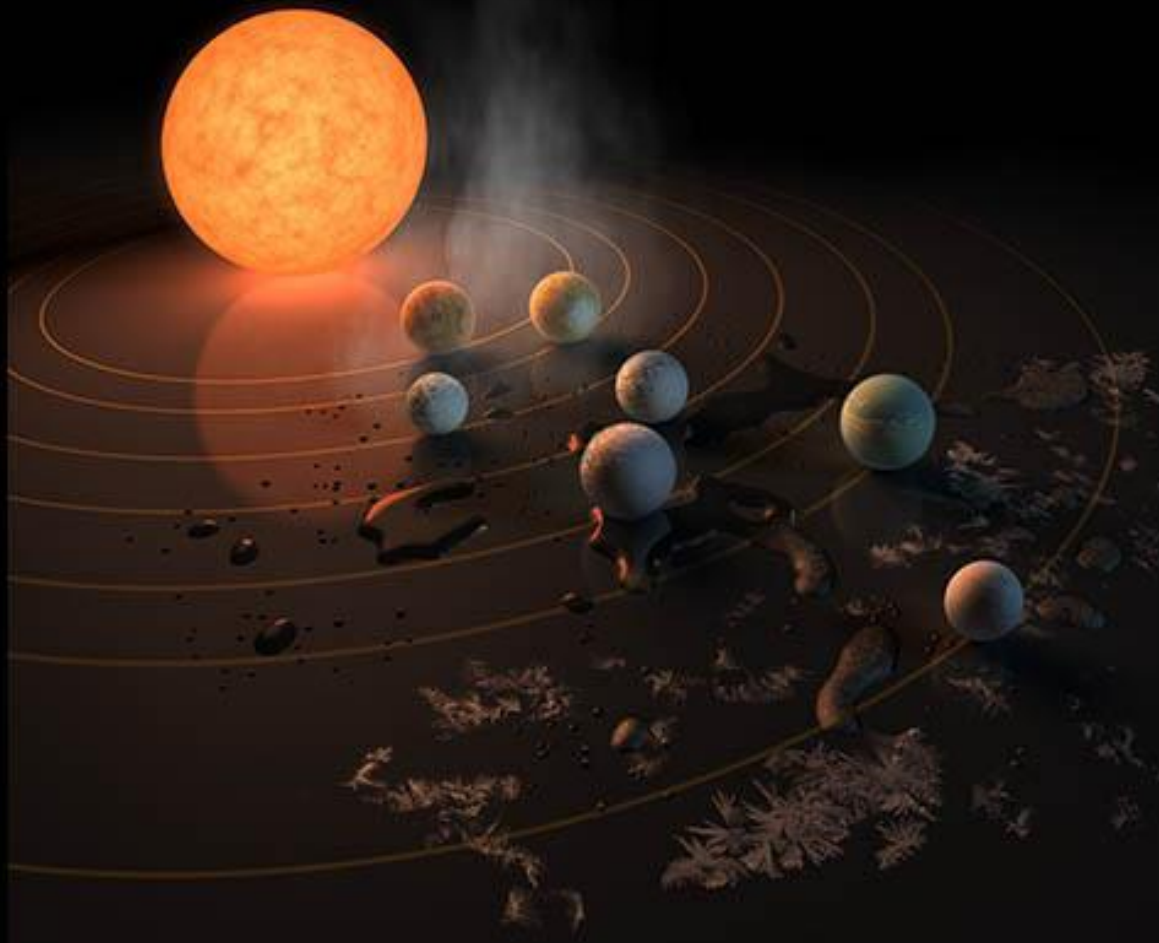
TRAPPIST-1 System



Inner Solar System



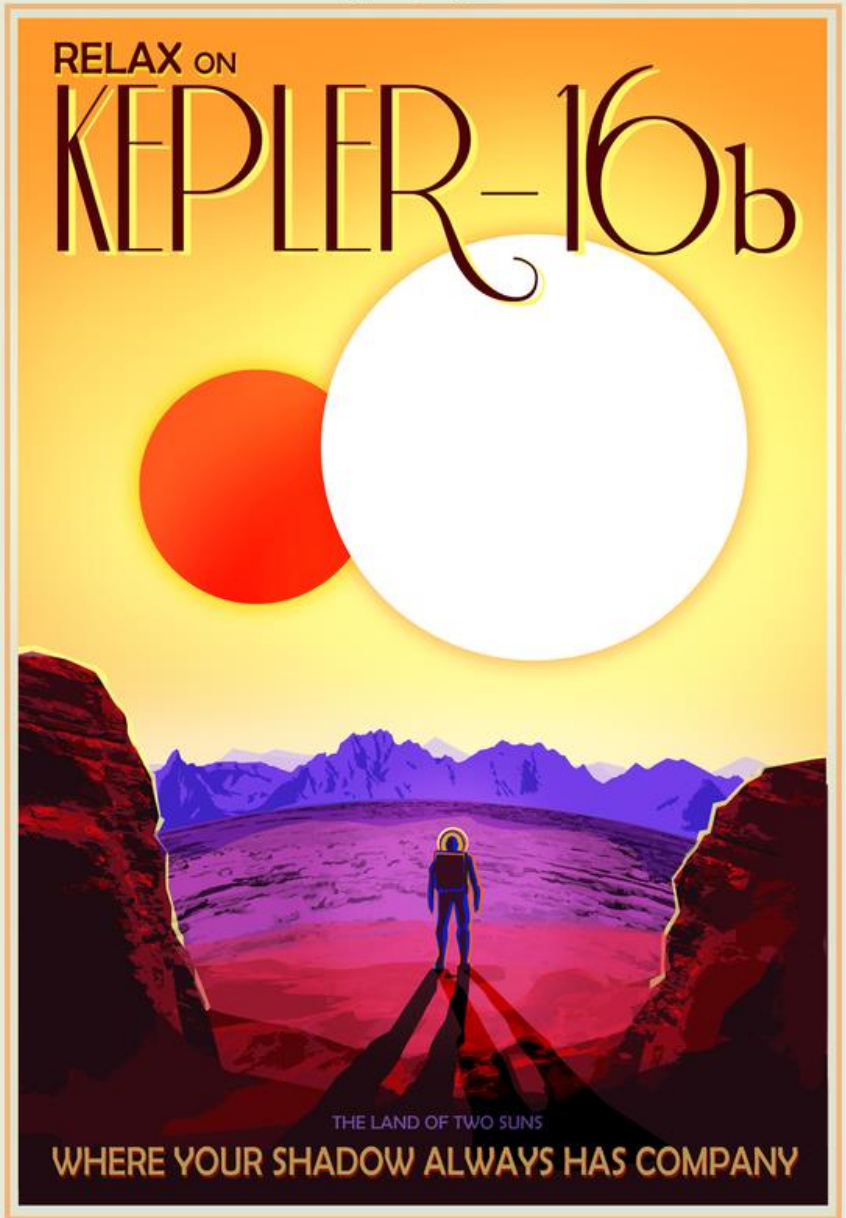
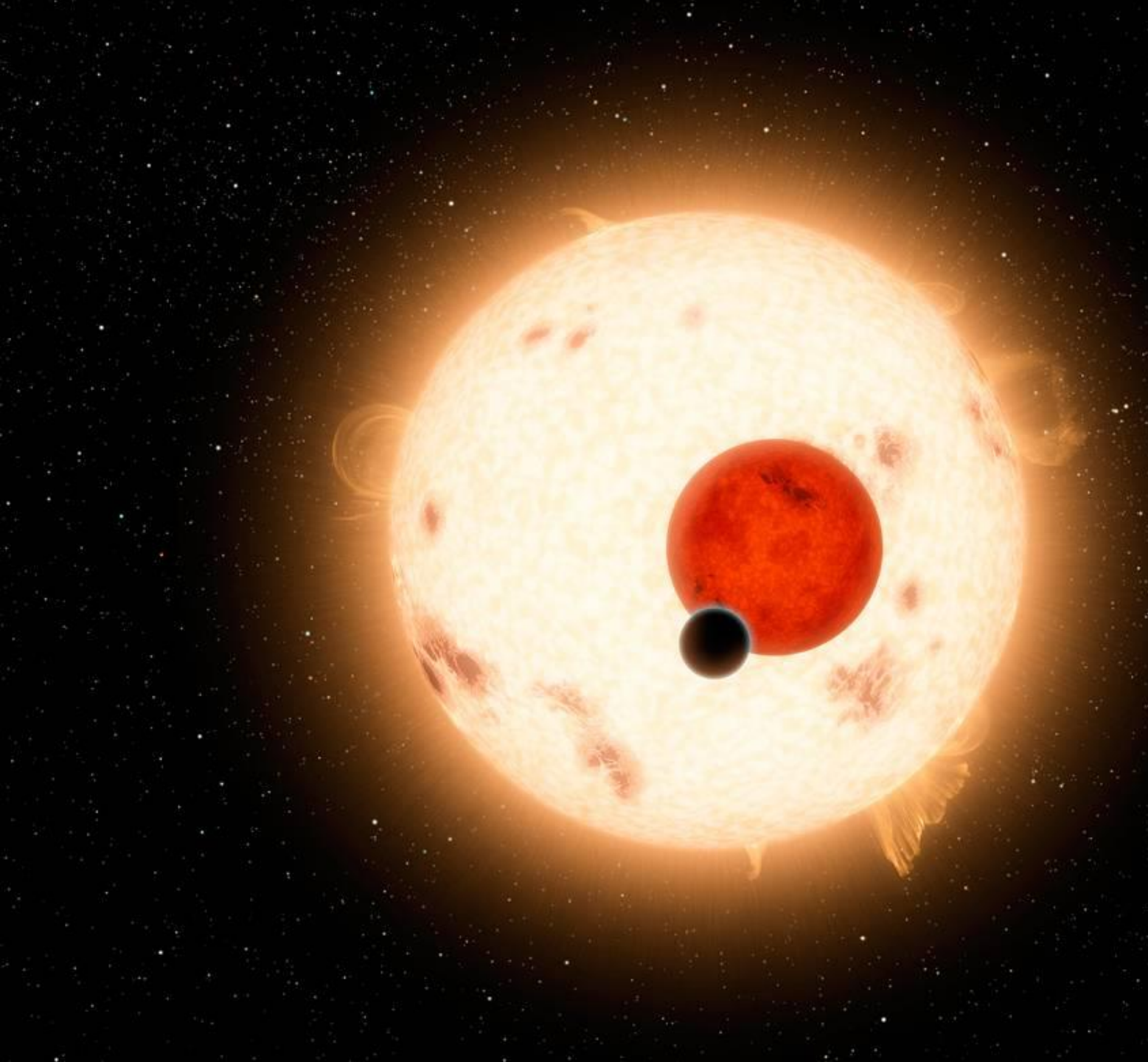
Enlarged 25x



PLANET HOP FROM
TRAPPIST-1e



VOTED BEST "HAB ZONE" VACATION WITHIN 12 PARSECS OF EARTH



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 iconic double-sunset is anything but science fiction.

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



VISIT THE PLANET WITH NO STAR



PSO J318.5-22

WHERE THE NIGHTLIFE NEVER ENDS!

Discovered in October 2013 using direct imaging, PSO J318.5-22 belongs to a special class of planets called rogue, or free-floating, planets. Wandering alone in the galaxy, they do not orbit a parent star. Not much is known about how these planets come to exist, but scientists theorize that they may be either failed stars or planets ejected from very young systems after an encounter with another planet. These rogue planets glow faintly from the heat of their formation. Once they cool down, they will be dancing in the dark. Confirmed and candidate exoplanets and all available data are listed in the NASA Exoplanet Archive.

Gliese 667 Cc



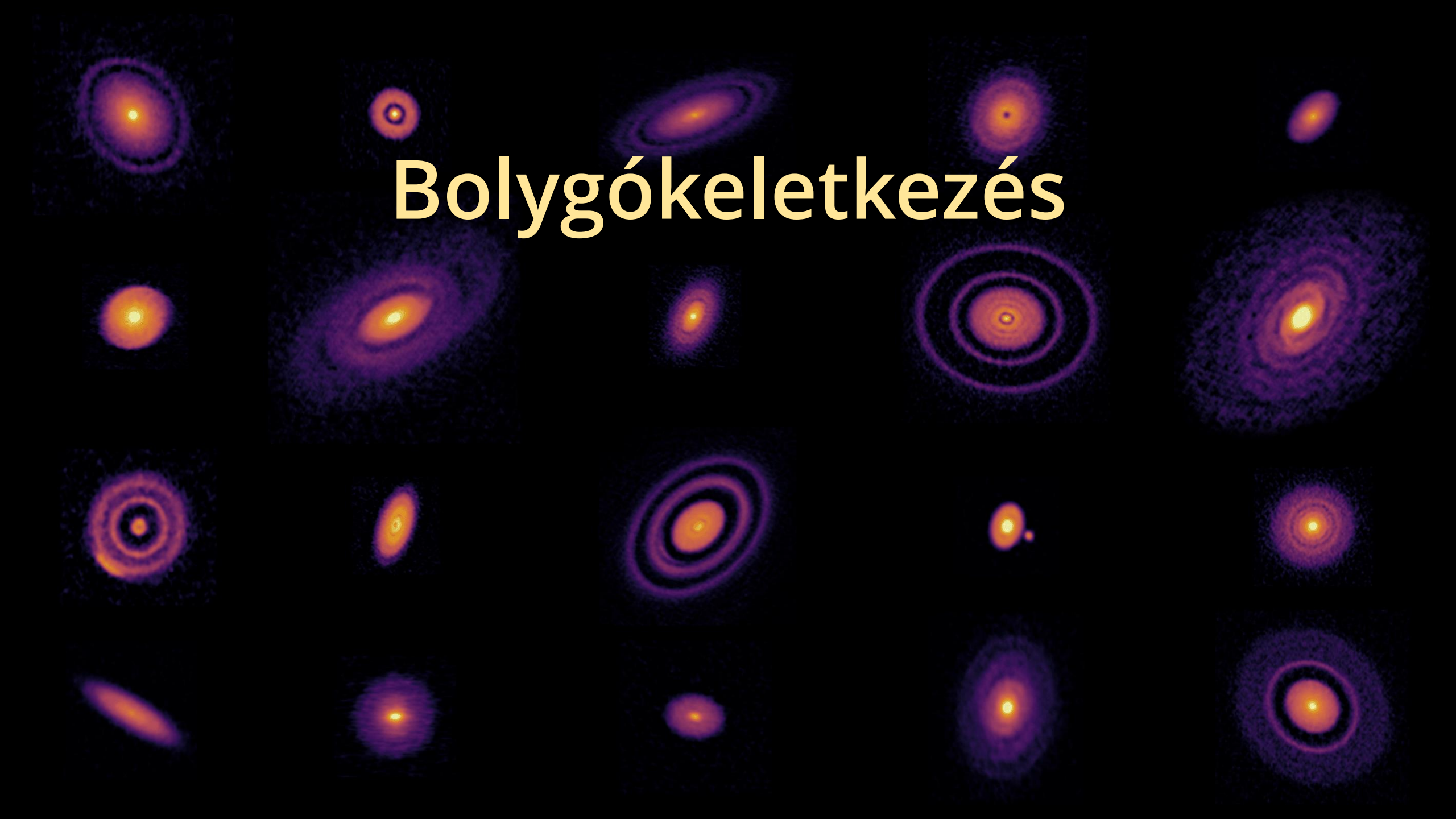
Proxima Centauri

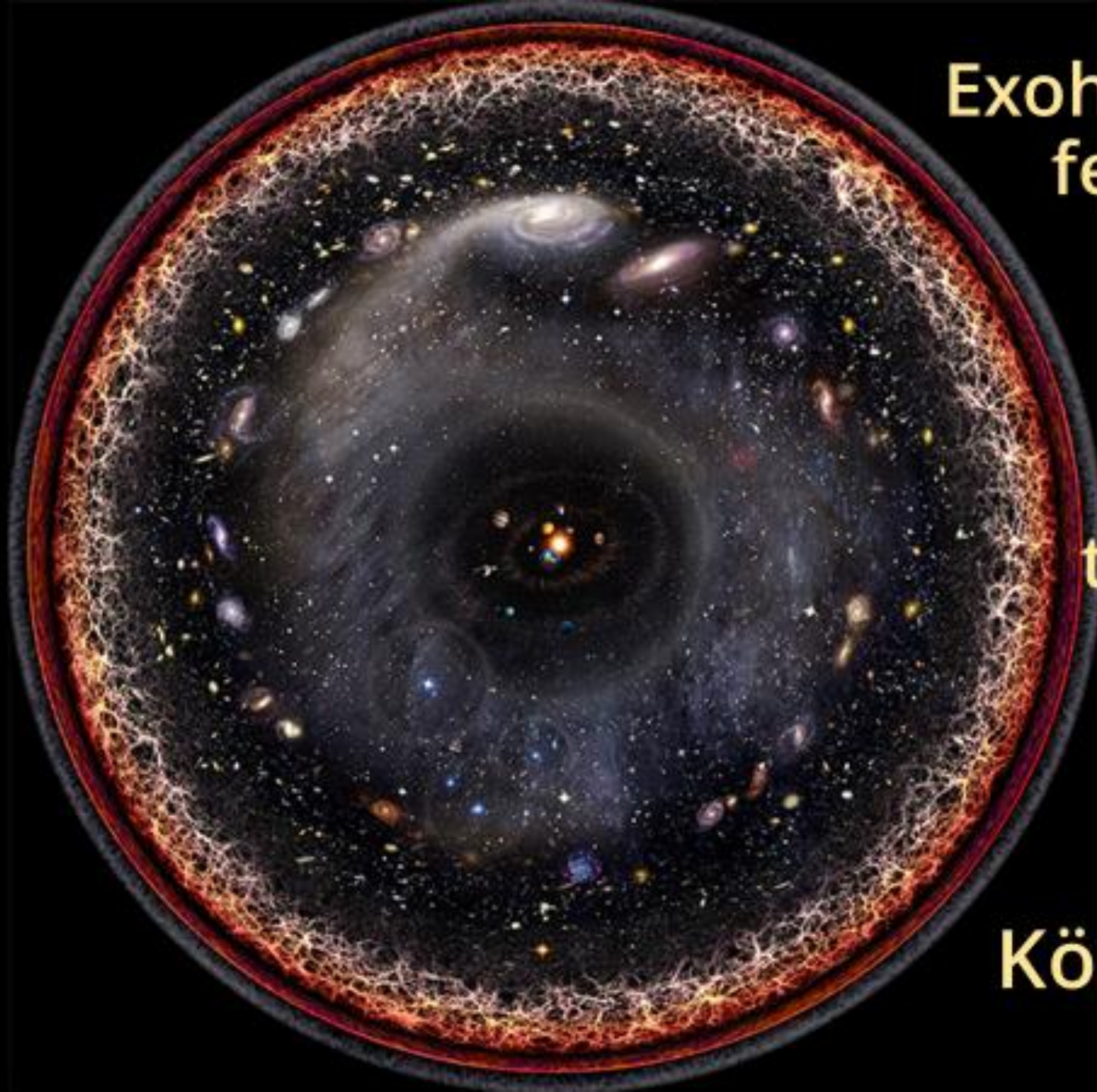
Alpha Centauri AB

Proxima b



Bolygókeletkezés





Exohold és más galaxisban
felfedezett exobolygó is
megerősítésre vár.

Az exobolygó kutatás
kiemelt tudományos
terület, eredményeivel
gyakran találkozunk a
médiában.

Köszönöm a figyelmet!



Exobolygó adatbázisok

<http://exoplanet.eu/>

<http://exoplanetarchive.ipac.caltech.edu/>

The screenshot shows the homepage of Exoplanet.eu. At the top, there is a navigation bar with links for Home, All Catalogs, Diagrams, Bibliography, Research, Meetings, and Other Sites. The main content area is titled "The Extrasolar Planets Encyclopaedia" and includes a brief history of the site, established in February 1995. Below this, there are sections for "All Catalogs" and "Diagrams". A "News" section on the left lists several recent updates, such as the discovery of 7 temperate telluric planets around TRAPPIST-1. On the right, there are sections for "Tutorials", "Meetings", "Bibliography", "Theory Work", "Research", and "Other sites". The footer contains logos for various organizations and a copyright notice for 1995-2014.

The screenshot shows the NASA Exoplanet Archive website. The header includes the IPAC logo and the text "NASA EXOPLANET ARCHIVE A SERVICE OF NASA EXOPLANET SCIENCE INSTITUTE". Below the header is a navigation bar with links for Home, About Us, Data, Tools, Support, and Login. The main content area features several statistics: 3,472 Confirmed Planets, 581 Multi-Planet Systems, and 4,499 Kepler Candidates. There is a search bar and an "Advanced Search" button. A prominent section is titled "Kepler Candidate Equilibrium Temperature" and contains a scatter plot of "Kepler Radius - Teq Distribution". The plot shows a positive correlation between planet radius and equilibrium temperature. Below the plot are navigation controls for "News" and "Plots". The bottom of the page has a "Tools & Services" section with various options like "Paradigm", "Predicted Observables for Exoplanets Service", and "Work with Data" section with options like "Mission Stars" and "Confirmed Planets".

Exobolygó adatbázisok

<http://www.openexoplanetcatalogue.com/>

Open Exoplanet Catalogue

an open source database of all discovered extrasolar planets

[Fork me on GitHub](#)

Catalogue

- All extrasolar planets
- Habitable zone planets
- Planets in binary systems

Plots

- Correlations plots
- Histograms
- Python scripts for offline use

Other

- iPhone Application
- About

Gliese 667

The planetary system Gliese 667 hosts at least 7 planets. Note that the system is a multiple star system. It hosts at least 3 stellar components.

System parameters	
Primary system name	Gliese 667
Alternative system names	N/A
Right ascension	17 18 57
Declination	-34 59 23
Distance [parsec]	6.97
Distance [lightyears]	22.7
Number of stars in system	3
Number of planets in system	7

Image

This artist's impression shows the view from the exoplanet Gliese 667 C d looking towards the planet's parent star (Gliese 667 C). In the background to the right the moon is visible.

Planet sizes

The following plot shows the approximate sizes of the planets in this system The Solar System (see Lissauer et al. 2011b).

Habitable zone

The following plot shows the approximate location of the planets in this system with respect to the habitable zone. The habitable zone is shown as a green shaded region. The planets are shown as circles of varying sizes, with Gliese 667 C d being the only planet within the habitable zone.

Scientific references and contributors

Links to scientific papers and other data sources

EYES ON EXOPLANETS

EXPLORE A VISUAL DATABASE OF NEW WORLDS

<http://eyes.jpl.nasa.gov/eyes-on-exoplanets.html>

The screenshot shows the 'EYES ON EXOPLANETS' interface. On the left, the 'About the Star' panel provides details for GJ 876. On the right, a diagram shows the orbital paths of the four planets in the system.

About the Star

Name: GJ 876
Distance from Earth: 15 light-years
Visible to the naked eye: no
Constellation: Aquarius
Planets: 4

Star type: M
Magnitude (brightness): 10.191
Mass: 0.33 Suns

PLANETARY SYSTEM VIEW **STAR VIEW**

HOW LONG TO TRAVEL HERE? **COMPARE WITH OUR SOLAR SYSTEM**

HABITABLE ZONE

The diagram on the right shows the star GJ 876 at the center, with four planets orbiting in elliptical paths labeled GJ 876 b, GJ 876 c, GJ 876 d, and GJ 876 e.