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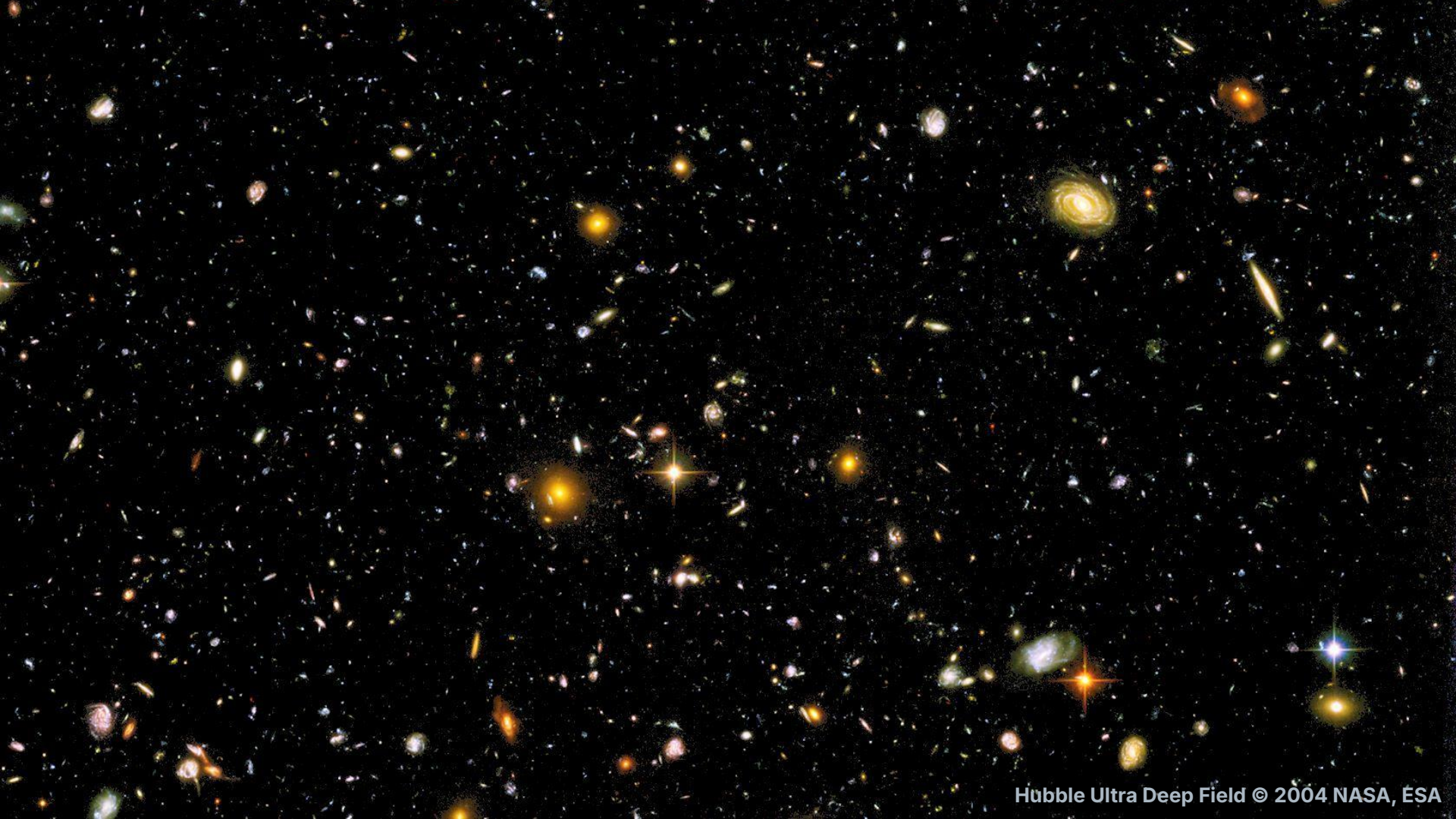
Stopárov Sprievodca Exoplanétami

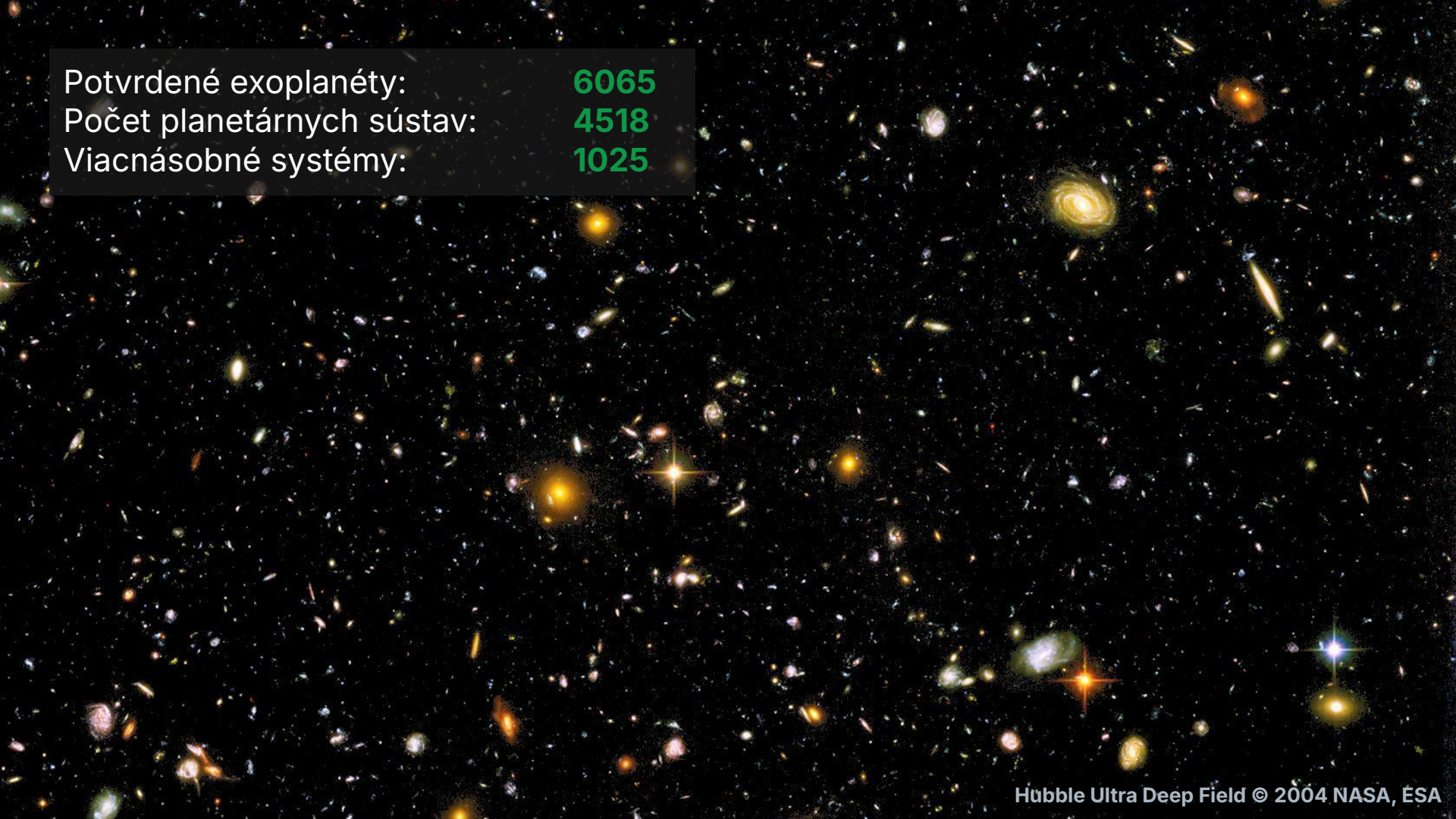
Daniel Dupkala



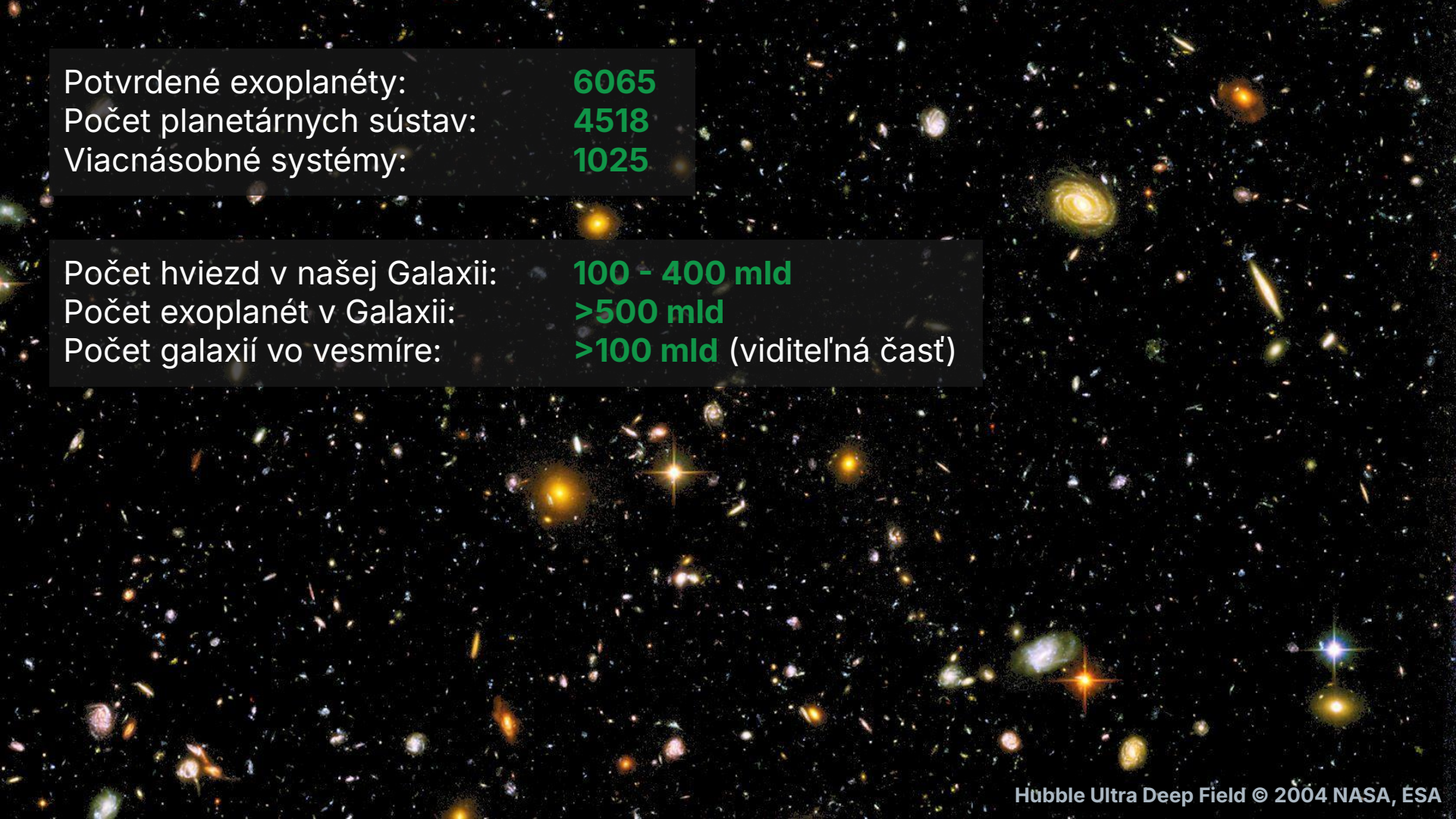
Fyziklani2026

14. február 2026



The background of the slide is a deep-field astronomical image, likely the Hubble Ultra Deep Field, showing a vast expanse of space filled with numerous galaxies of various shapes and sizes, as well as individual stars. The galaxies range from small, distant specks to larger, more detailed structures with visible spiral arms or elliptical shapes. The colors of the galaxies vary, with many appearing in shades of yellow, orange, and blue against the black background of space.

Potvrdené exoplanéty: **6065**
Počet planetárnych sústav: **4518**
Viacnásobné systémy: **1025**

The background of the slide is a deep-field astronomical image from the Hubble Space Telescope, showing a vast field of galaxies and stars. The galaxies are of various shapes and sizes, some appearing as bright, distinct objects and others as faint, distant specks. The stars are scattered throughout the field, with some showing prominent diffraction spikes. The overall color palette is dominated by the yellows and oranges of distant galaxies and stars against the blackness of space.

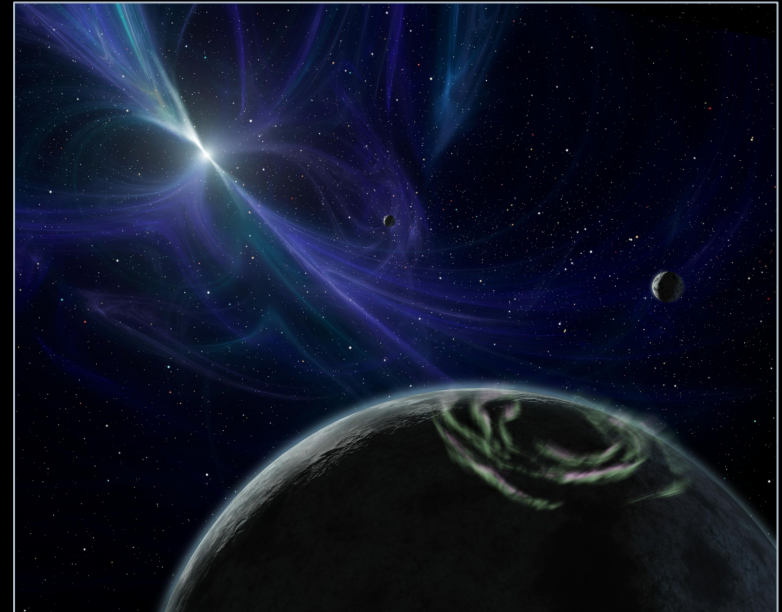
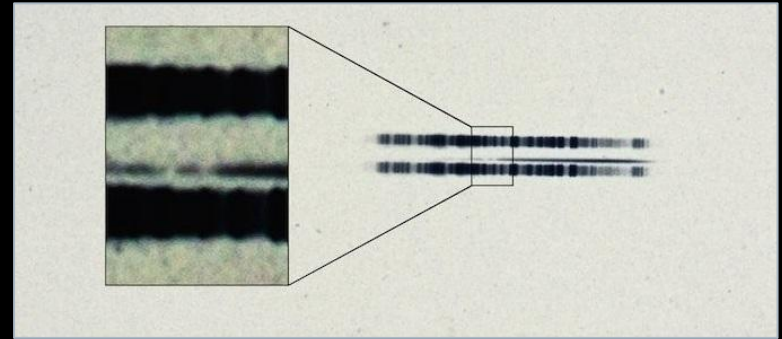
Potvrdené exoplanéty: **6065**
Počet planetárnych sústav: **4518**
Viacnásobné systémy: **1025**

Počet hviezd v našej Galaxii: **100 - 400 mld**
Počet exoplanét v Galaxii: **>500 mld**
Počet galaxií vo vesmíre: **>100 mld** (viditeľná časť)

Stručná história výskumu exoplanét

- 1992** - Planetárny systém pulzaru
- 1995** - Prvá planéta pri hviezde podobnej Slnku
- 1999** - Prvý zaznamenaný tranzit exoplanéty
- 2002** - Potvrdený objav exoatmosféry
- 2006** - Vypustenie teleskopu CoRoT
- 2009** - Vypustenie teleskopu Kepler
- 2013** - Prvé výsledky teleskopu Kepler
- 2018** - Vypustenie vesmírnej misie TESS
- 2019** - Nobelova cena za objav prvej exoplanéty pri hviezde podobnej Slnku
- 2021** - Vypustený Webbov vesmírny ďalekohľad

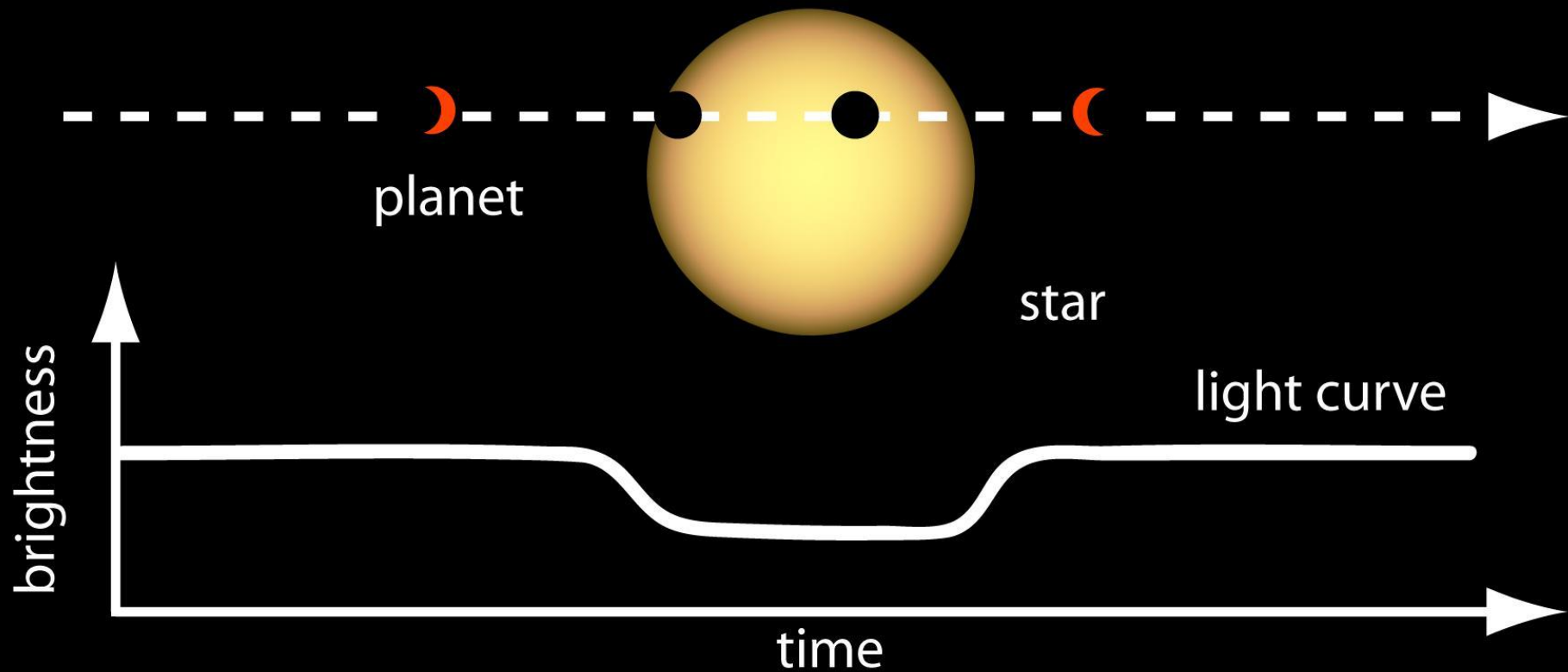
© Carnegie Institution for Science



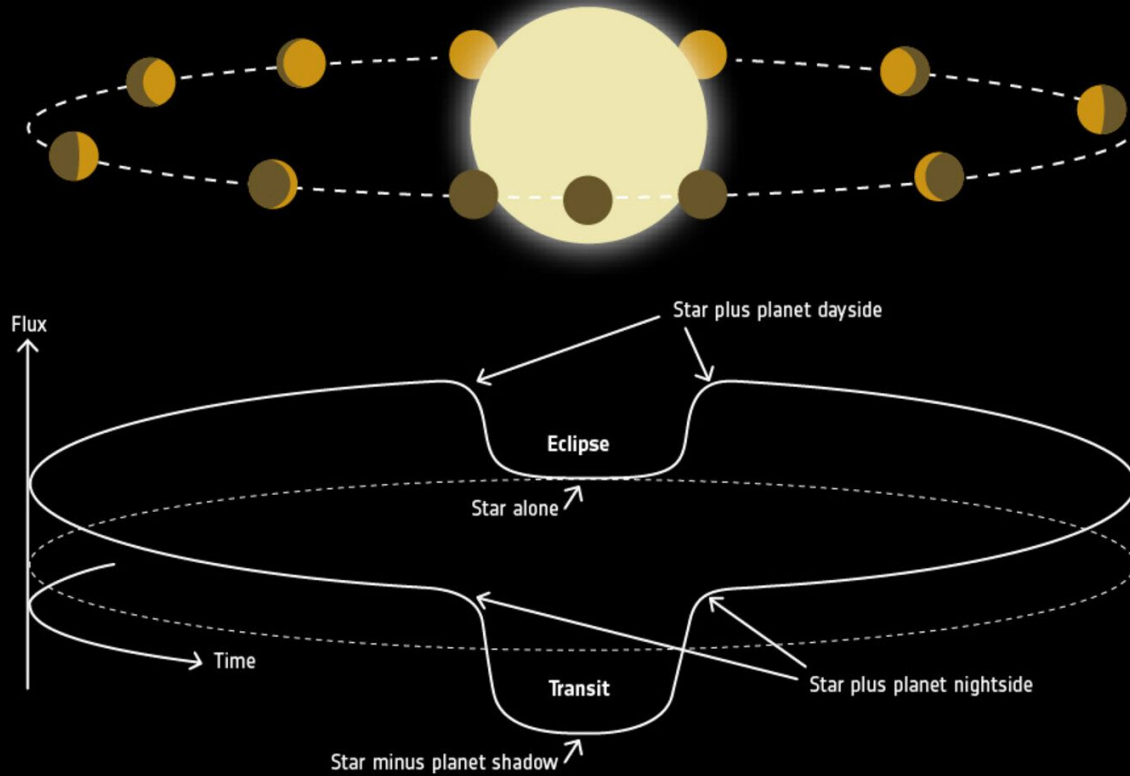
© NASA/JPL-Caltech

Metódy výskumu exoplanét

Fotometria tranzitov

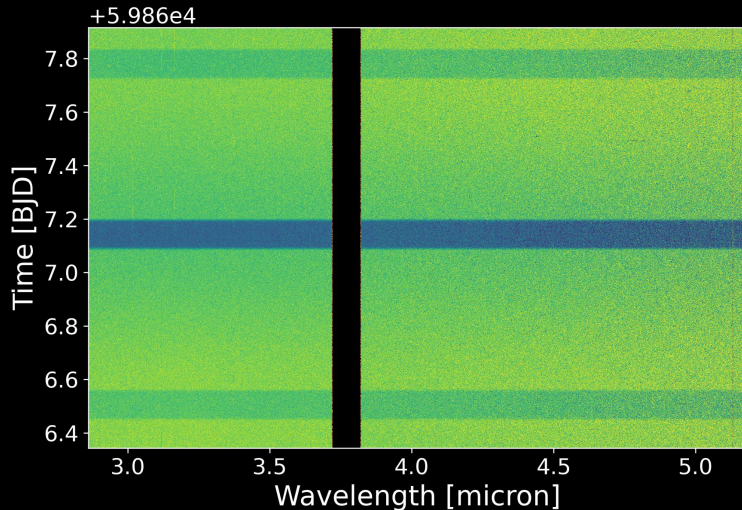


Fotometria tranzitov

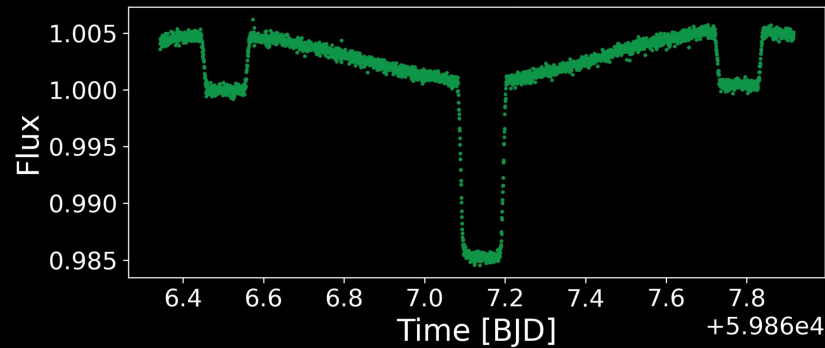


Fotometria tranzitov

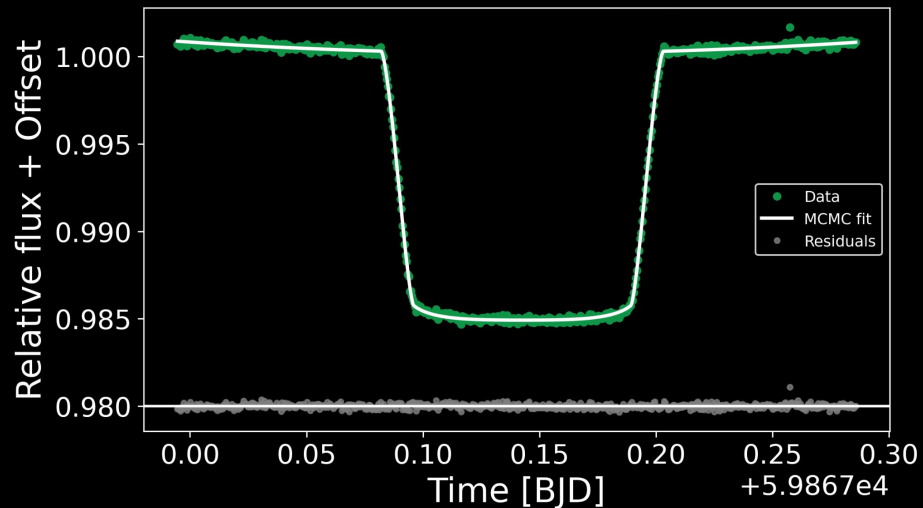
JWST/NIRSpec spektrá **WASP-121 b**



Fázová svetelná krivka **WASP-121 b**

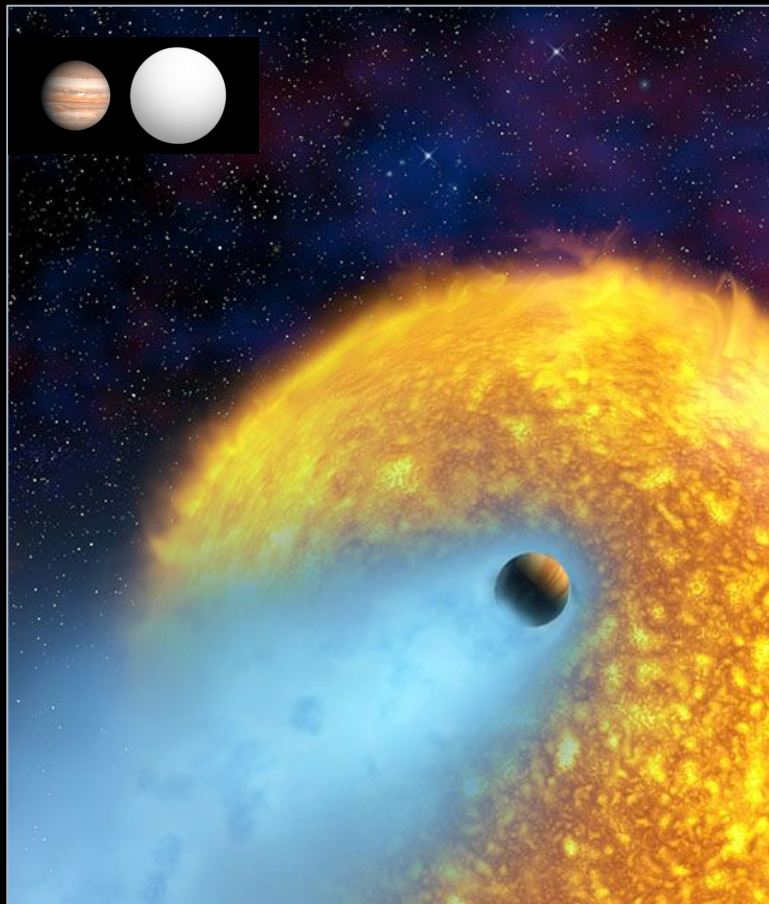


Svetelná krivka tranzitu **WASP-121 b**

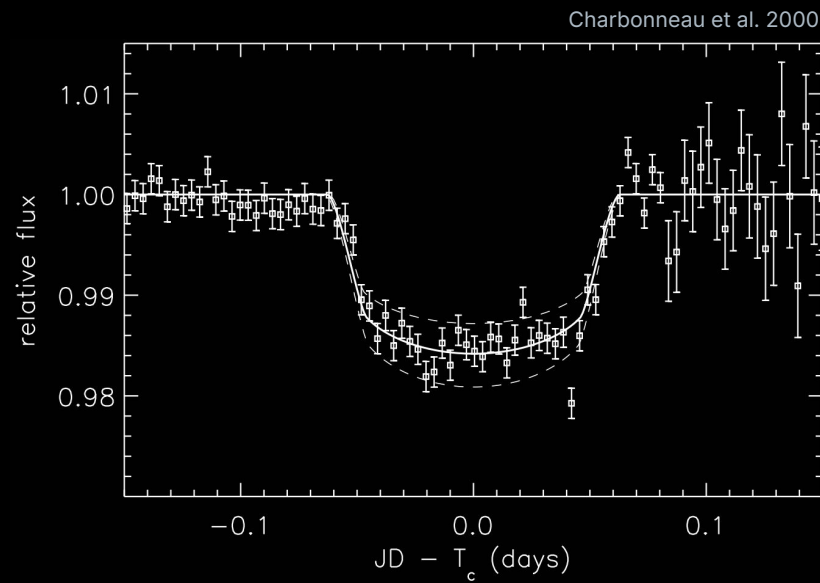


→ Zväčša však pozorujeme tranzity vo viditeľnom spektre

HD 209458 b



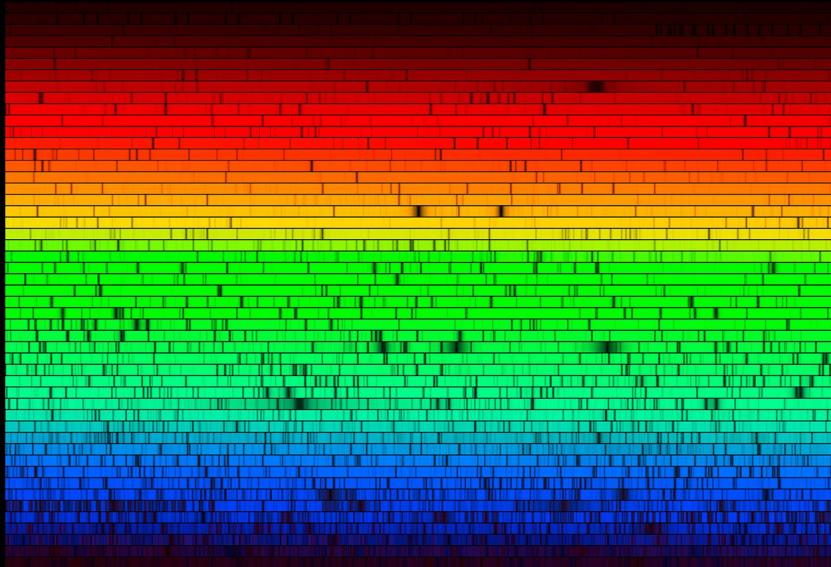
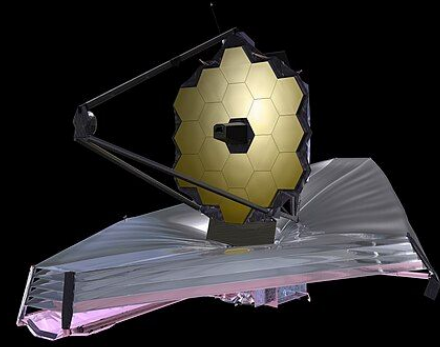
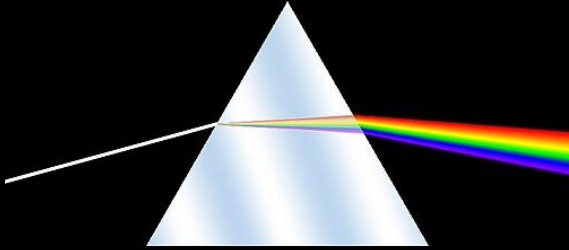
© NASA/JPL-Caltech



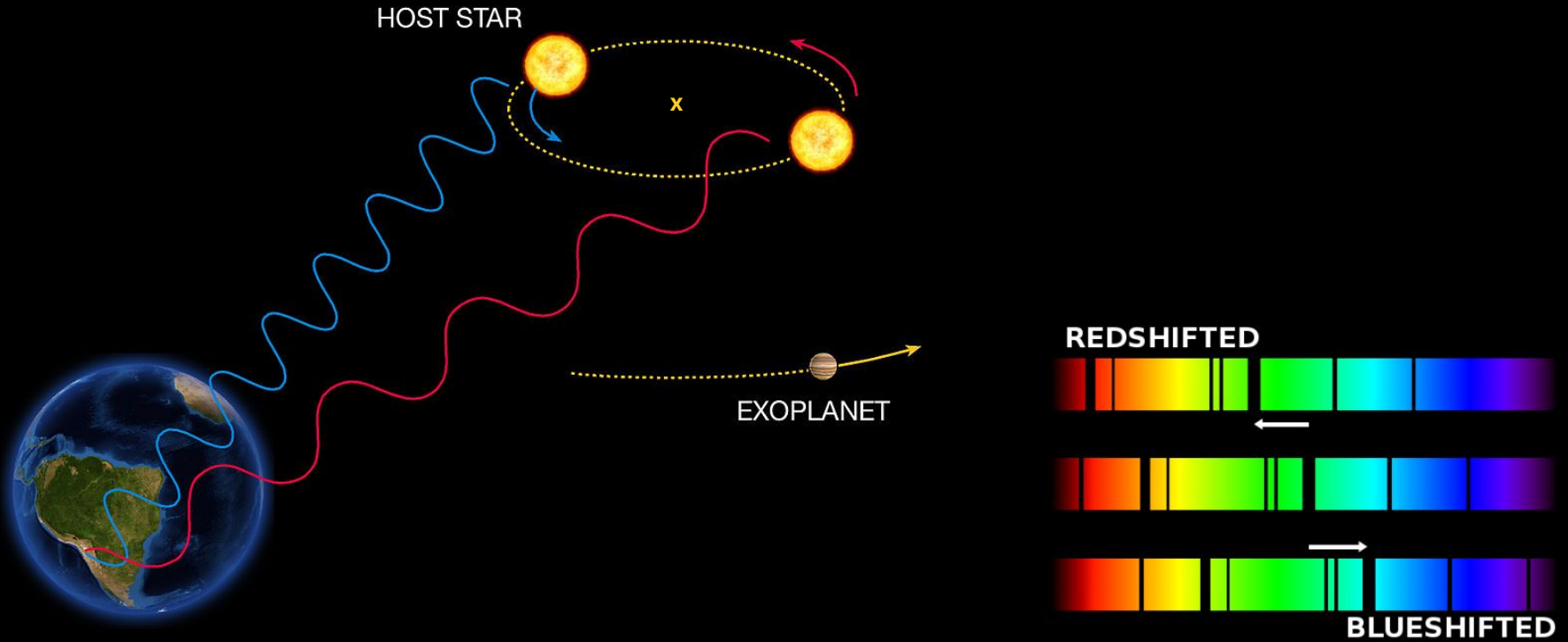
Velká červená
škvřna, Jupiter

© NASA/ESA

Spektroskopia

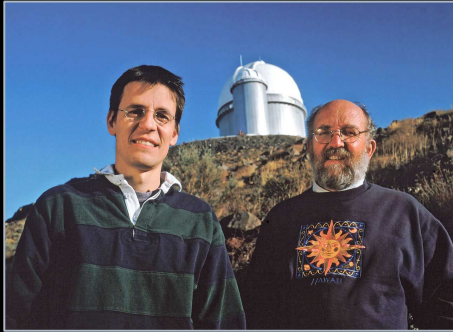


Meranie radiálnych rýchlostí

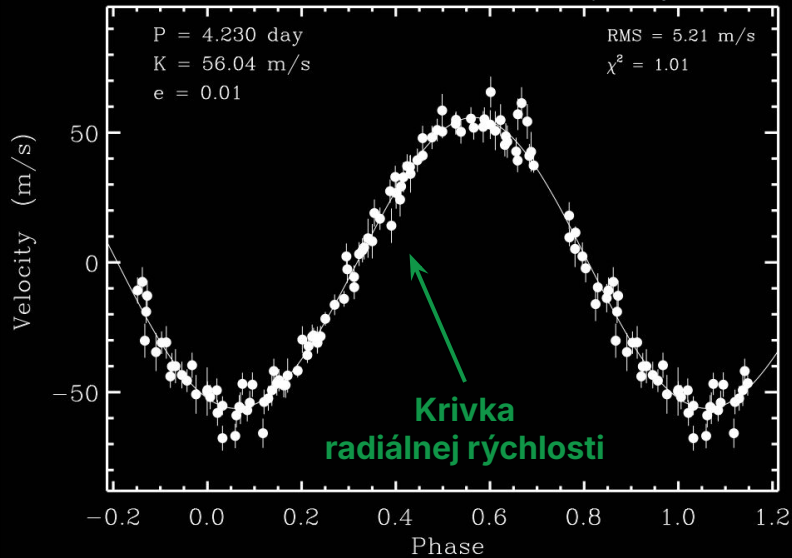


51 Pegasi b

Didier Queloz
& Michel Mayor



Zdroj: Marcy et al. 1997



Earth

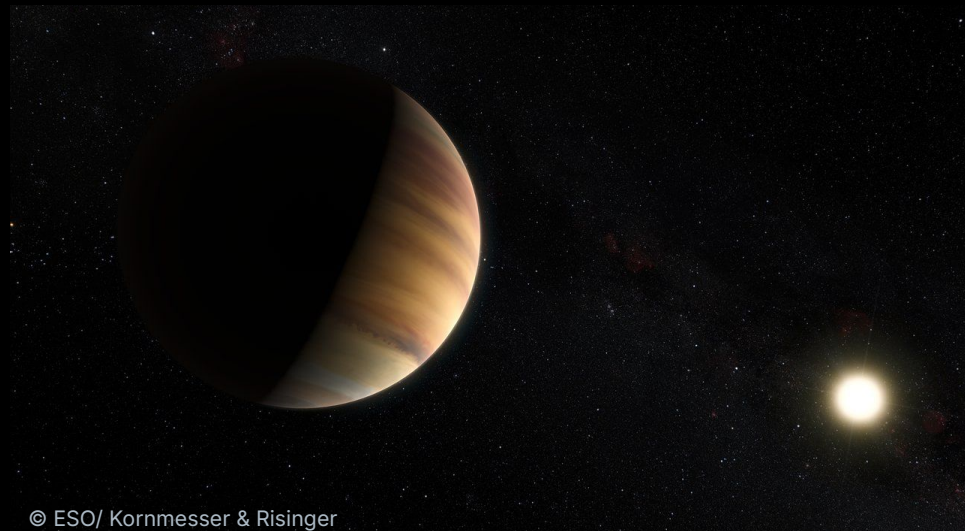
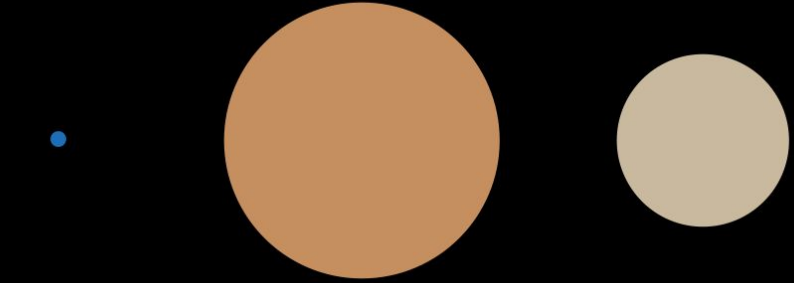
Radius: 6,371 km
Mass: 1 $M_{\oplus}$

51 Pegasi b

Radius: 111,858 km
Mass: 146 $M_{\oplus}$

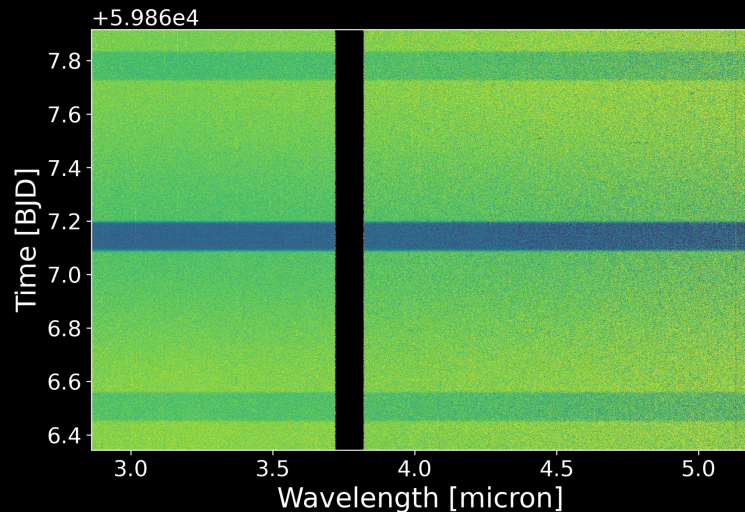
Jupiter

Radius: 69,911 km
Mass: 317.8 $M_{\oplus}$

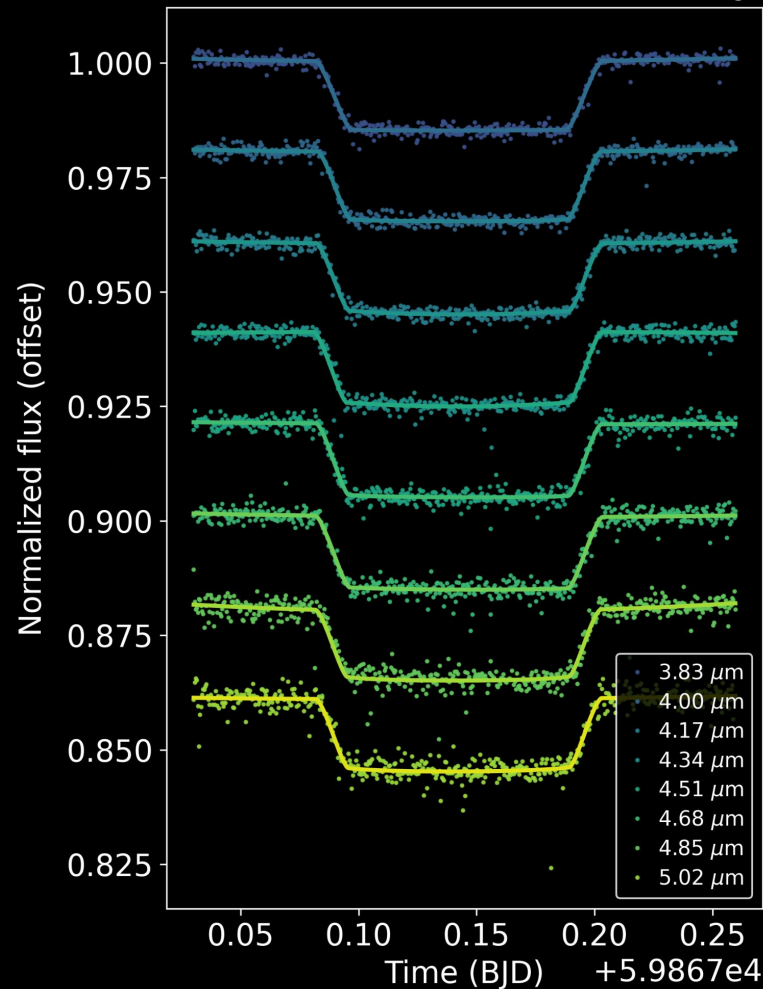


Transmisná spektroskopia

JWST/NIRSpec spektrá **WASP-121 b**

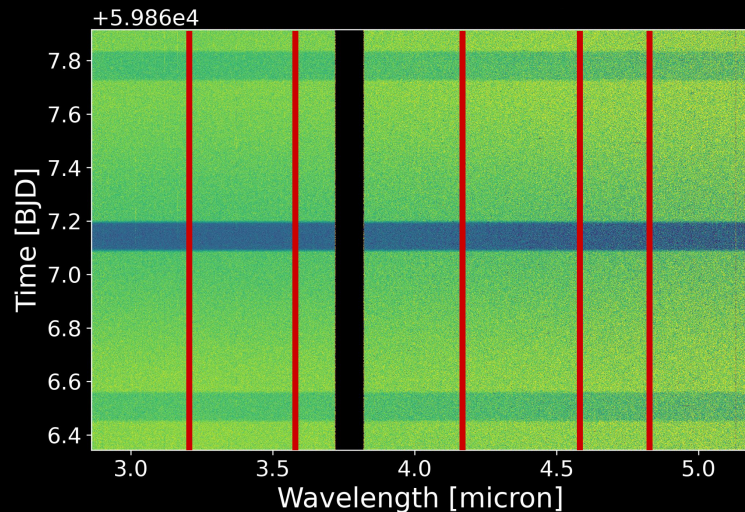


Tranzit **WASP-121 b** - rôzne vln. dĺžky

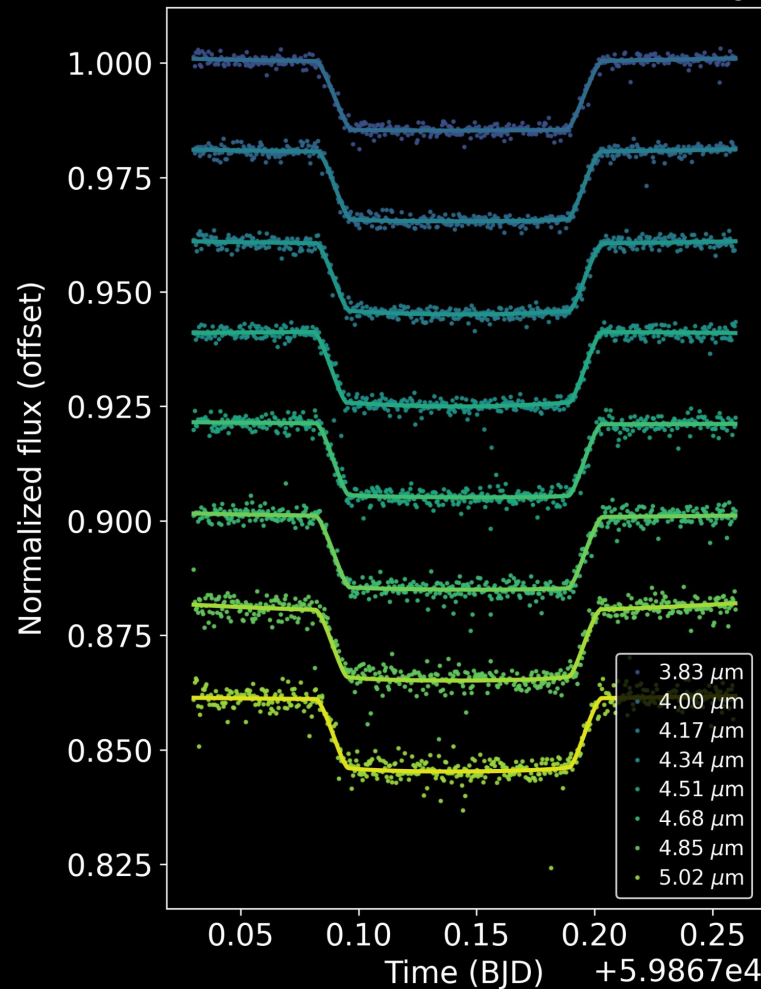


Transmisná spektroskopia

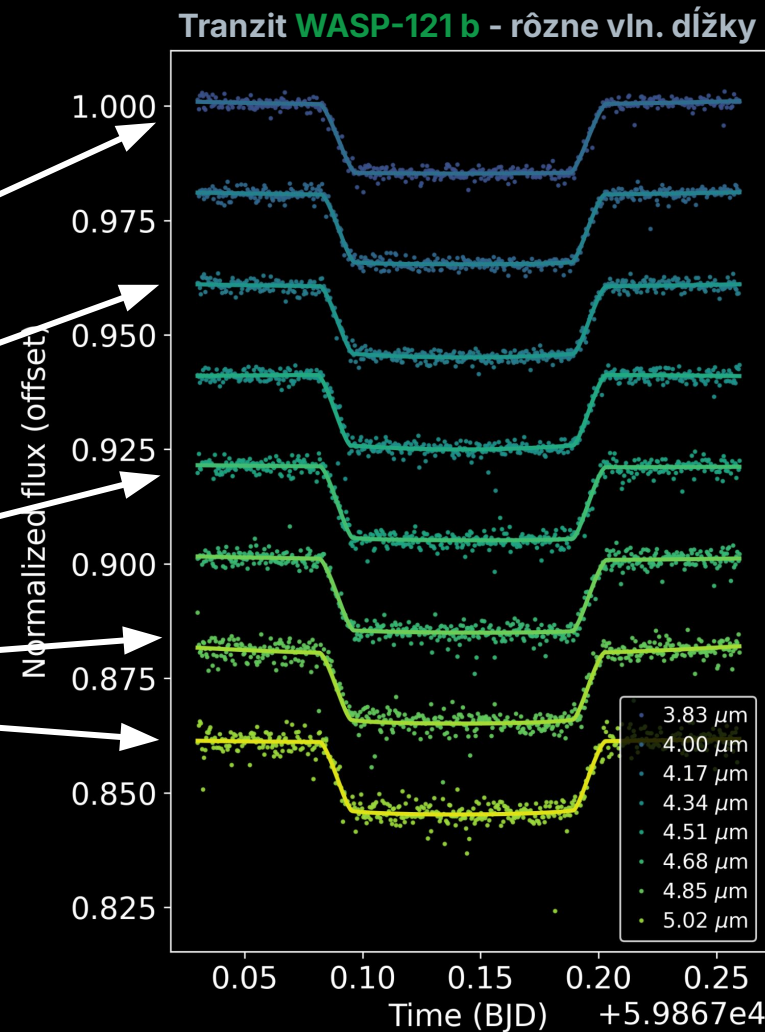
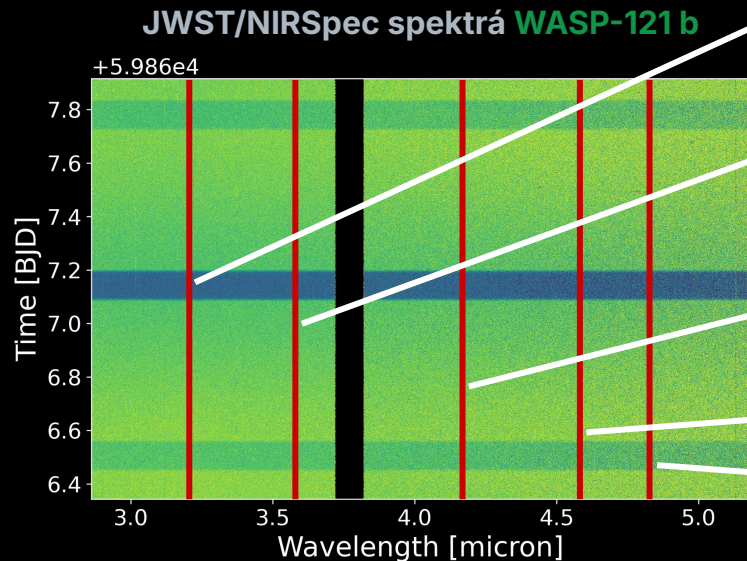
JWST/NIRSpec spektrá **WASP-121 b**



Tranzit **WASP-121 b** - rôzne vln. dĺžky

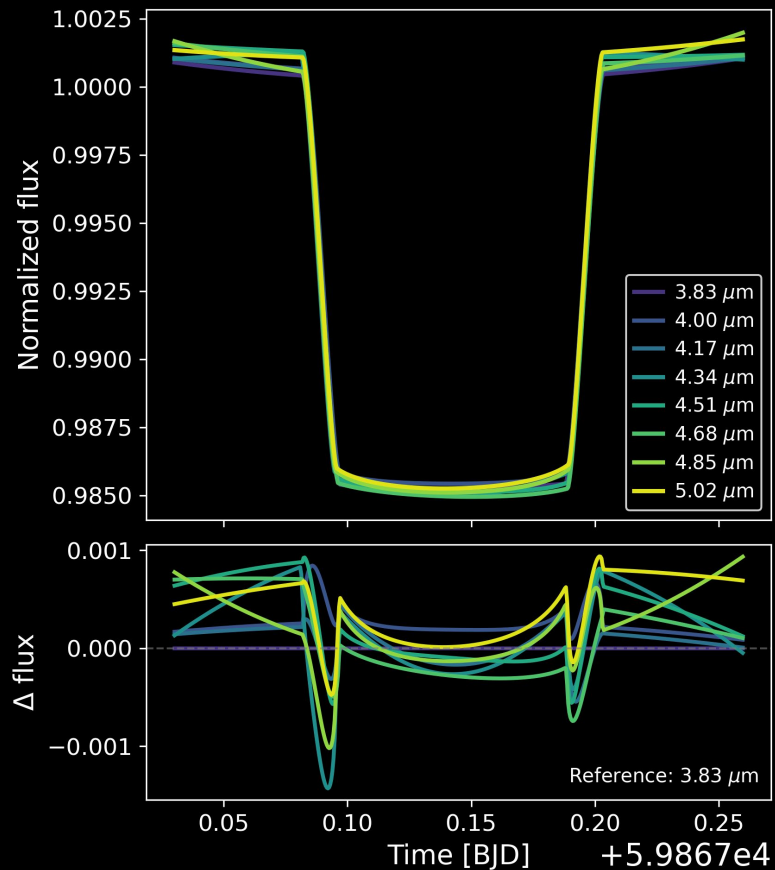


Transmisná spektroskopia

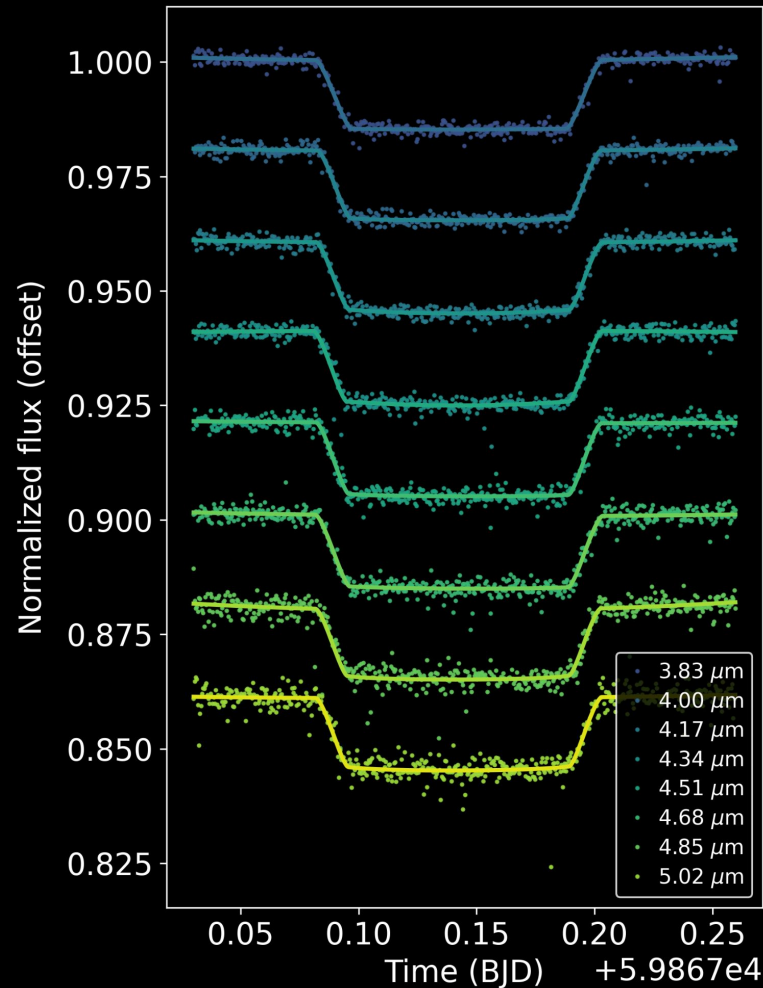


Transmisná spektroskopia

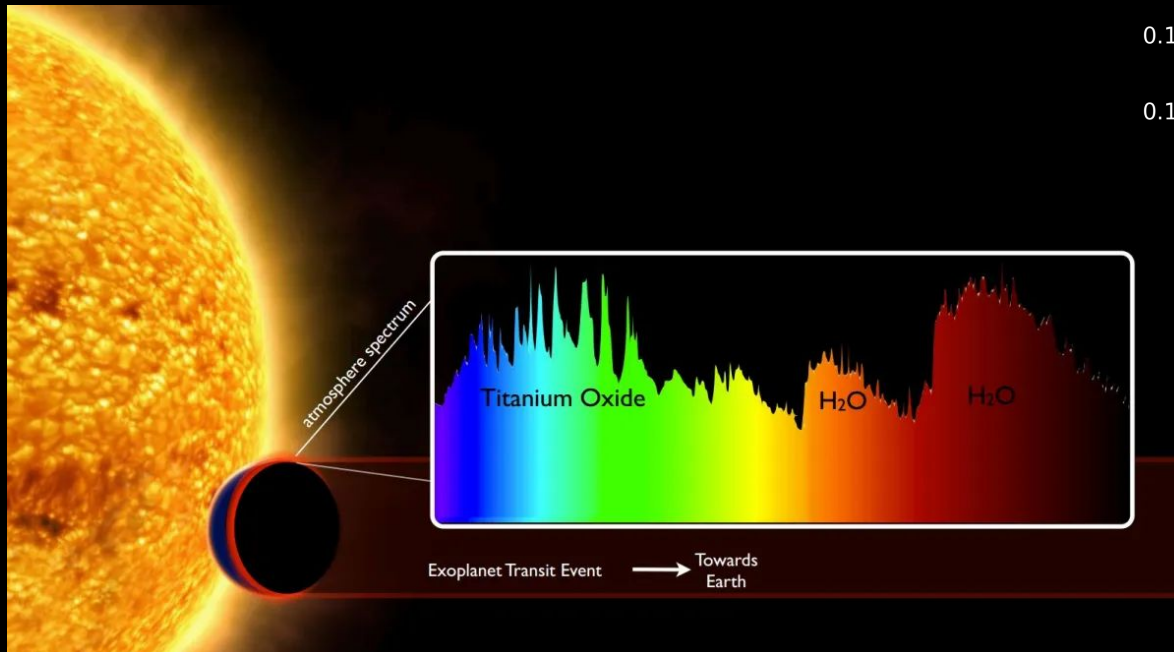
Hĺbka tranzitu - rôzne vlnové dĺžky



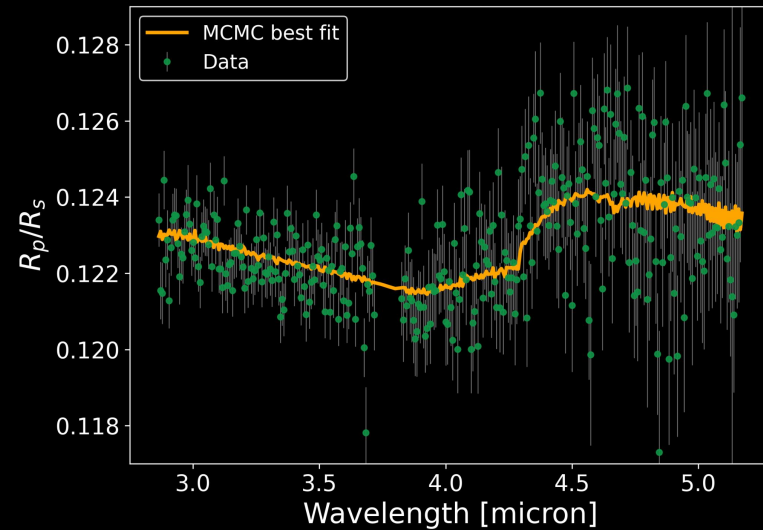
Tranzit **WASP-121 b** - rôzne vln. dĺžky



Transmisná spektroskopia



Transmisné spektrum WASP-121 b



GAS-GIANT EXOPLANET WASP-107 b

TRANSMISSION SPECTRUM

Hubble WFC3

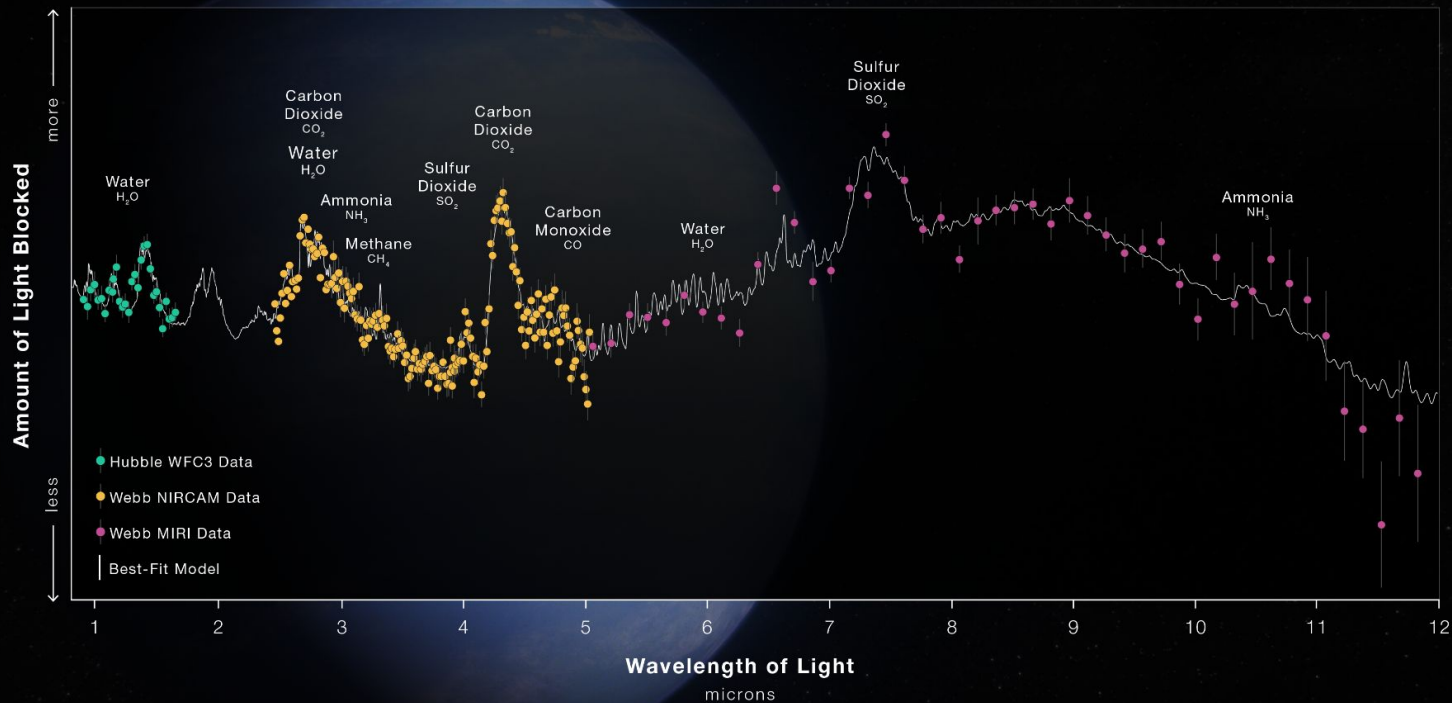
Grism Spectroscopy

Webb NIRCarn

Grism Spectroscopy

Webb MIRI

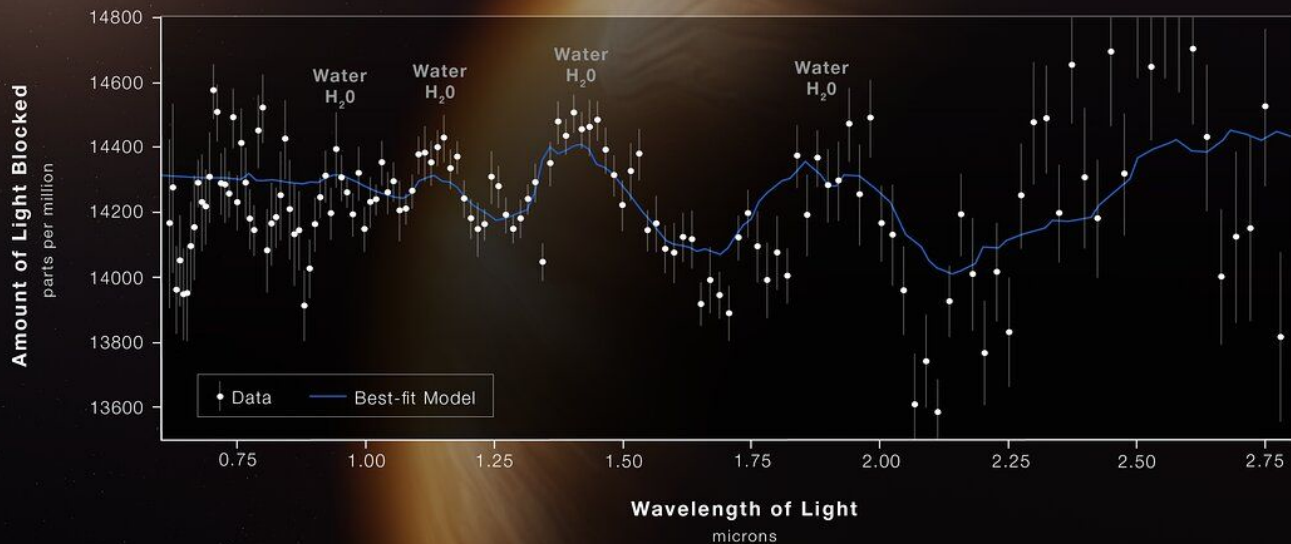
Low-Resolution Spectroscopy



HOT GAS GIANT EXOPLANET WASP-96 b

ATMOSPHERE COMPOSITION

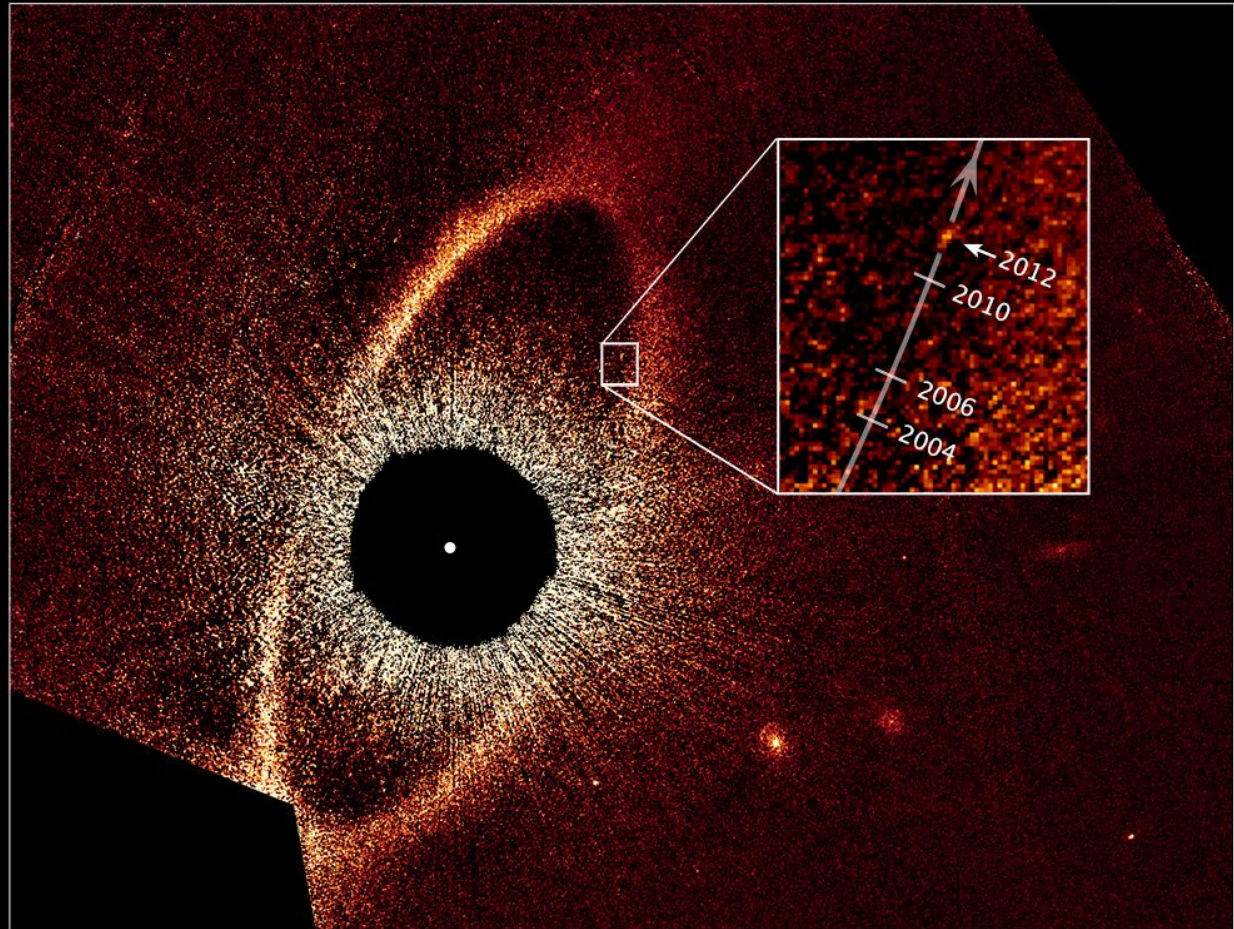
NIRISS | Single-Object Slitless Spectroscopy



Priame pozorovanie

Fomalhaut System

Hubble Space Telescope • STIS

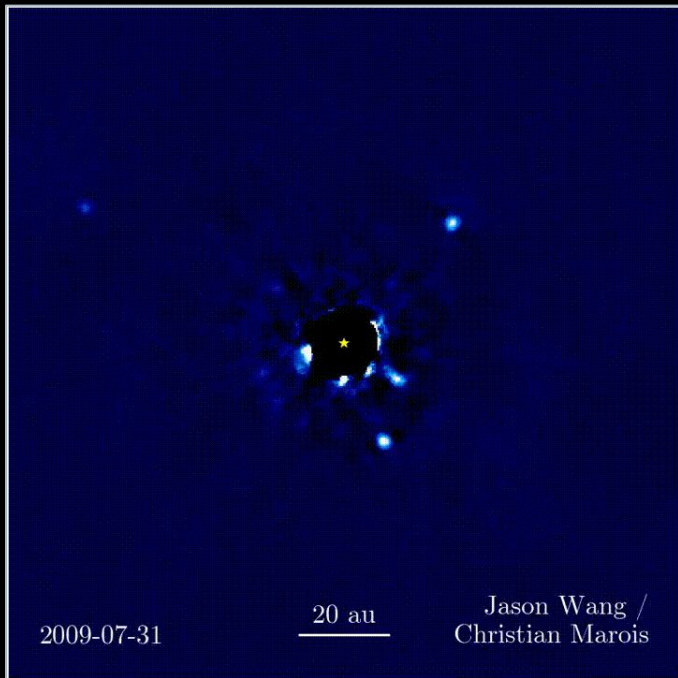


NASA and ESA and P. Kalas

STScI-PRC13-01a

Priame pozorovanie

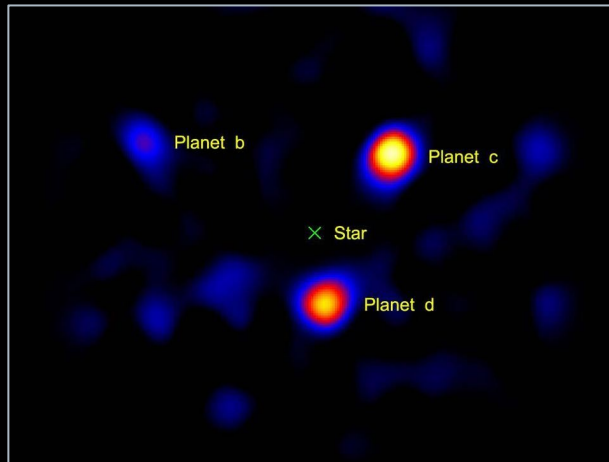
Hnedý trpaslík **2M1207**
s exoplanétou?



Planetárny systém
pri hviezde **HR 8799**



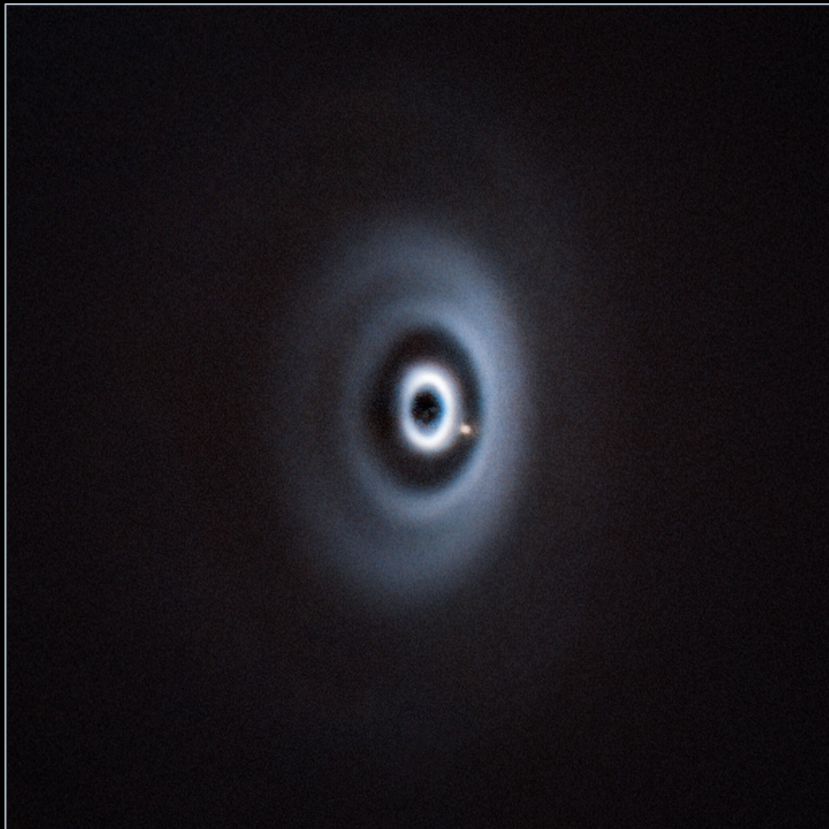
© NaCo, VLT, ESO



© NASA/JPL-Caltech/
Palomar Observatory

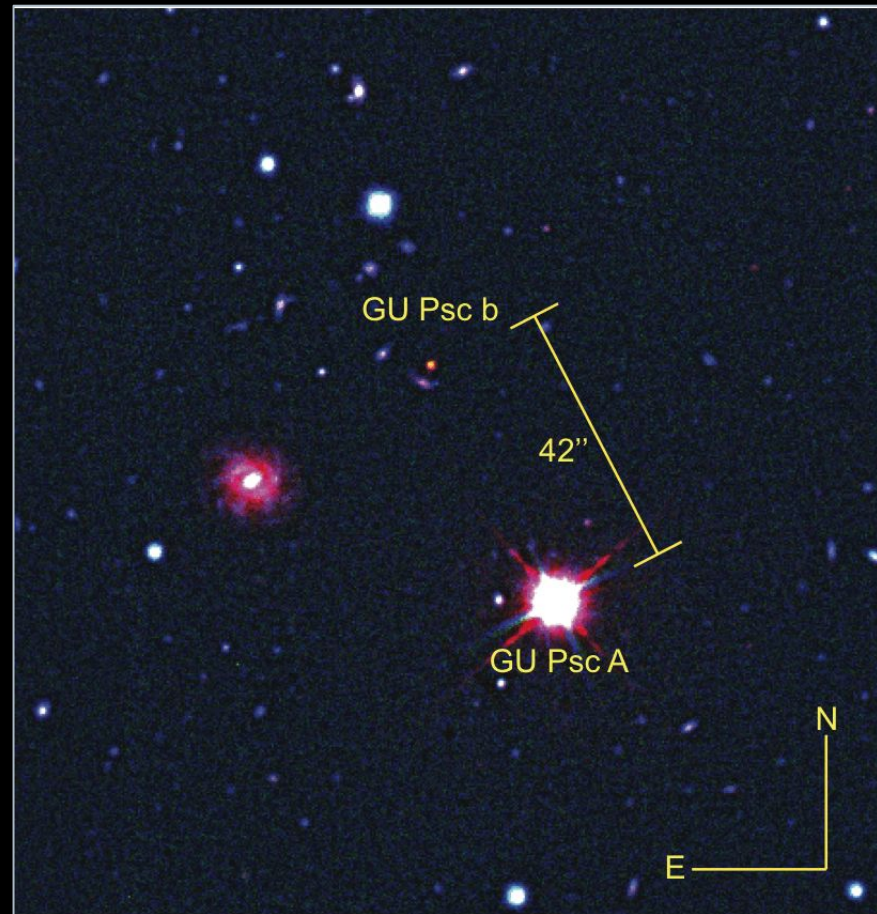
Priame pozorovanie

Mladá planéta **WISPIT 2b** v proto-planetárnom disku



© ESO/R. F. van Capelleveen et al.

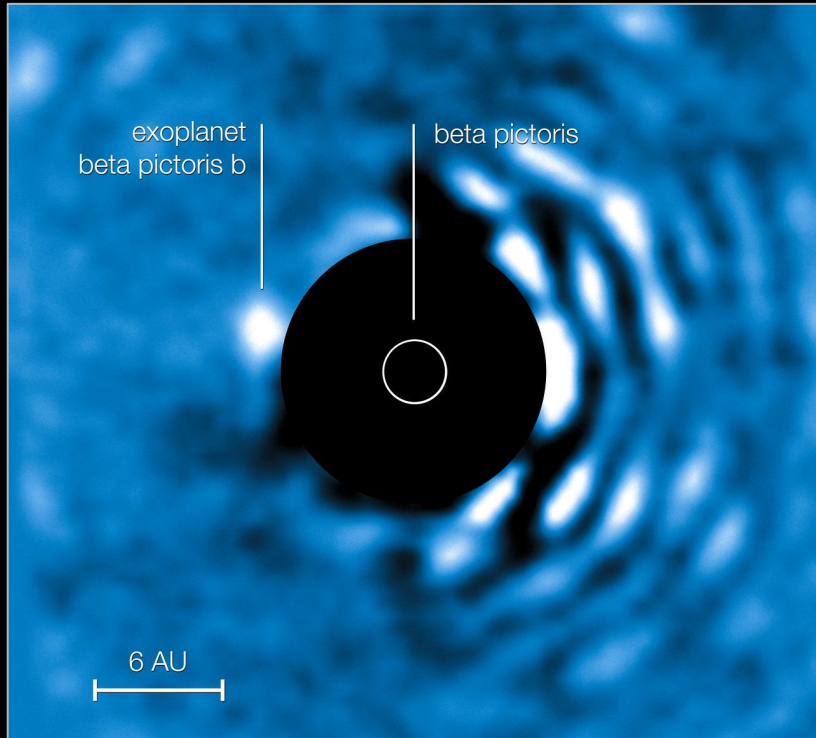
Infra-červené snímky **GU Psc b**:
planéta alebo hnedý sub-trpaslík



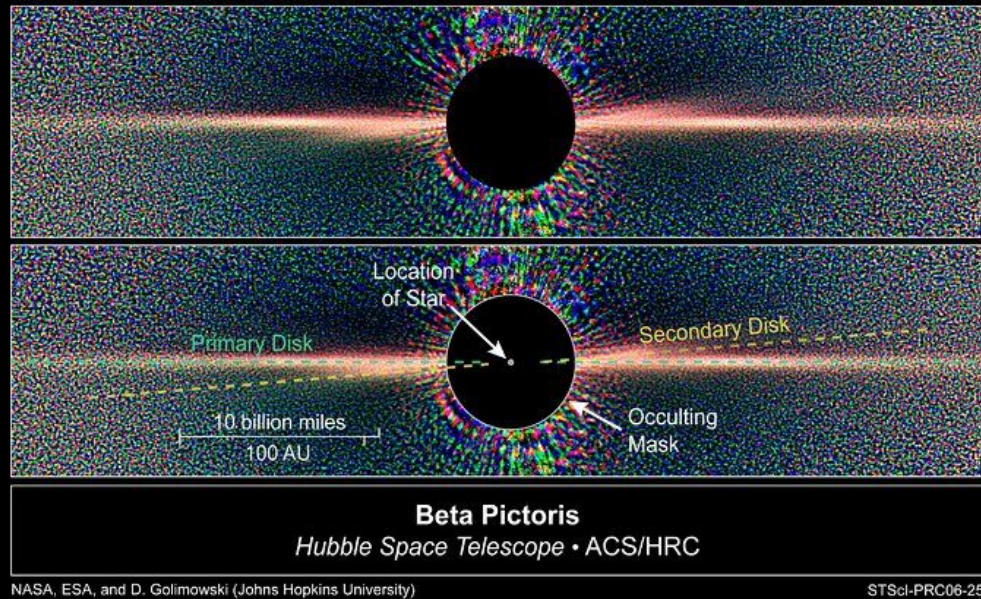
© NASA, Marie-Eve Naud et al, Gemini Observatory

Priame pozorovanie

Pohyb exoplanéty Beta Pictoris b

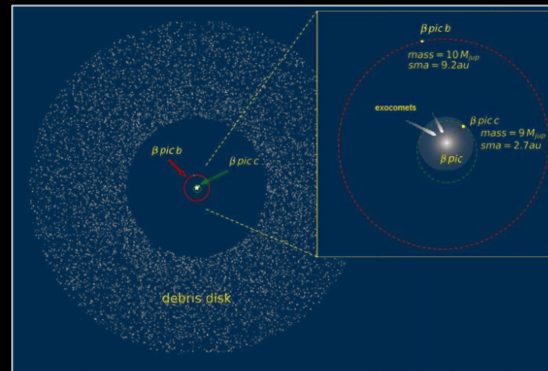


© ESO



NASA, ESA, and D. Golimowski (Johns Hopkins University)

STScI-PRC06-25

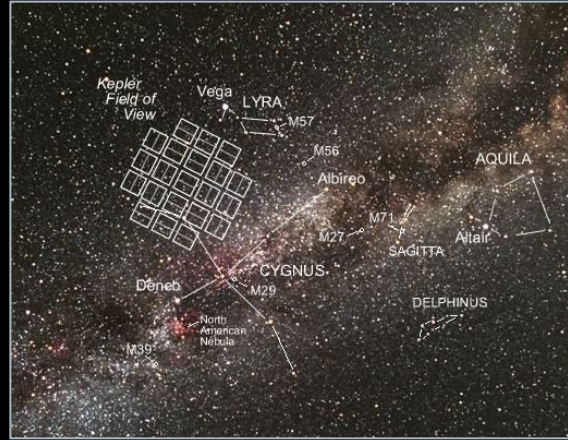


© P. Rubini /
A.-M. Lagrange

Vesmírne teleskopy - Kepler & TESS



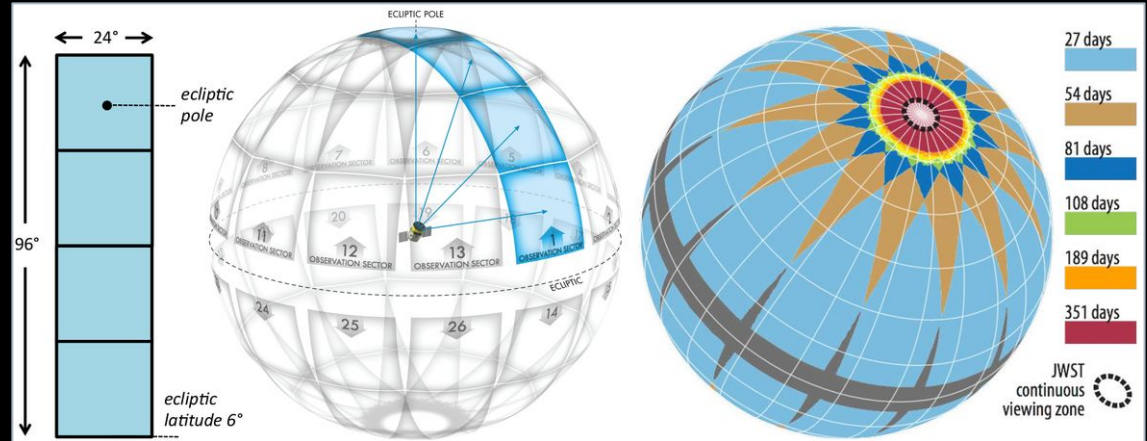
© NASA



© C. Roberts

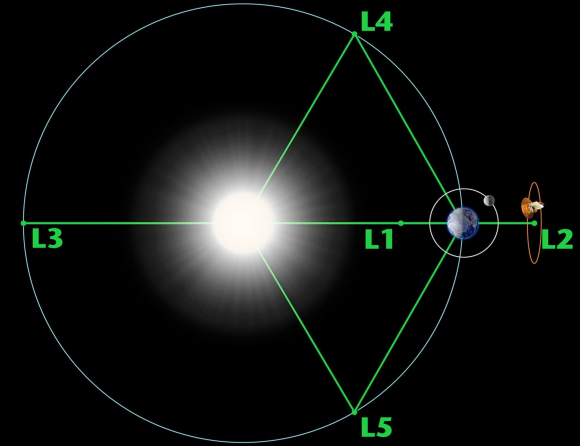
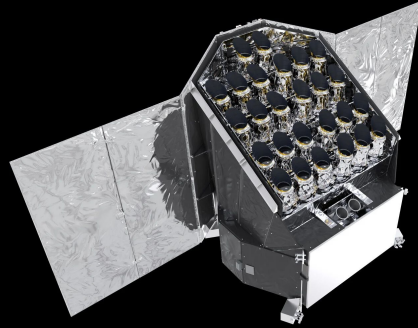


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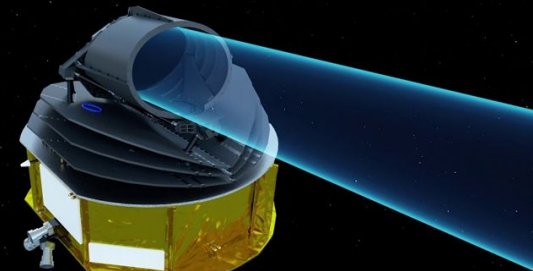
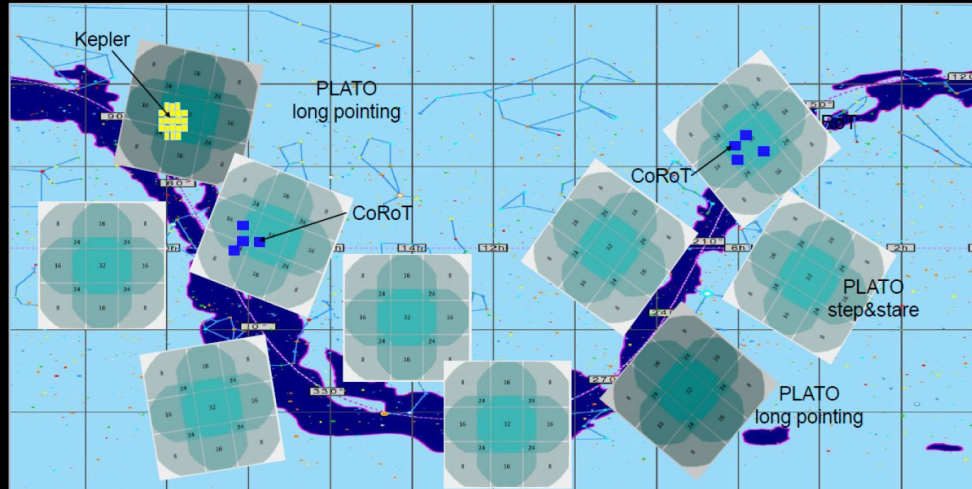


Vesmírne teleskopy - Plato & Ariel

© NASA/WMAP Science Team



© CNES/ESA

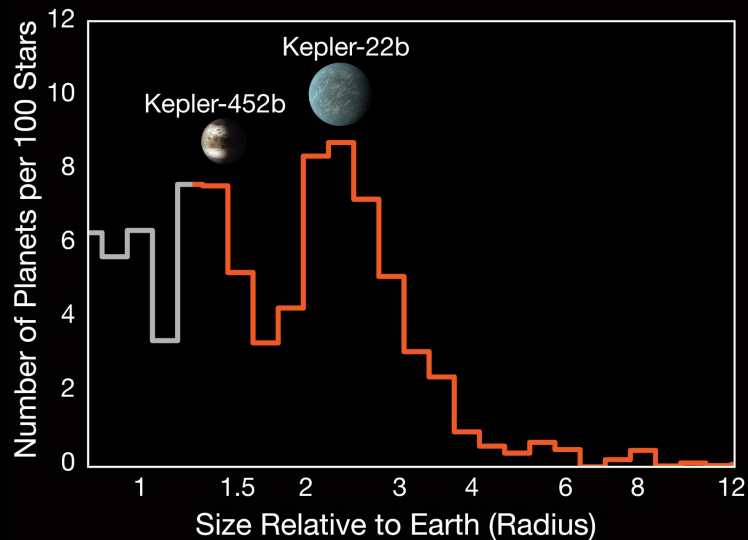


© ESA

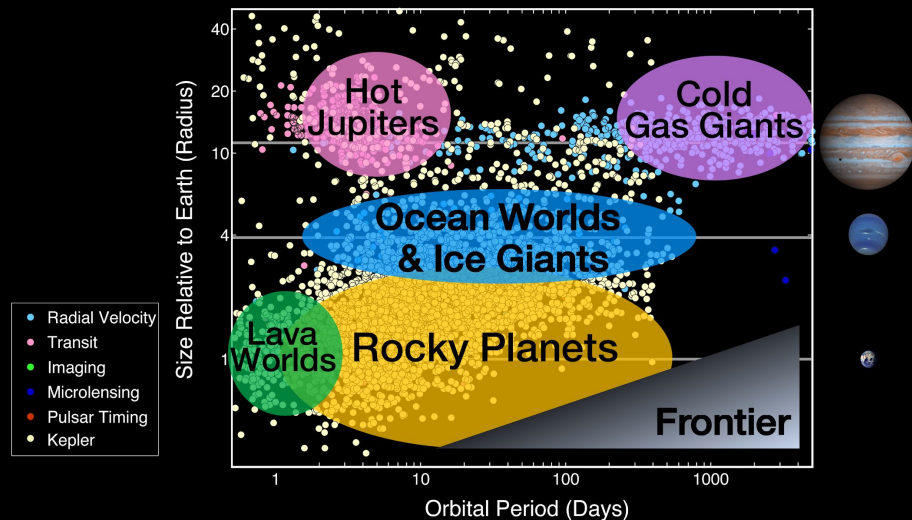
SúčasnÉ poznatky o exoplanétach

Doterajšie výsledky

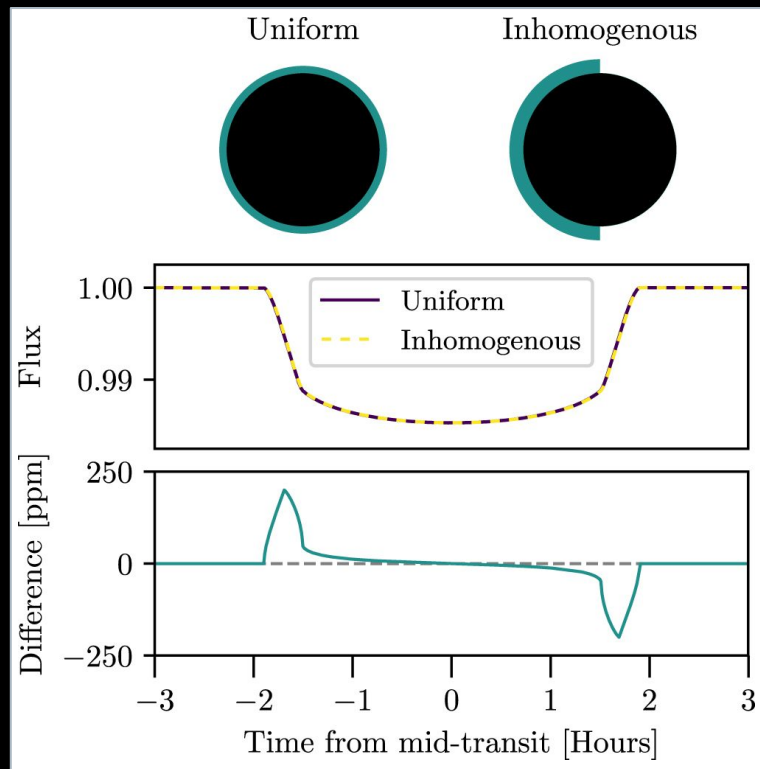
Small Planets Come in Two Sizes



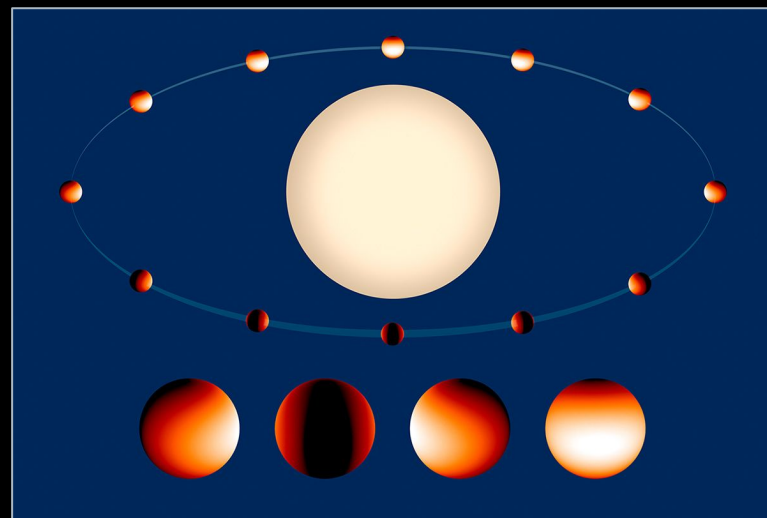
Exoplanet Populations



Horúce Jupitery

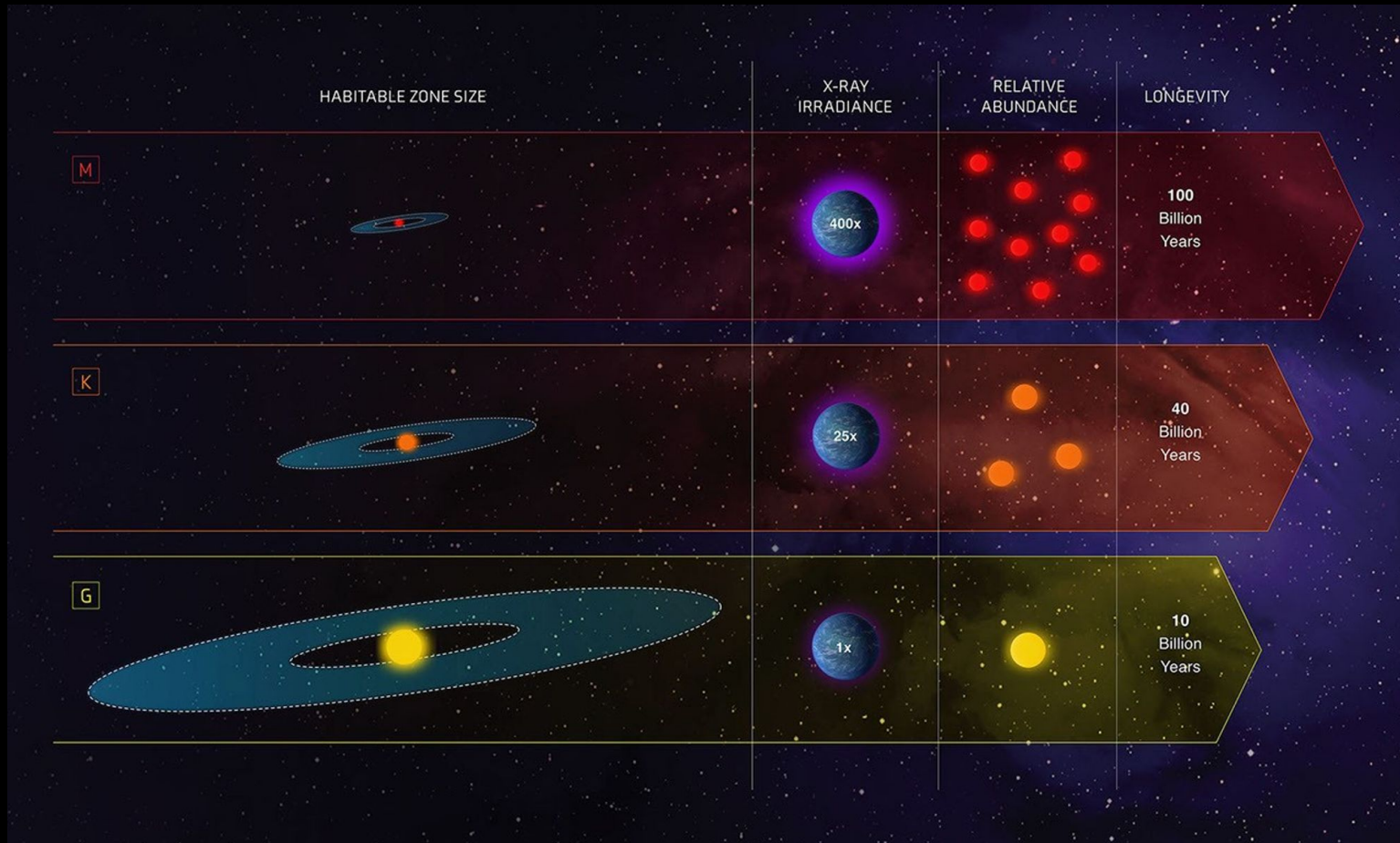


Guangwei Fu et al 2025

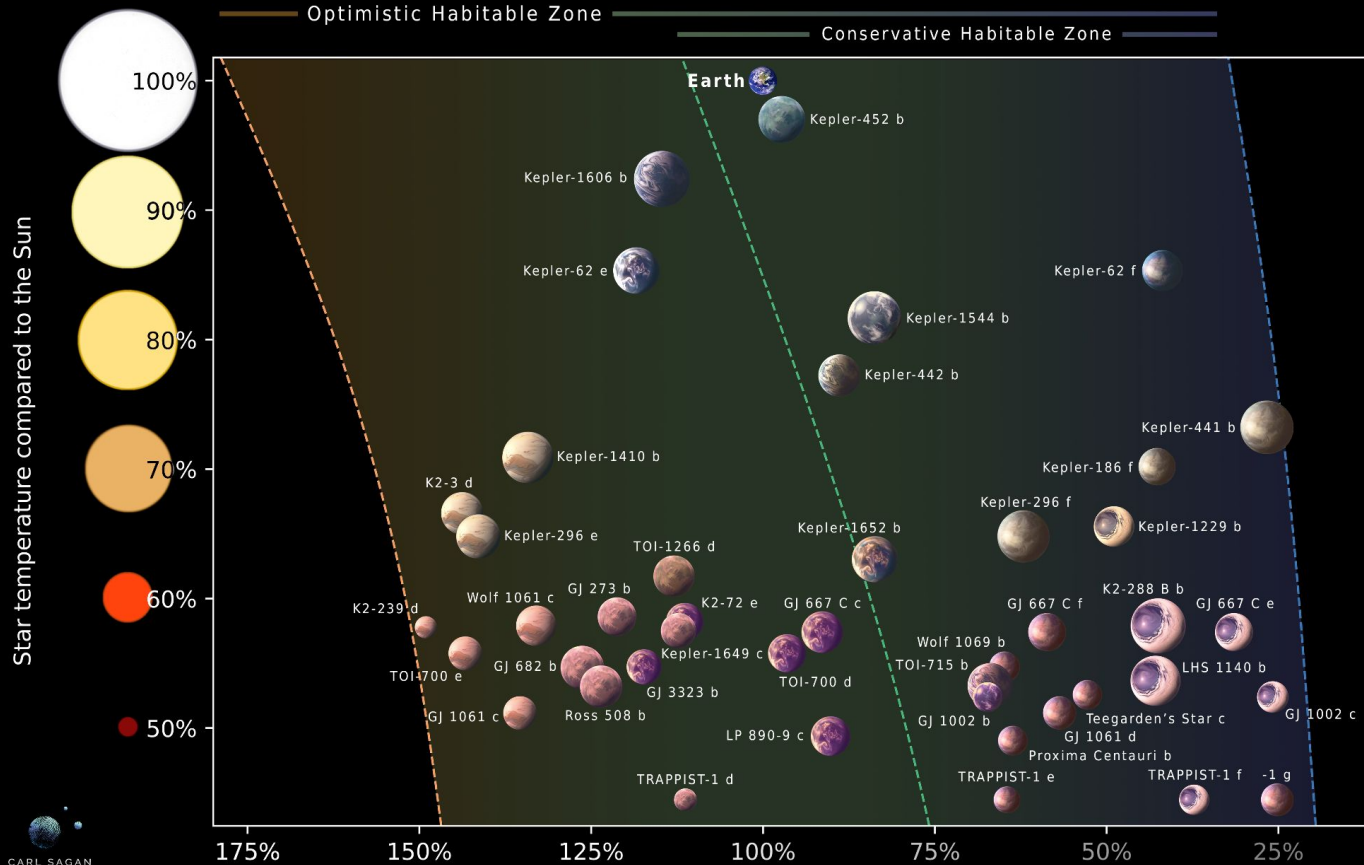


© Hubble

Obývatel'ná zóna (habitable zone)



Obývateľná zóna (habitable zone)



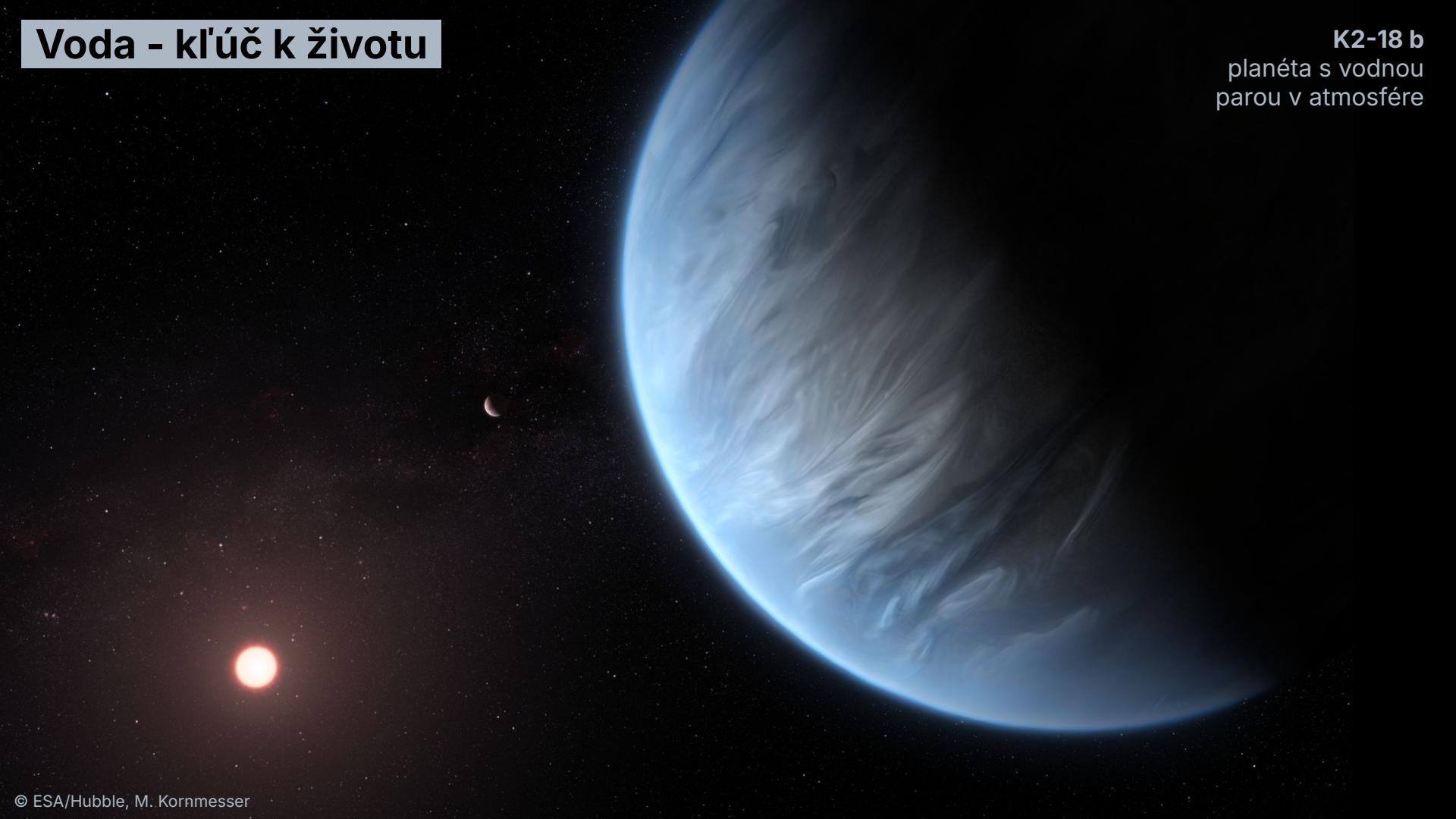
Gillis Lowry / CSI, insp. by Chester Harman
Planets: Pablo Carlos Budassi (Celestialobjects)

Cesta k životu

Voda - klíč k životu

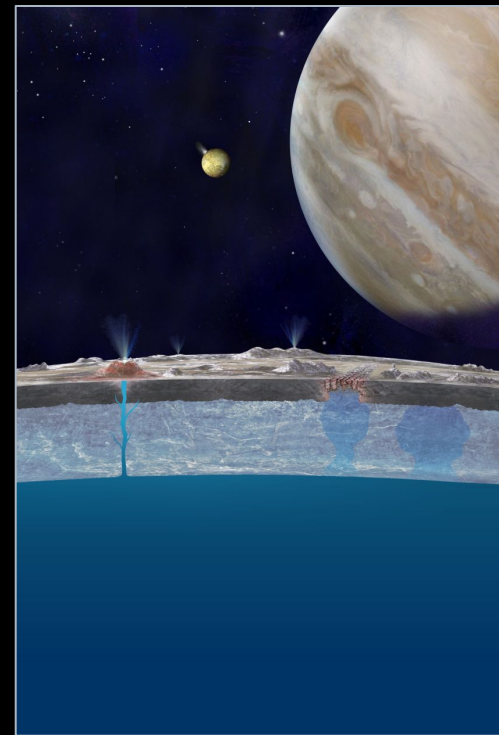
K2-18 b

planéta s vodnou
parou v atmosféře



Voda - kl'úč k životu

Európa
mesiac Jupitera s
ľadovou pokrývkou



© NASA/JPL-Caltech

Mimozemský život sme zatiaľ neobjavili...?



© NASA



© ESO/
Kornmesser

Pomalky

© G. Willow



→ Želvušky

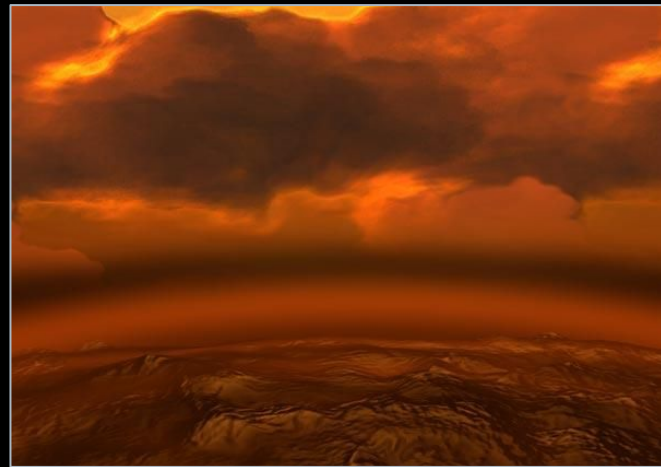
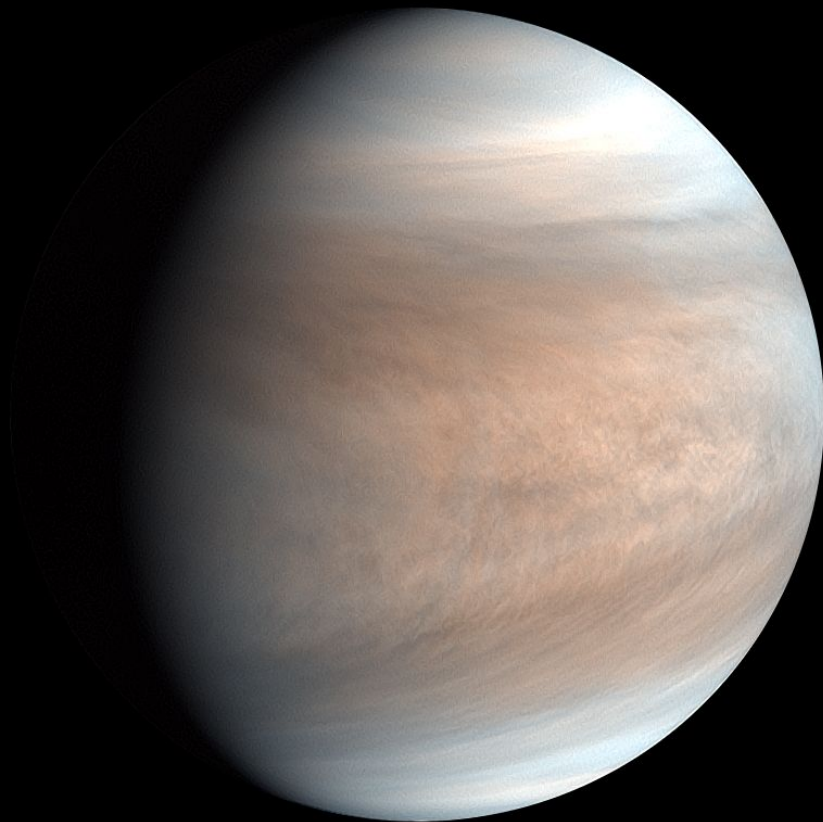


ALH84001,0

1 cm.



Mimozemský život sme zatiaľ neobjavili...?



© ESA



Nobelova cena za fyziku v roku 2019

N. Elmedhed; © Nobel Media

The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos" with one half to James Peebles "for **theoretical discoveries in physical cosmology**", the other half jointly to Michel Mayor and Didier Queloz "for **the discovery of an exoplanet orbiting a solar-type star.**"



James Peebles



Michel Mayor



Didier Queloz

Ďakujem za pozornosť

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Research Ireland



Referencie

Mayor M., Queloz D. (1995): A Jupiter-mass companion to a solar-type star. Nature 378, 355–359

Marcy G.W., Butler R.P., Williams E., et al. (1997): The planet around 51 Pegasi. ApJ 481, 926–935

Charbonneau D., Brown T.M., Latham D.W., Mayor M. (2000): Detection of Planetary Transits Across a Sun-like Star. ApJ 529 1, L45–L48

NASA Exoplanet Archive. Retrieved from https://exoplanetarchive.ipac.caltech.edu/docs/counts_detail.html

The Nobel Prize in Physics 2019. [online] NobelPrize.org. Nobel Media AB 2020. Mon. 20 Jan 2020. Retrieved 2020-01-20 from <https://www.nobelprize.org/prizes/physics/2019/summary/>

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Research Ireland

Anotácia

Sme vo vesmíre sami? Alebo sú planéty s vodou, atmosférou a možno aj životom úplne bežné?

V prednáške sa vydáme za svetmi mimo našej Slnecnej sústavy – exoplanétami. Od prvých objavov až po pozorovania pomocou vesmírneho teleskopu Jamesa Webba si ukážeme, ako je možné objavovať planéty pri vzdialených hviezdach a určovať zloženie ich atmosfér.

Na konkrétnych príkladoch si ukážeme reálne dáta, z ktorých vieme vyčítať prítomnosť vody a ďalších molekúl v atmosférach cudzích svetov. Predstavené budú aj hlavné metódy objavovania exoplanét – tranzity, meranie radiálnych rýchlostí a priame zobrazenie.

Na záver sa pozrieme na pojem obývateľnej zóny a na to, ktoré typy planét sú dnes považované za najlepších kandidátov na mimozemský život.

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