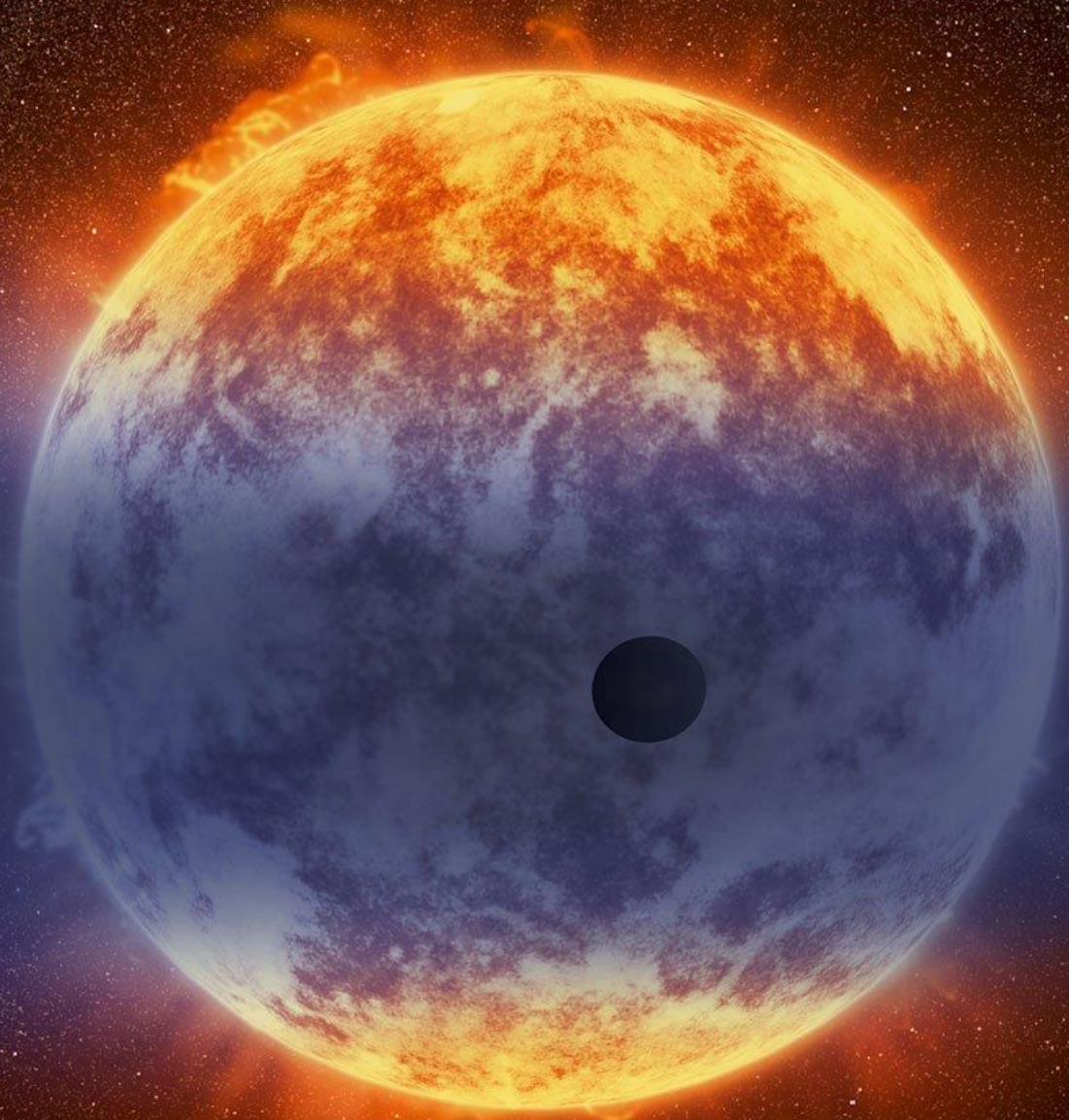
Exoplaneten



Wat zijn exoplaneten?

Waarom bestuderen we ze?

Hoe geraken we er?

Jana Bosschaerts

Educatieve master Wetenschappen (Fysica & Sterrenkunde)

Overzicht

- Definitie en classificatie
  - Gasreuzen
  - Neptunus-achtige
  - Super aardes
  - Rotsachtige
- Zoektocht
  - Naar leven
  - De tools
- Vervoer

Overzicht

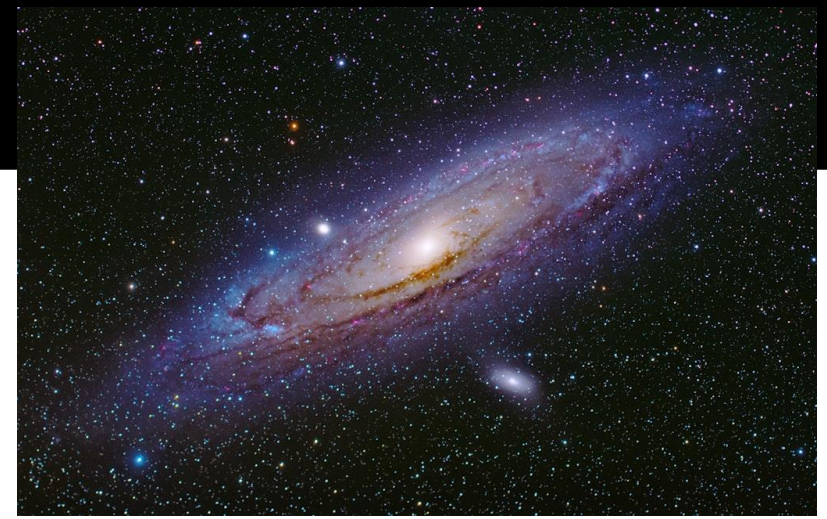
- **Definitie en classificatie**
  - **Gasreuzen**
  - **Neptunus-achtige**
  - **Super aardes**
  - **Rotsachtige**
- Zoektocht
  - Naar leven
  - De tools
- Vervoer

Definitie

- Exoplaneet = planeten buiten het zonnestelsel
  - Rond ster
  - Solitaire planeten

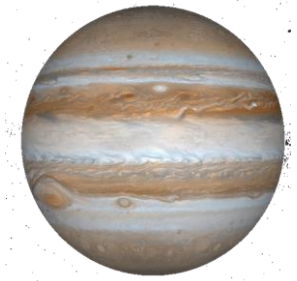
4,2 ly

Definitie



- Exoplaneet = planeten buiten het zonnestelsel
  - Rond ster
  - Solitaire planeten

  - Melkweg 100 000 ly



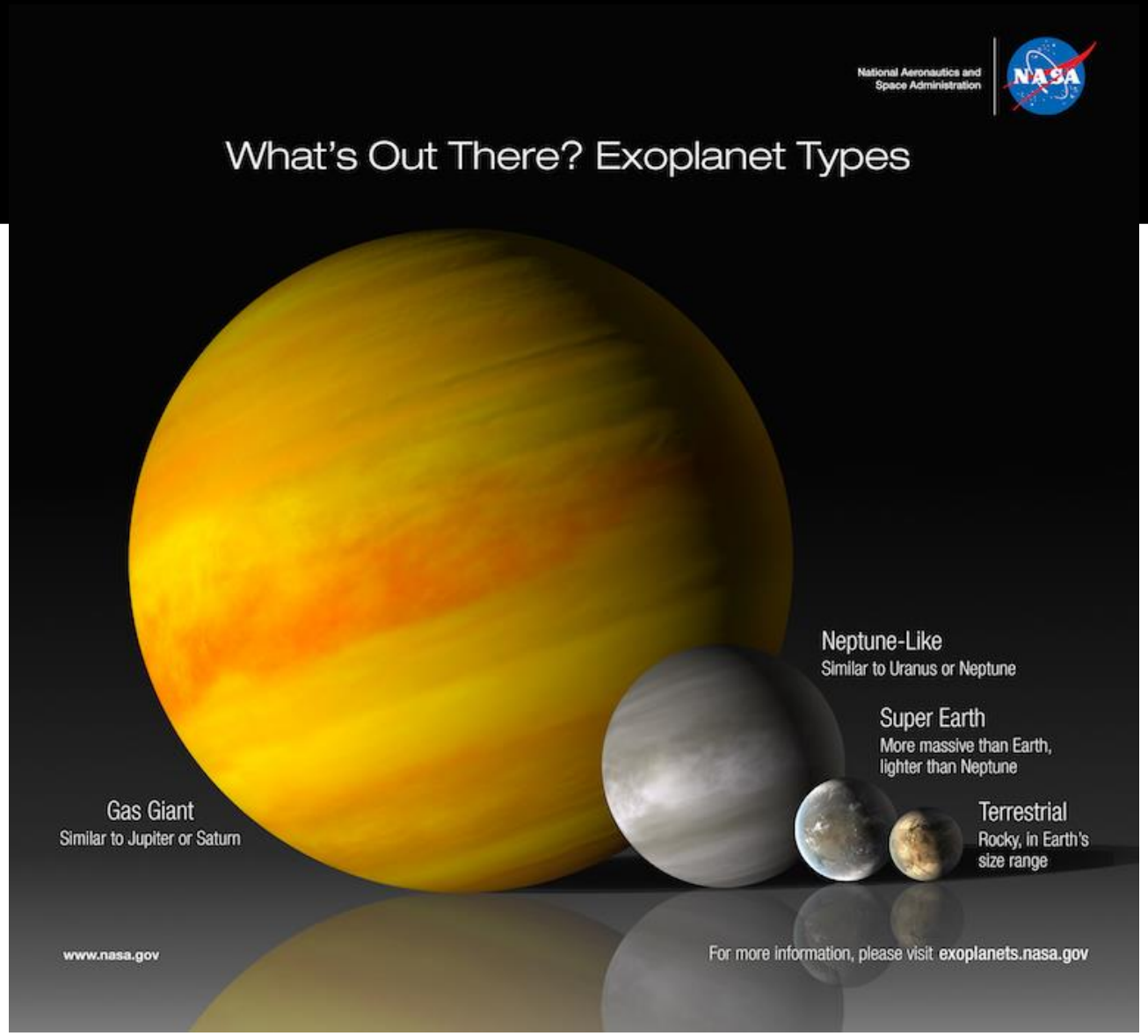
4.2 ly

...

17000 ly

Classificatie

- > 5000 exoplaneten



Classificatie: Gasreuzen

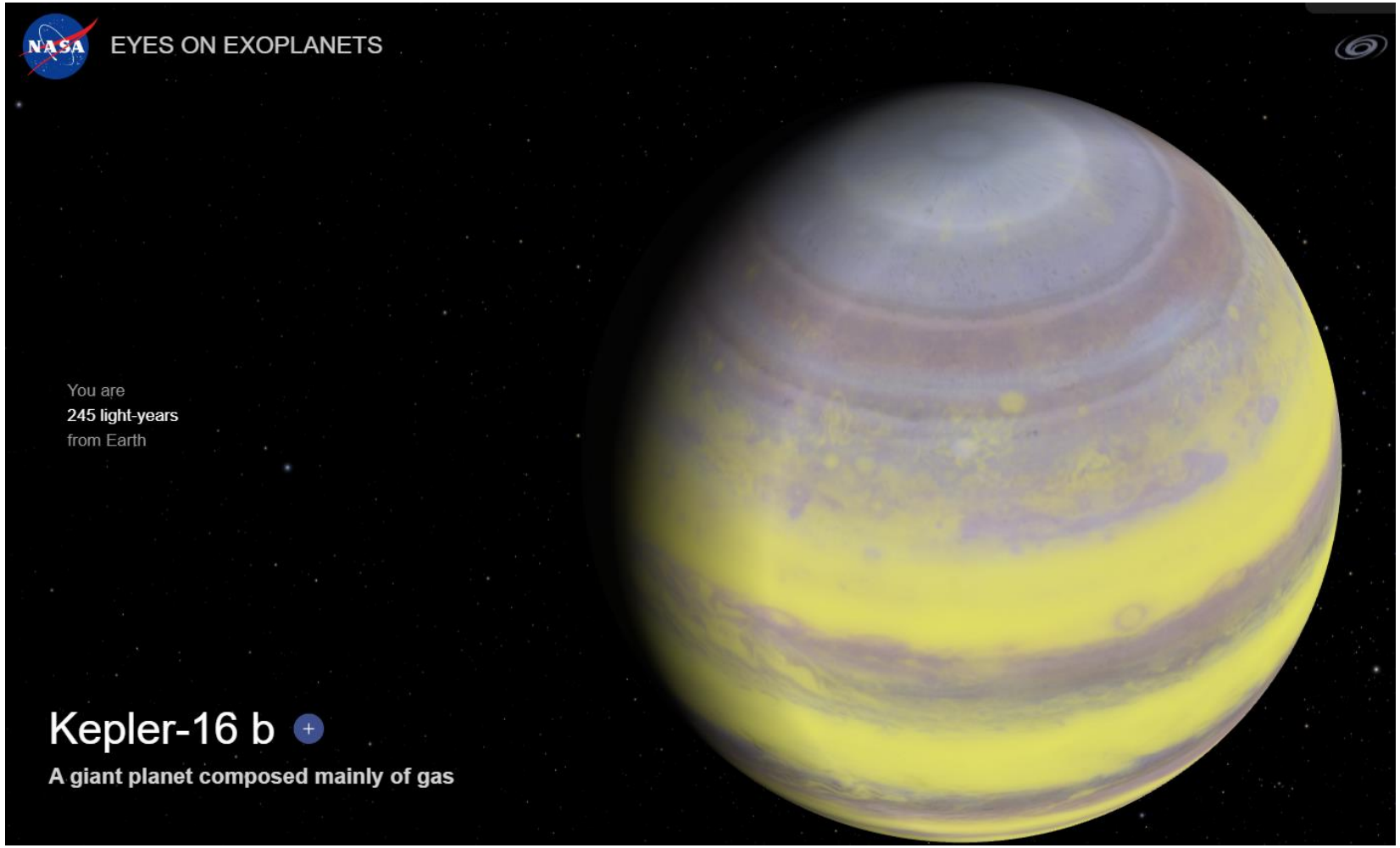
- He, H
- Grootte >= Jupiter

- Hot Jupiters
  A. Dicht bij ster ontstaan
  B. Gemigreerd naar binnen in vroege jaren
  C. Gemigreerd naar binnen in late jaren

Classificatie: Gasreuzen

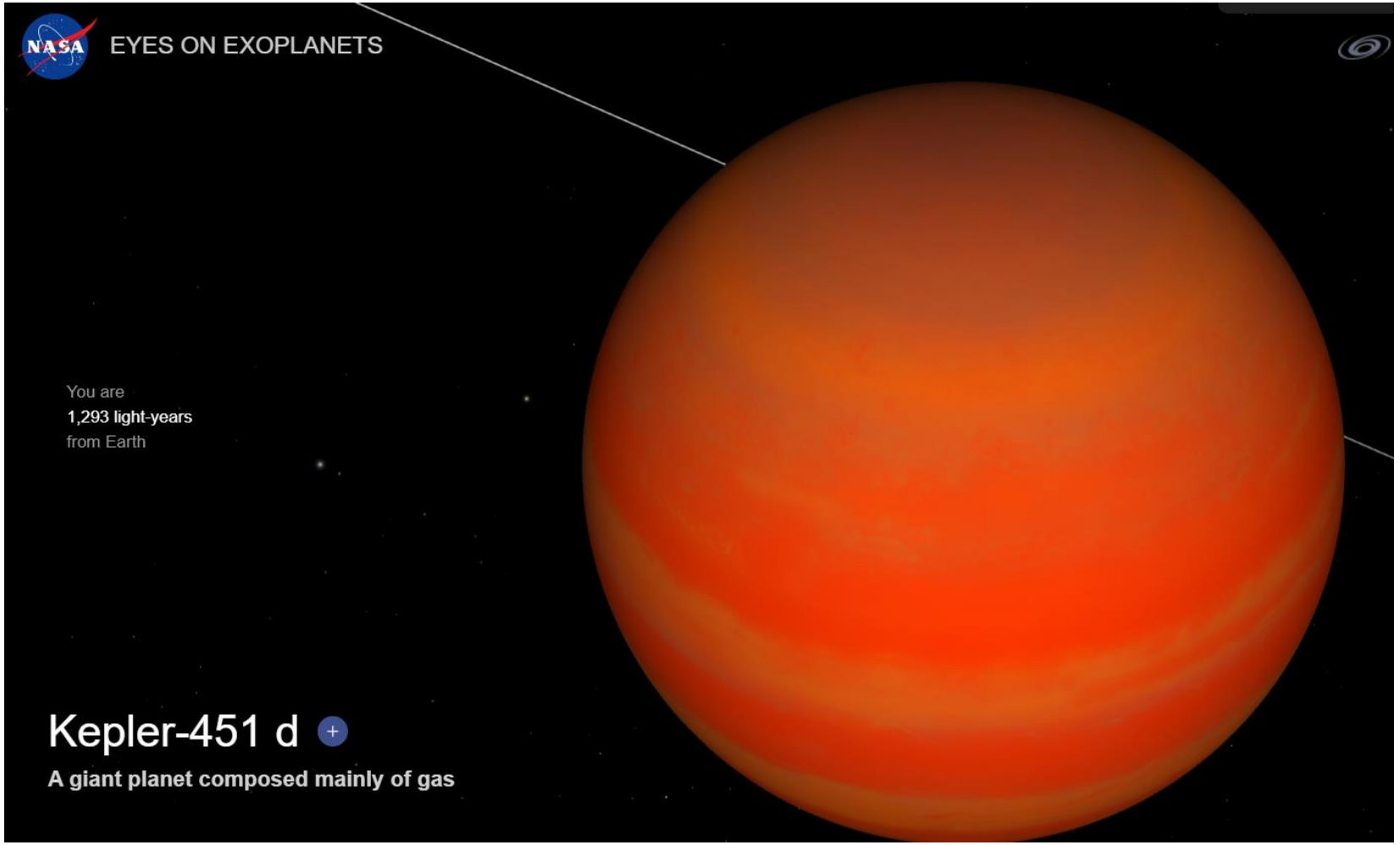
Kepler-16b

- Dubbel stersysteem



Classificatie: Gasreuzen

Kepler-451d

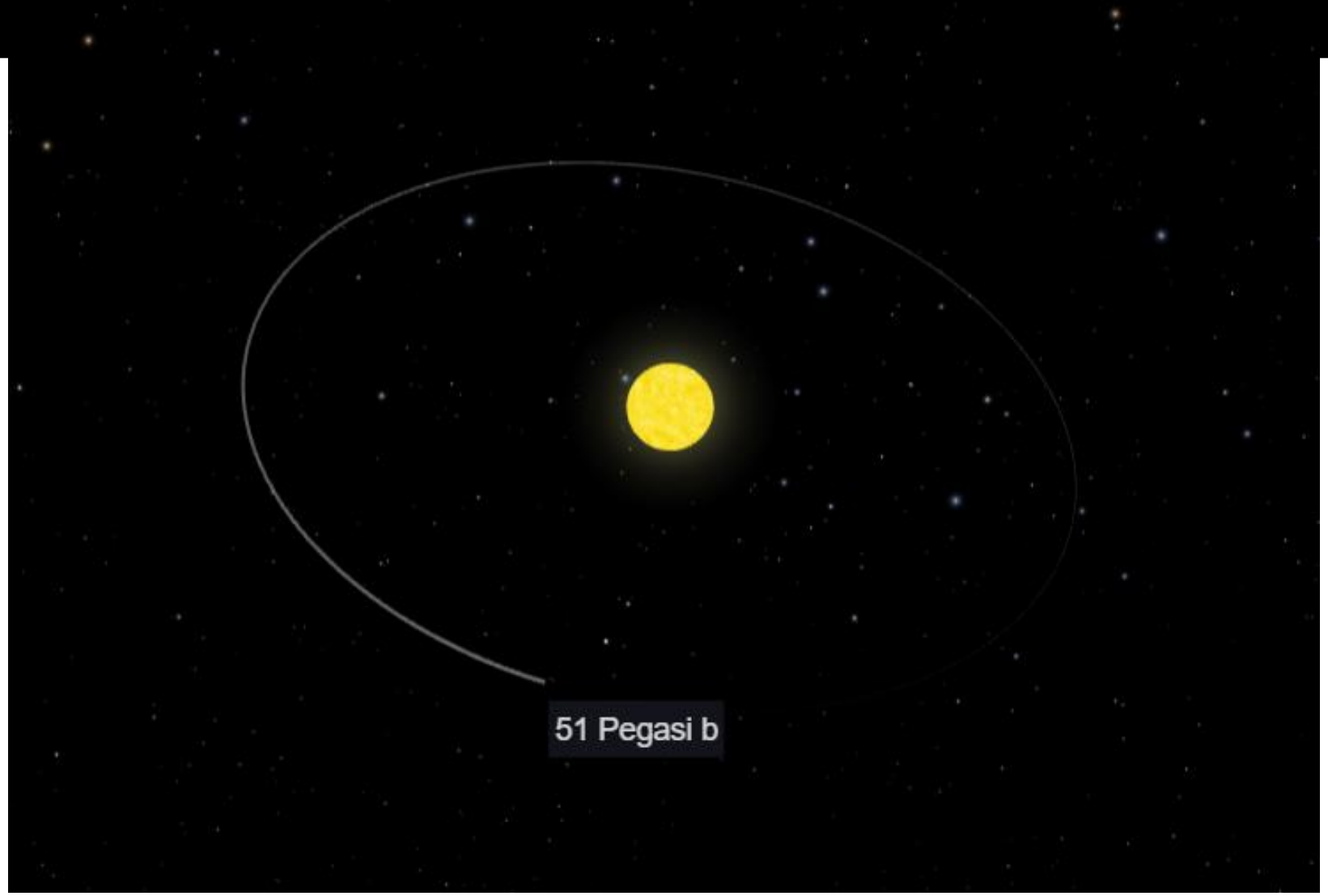


Classificatie: Gasreuzen

<u>51 Pegasi b</u>

- De eerste!

- 50 ly
- Periode:
  4 dagen

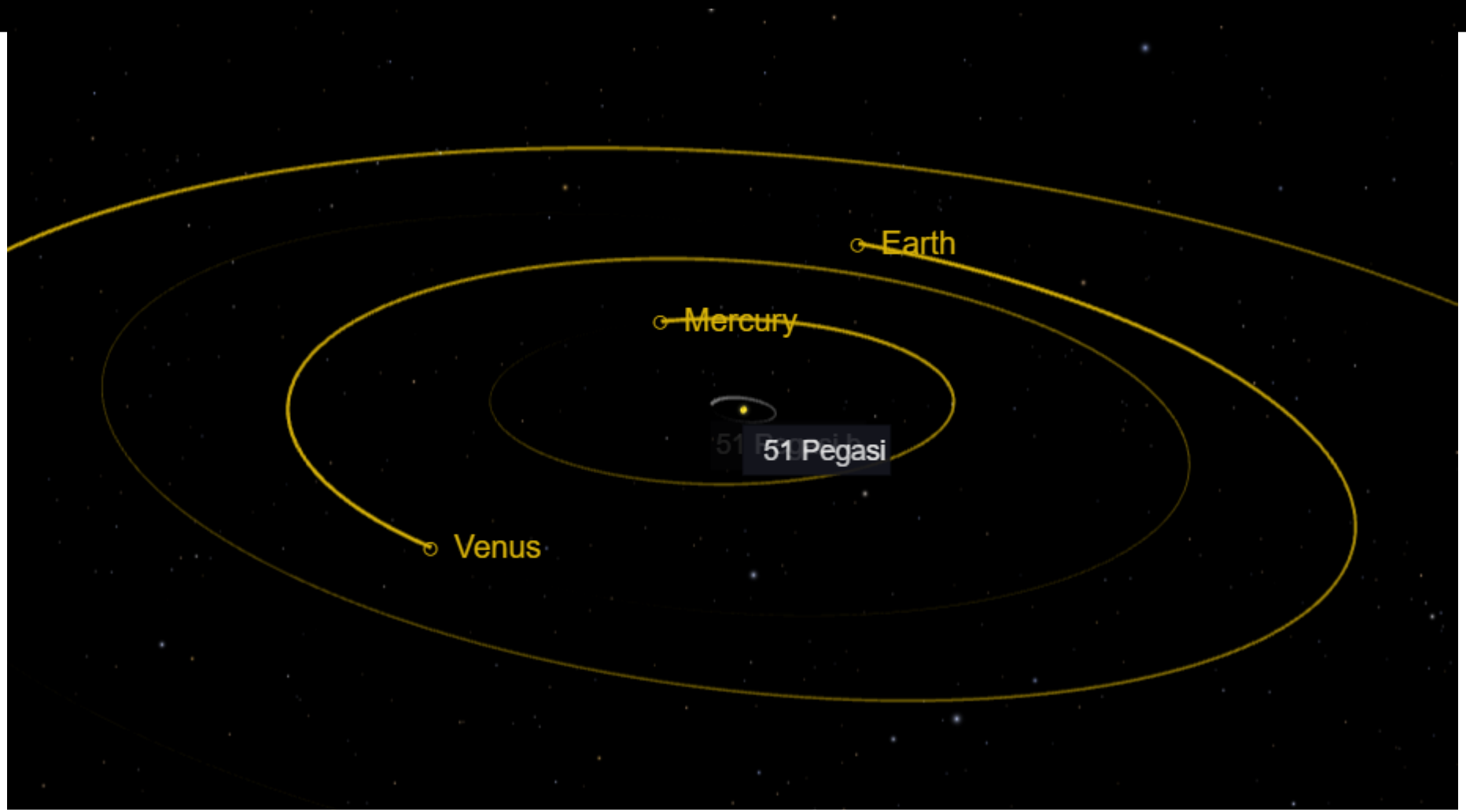


Classificatie: Gasreuzen

<u>51 Pegasi b</u>

- De eerste!

- 50 ly
- Periode:
  4 dagen



Classificatie: Neptunus-achtige

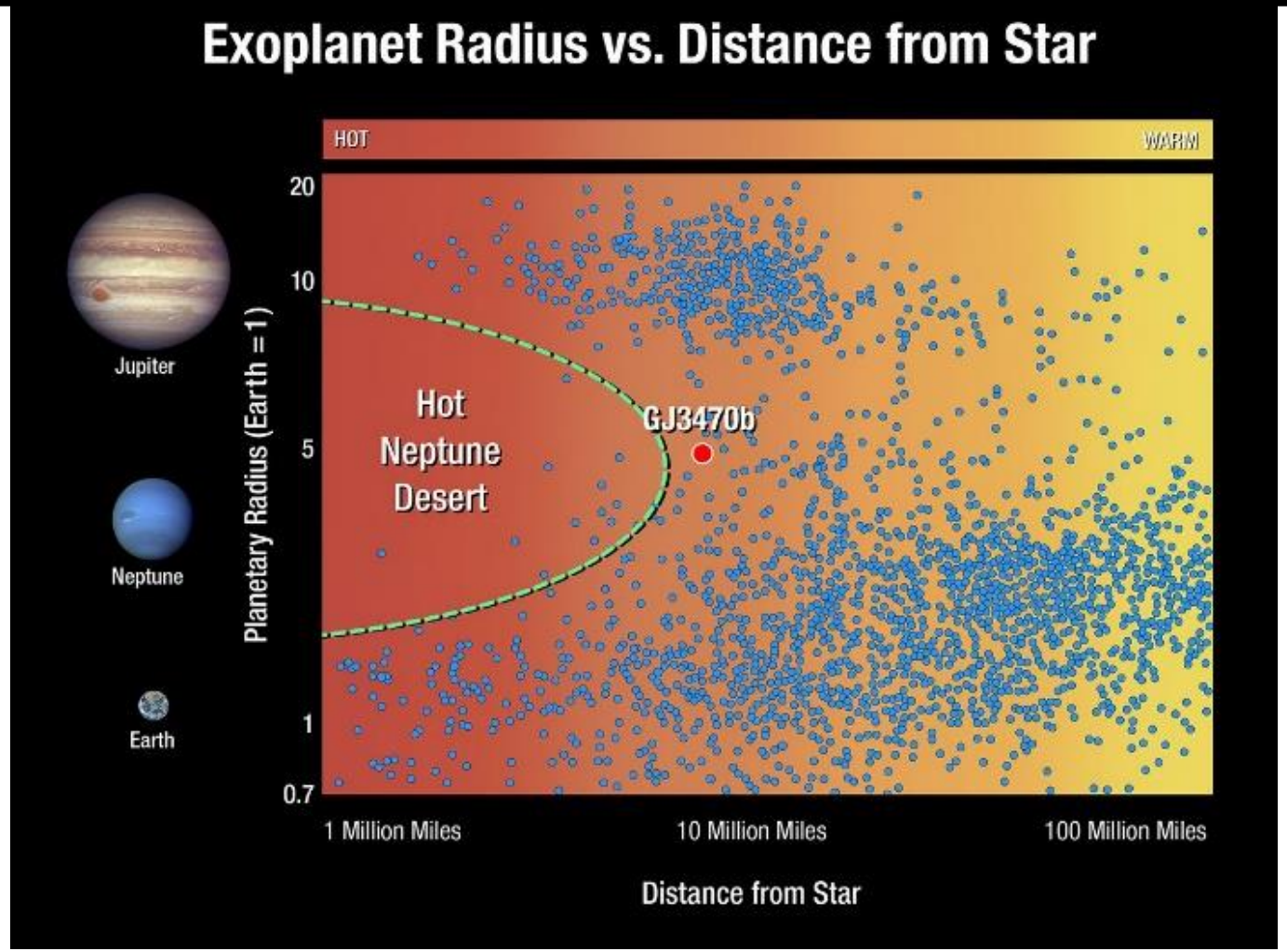
- Vaste kernen: gesteente en metaal
- Dichte atmosferen: H en He
- Grootte en massa ≈ Neptunus, Uranus
- Voorbij de sneeuwlijn

- Hot Neptunes?

Classificatie: Neptunus-achtige

- Hot Neptunes?
- Voorbij de sneeuwlijn

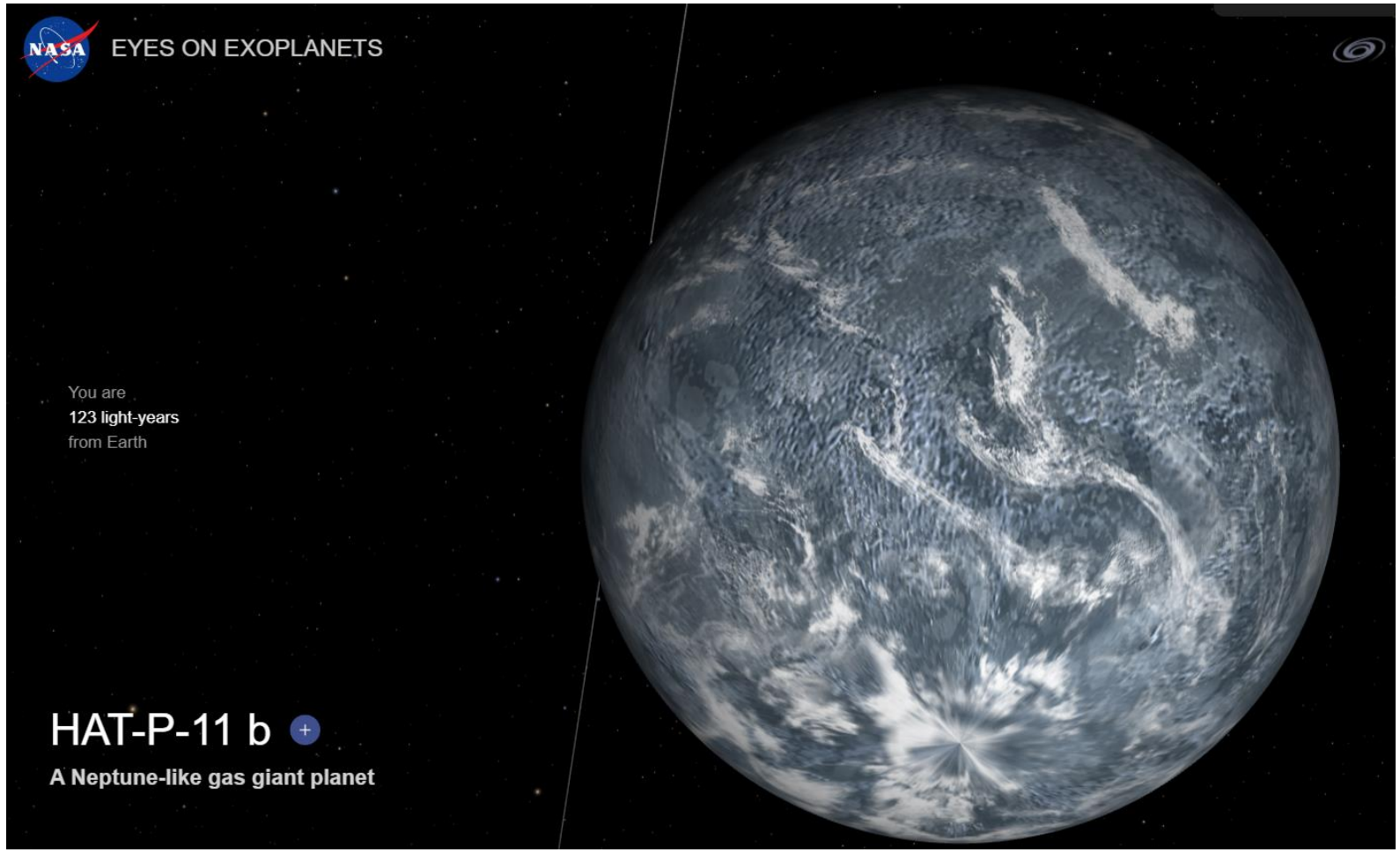
- 1 AU = 149 597 871 km
- 1 mijl = 1.609344 km



Classificatie: Neptunus-achtige

HAT-P-11 b

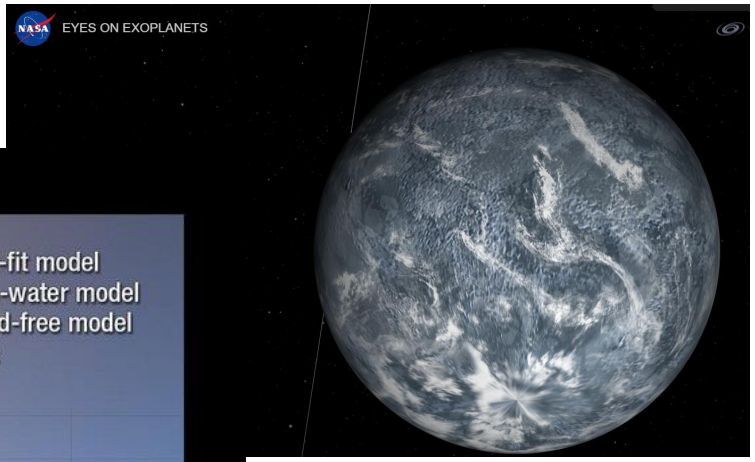
- 0.05254 AU
- Hot Neptune

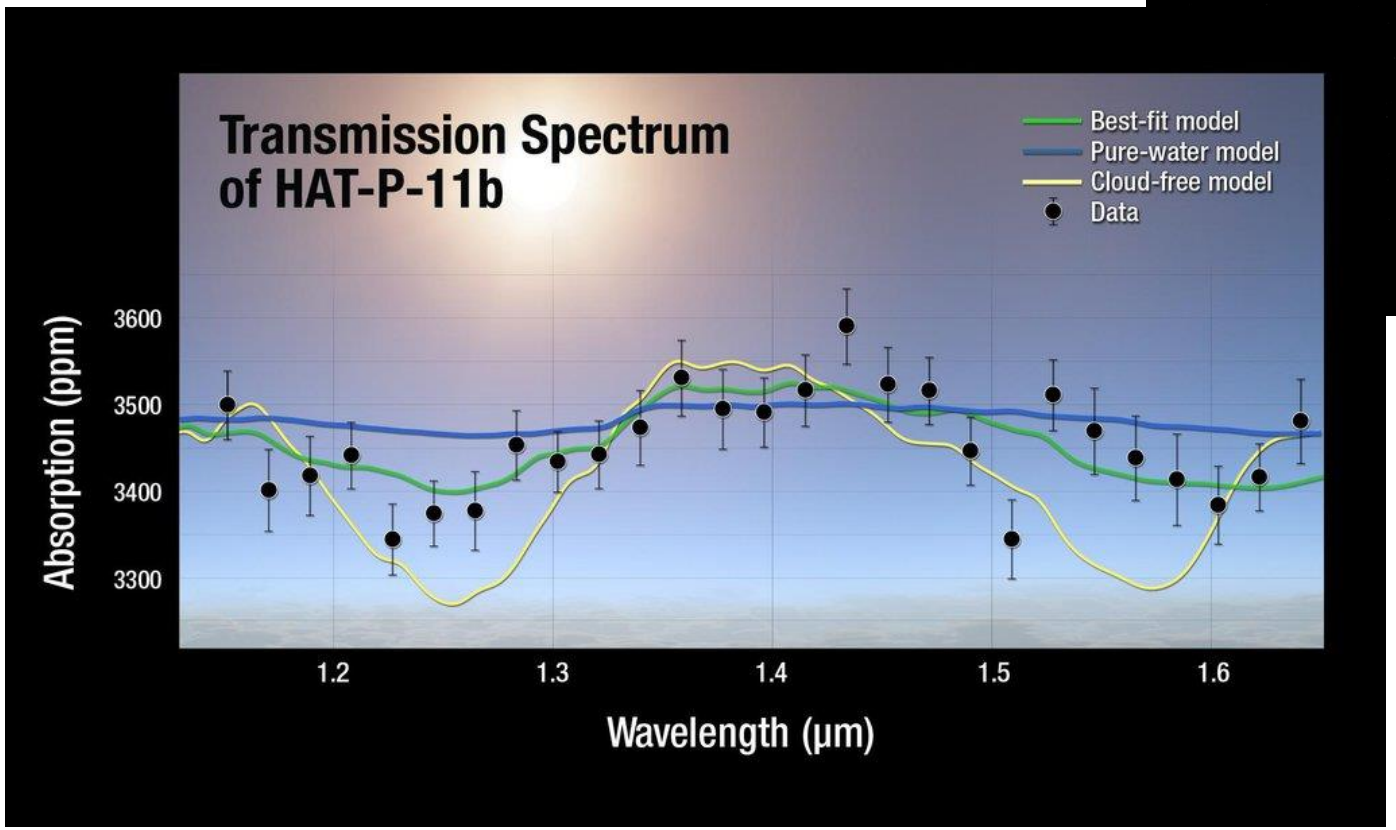


Classificatie: Neptunus-achtige

HAT-P-11 b

- Waterdamp!



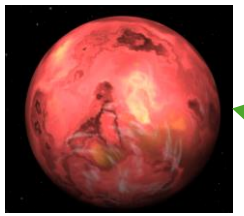


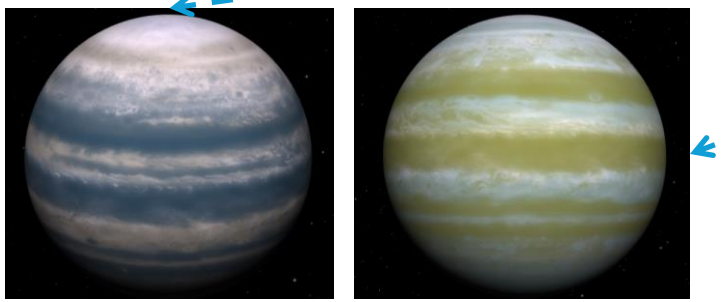
Classificatie: Super Aardes

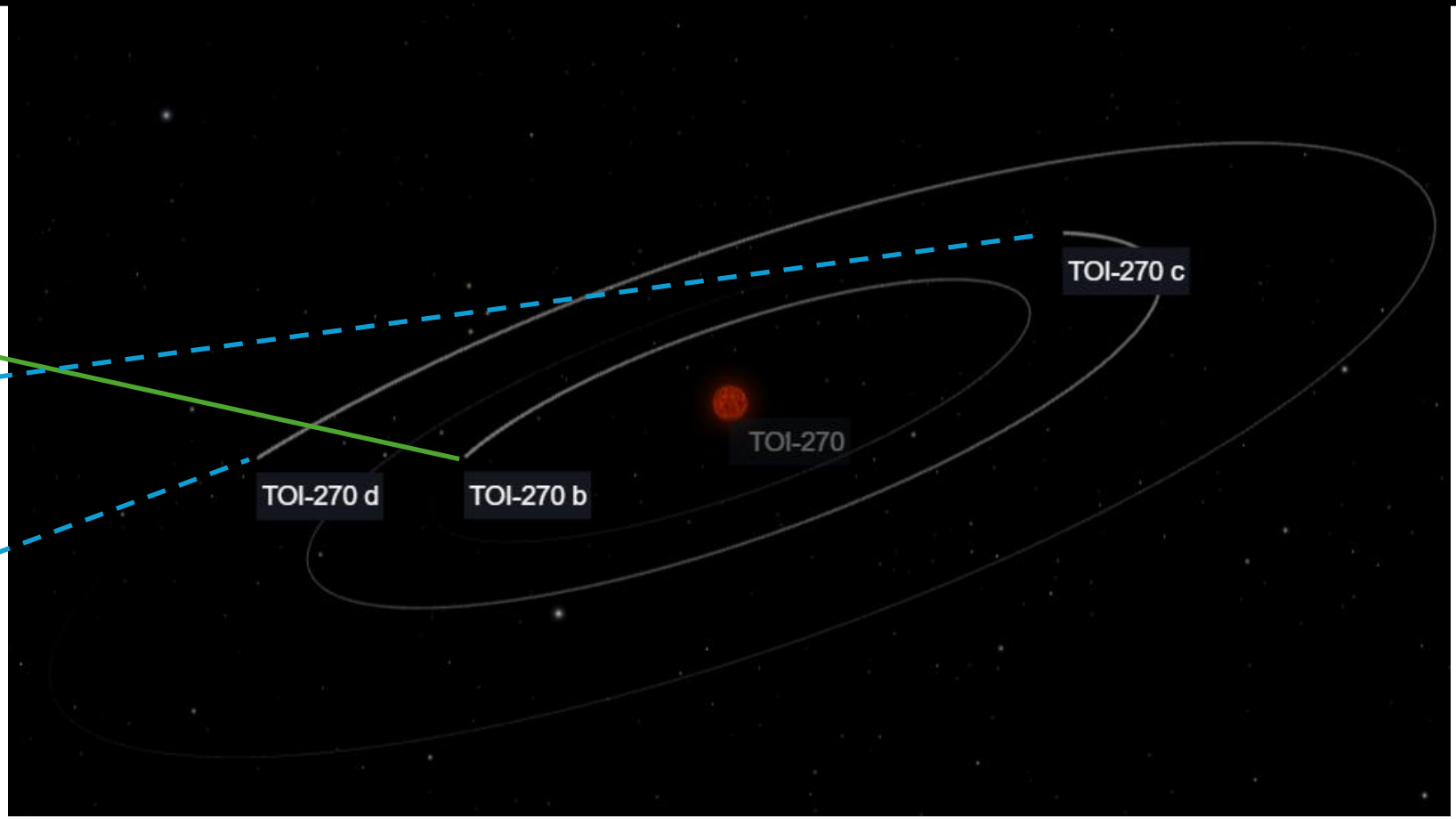
- ‘Mini-Neptunussen’
- Aarde < grootte < Neptunus
- Zeer variërende samenstelling: gas, gesteente of combinatie

Classificatie: Super Aardes

TOI 270 systeem







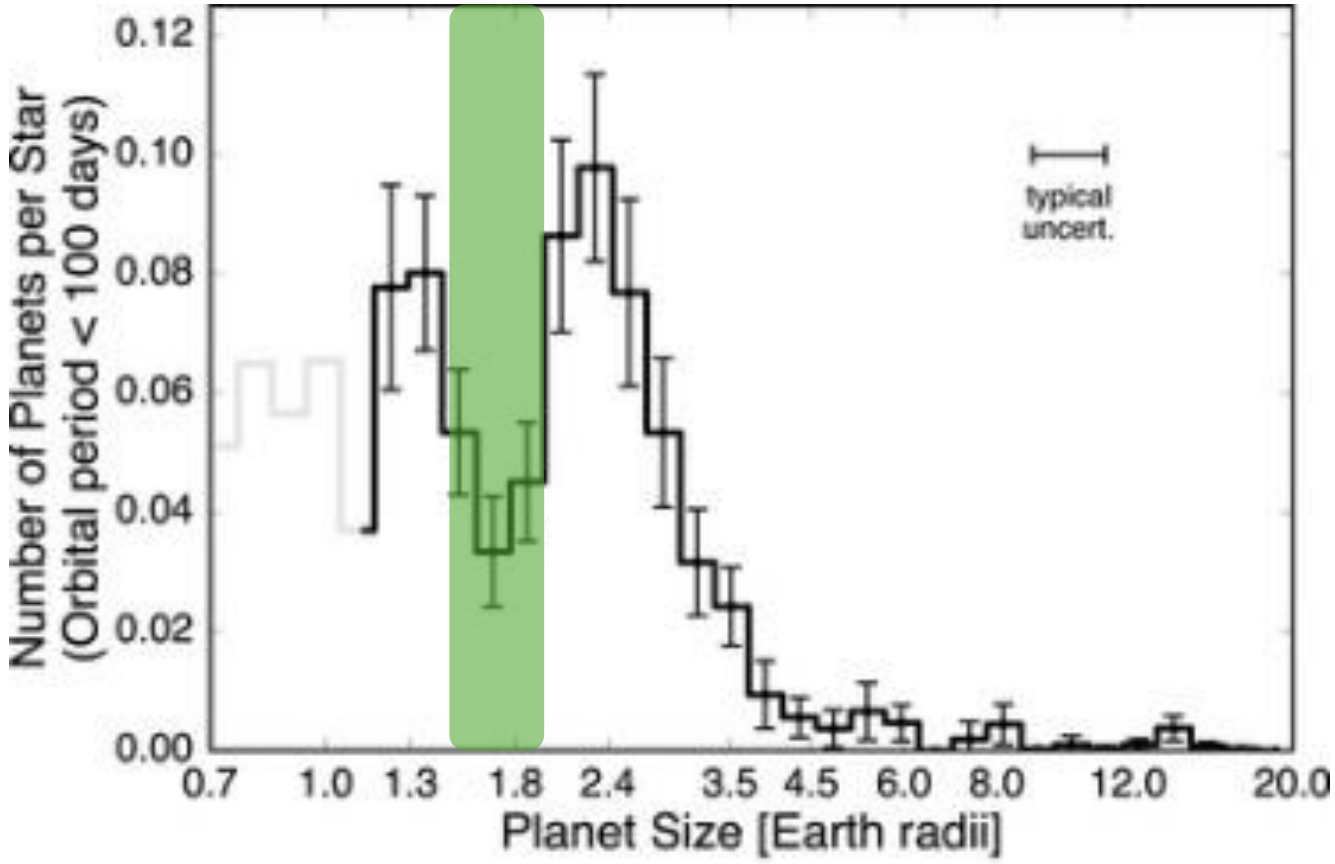
Classificatie: Super Aardes

<u>Fulton gat /</u>

<u>Straal vallei</u>

- 2025 Kepler planeten
- Periode < 100 dagen

- Kritiek interval

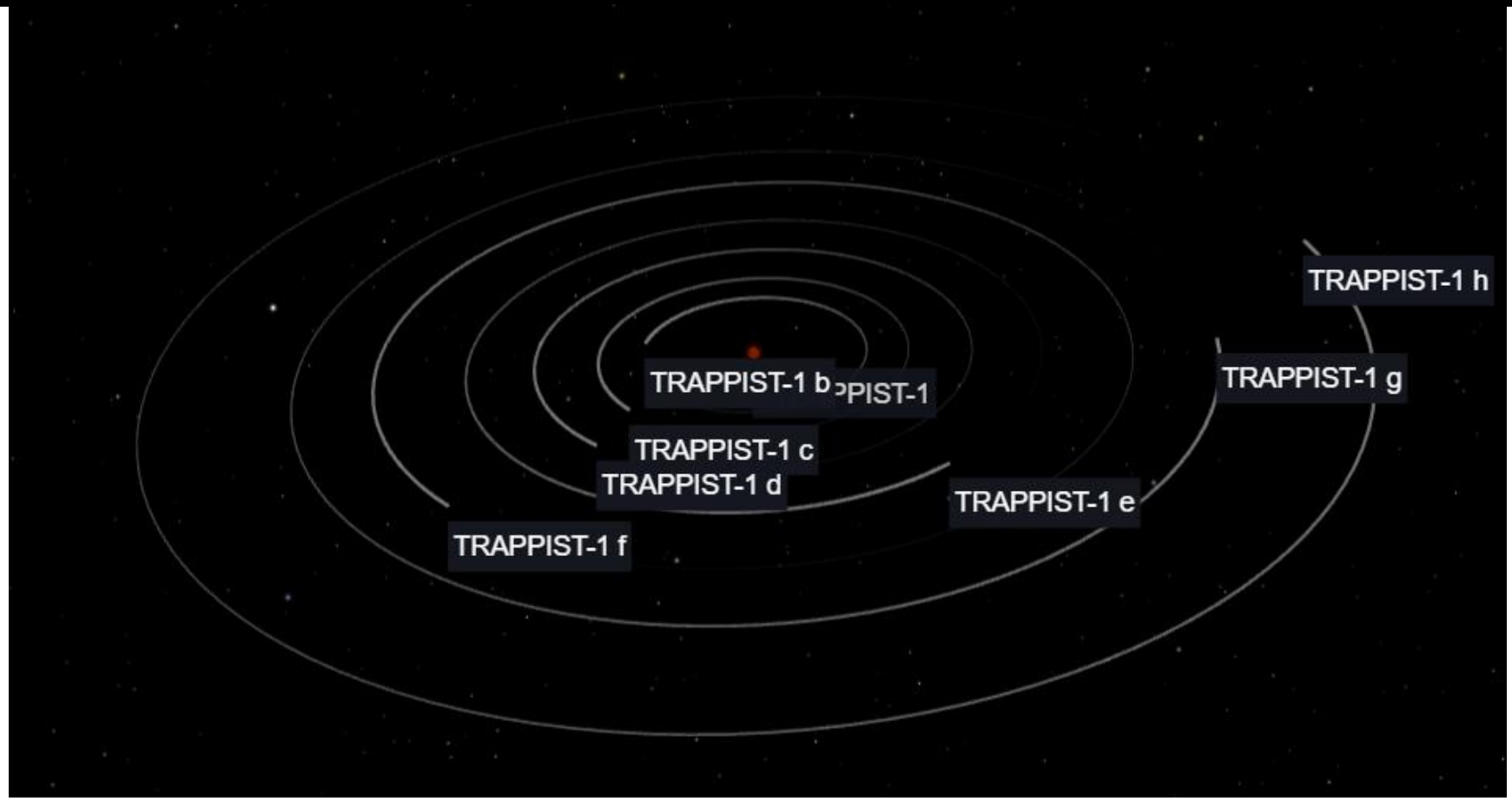


Classificatie: Rotsachtige

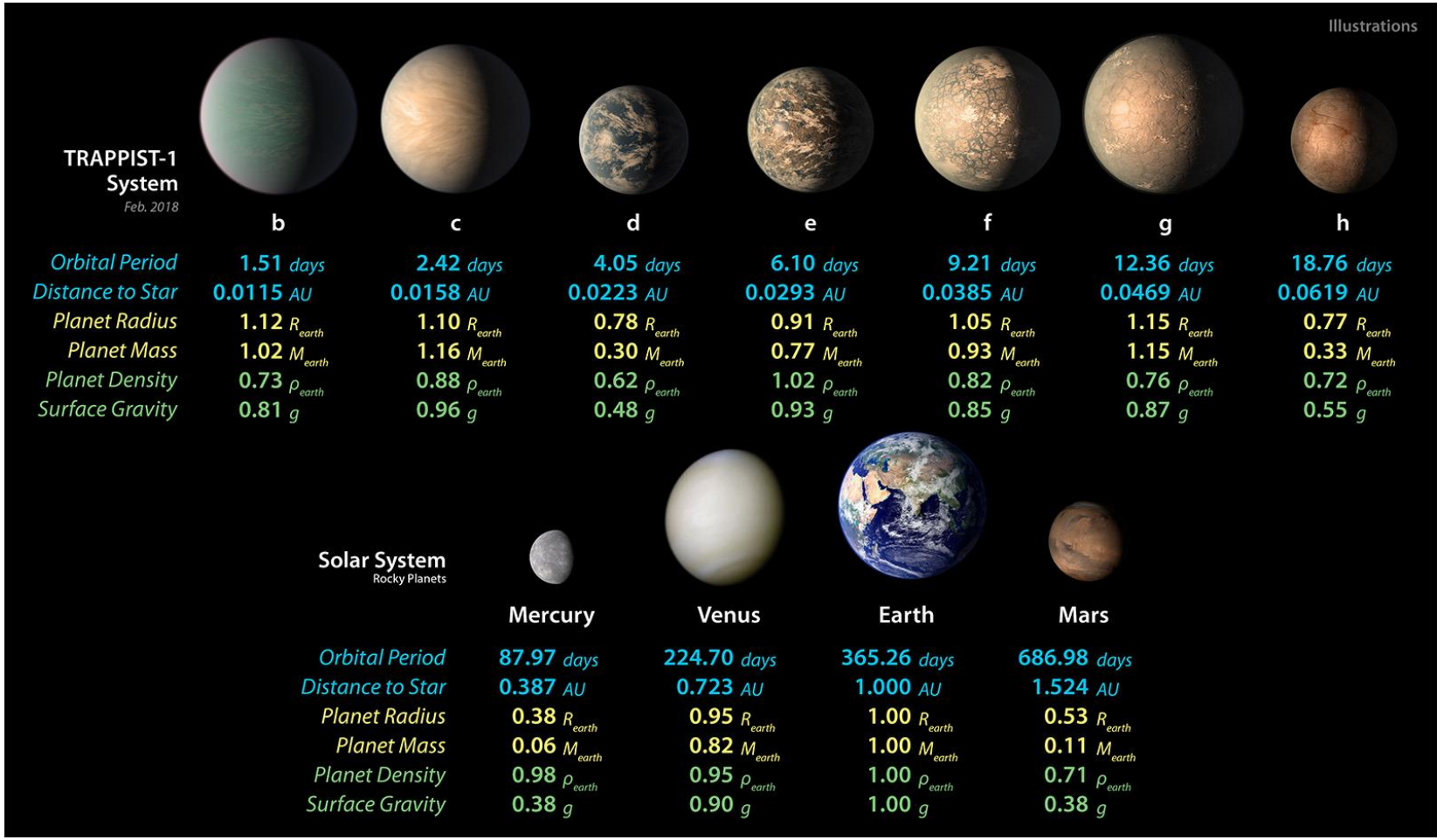
- Samenstelling: gesteente
- Grootte <= Aarde

Classificatie: Rotsachtige

TRAPPIST 1 systeem



Classificatie: Rotsachtige



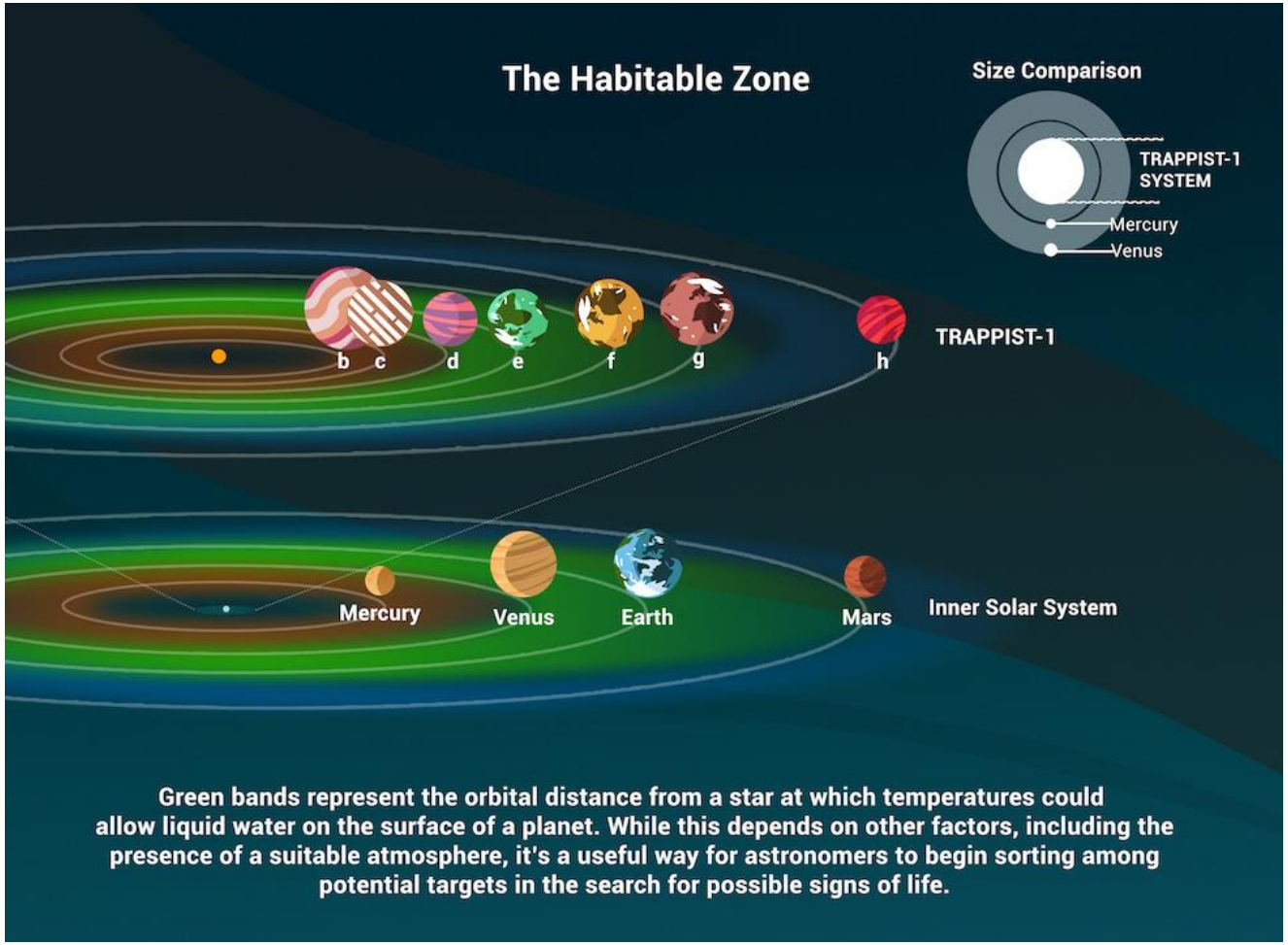
Overzicht

- Definitie en classificatie
  - Gasreuzen
  - Neptunus-achtige
  - Super aardes
  - Rotsachtige
- **Zoektocht**
  - **Naar leven**
  - **De tools**
- Vervoer

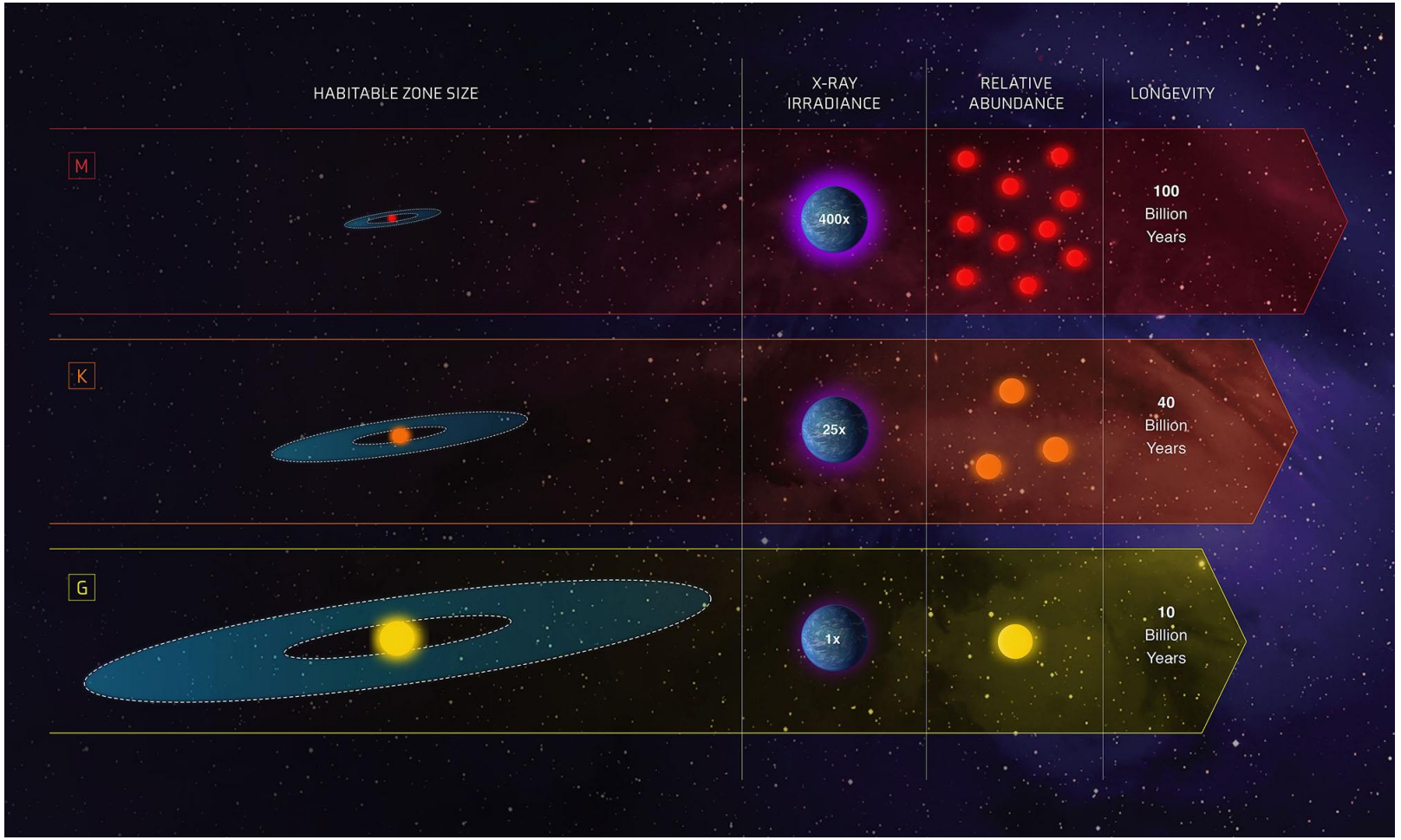
Zoektocht: leven

<u>Goudlokjeszone</u>

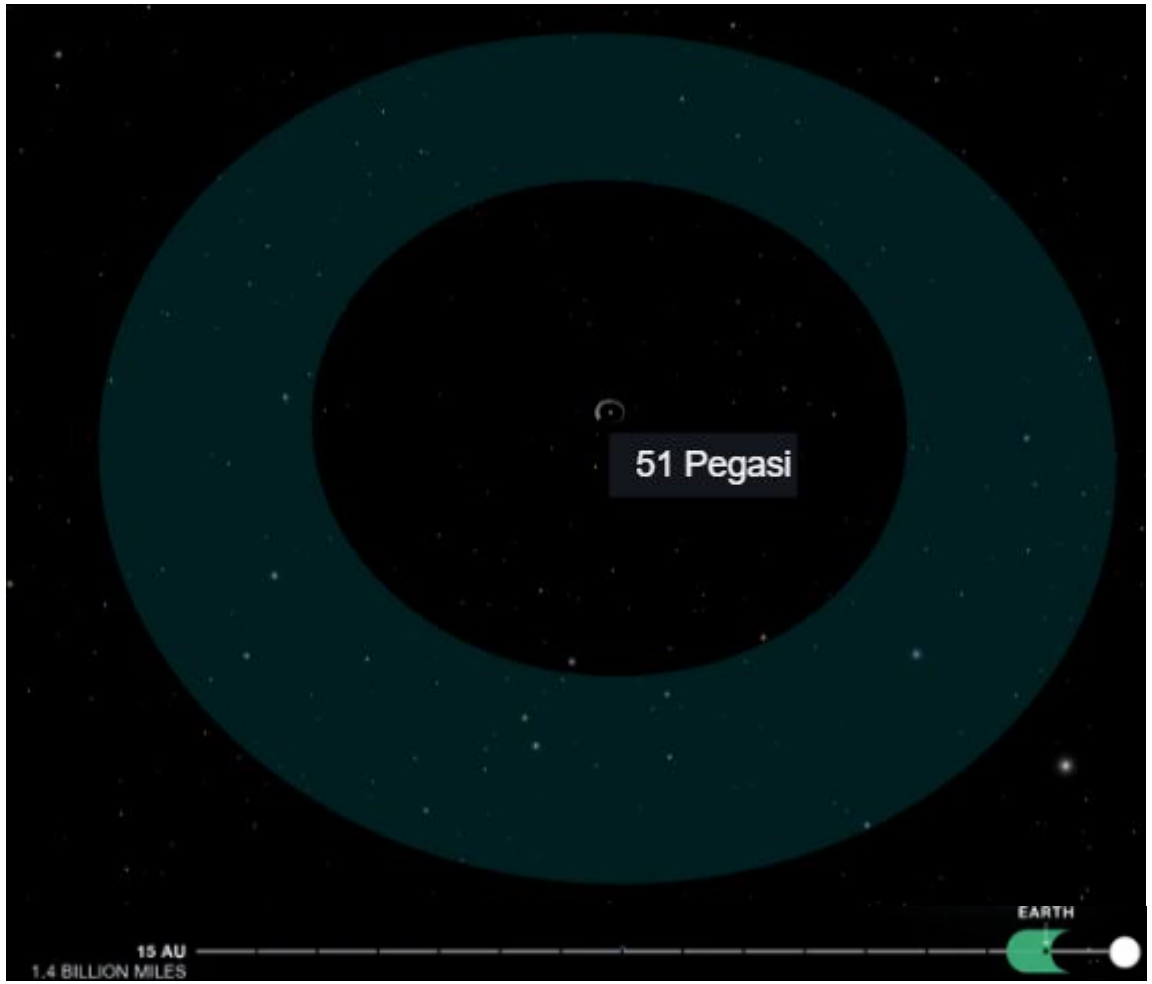
= zone rond ster waar de temperaturen het toelaten om vloeibaar water te hebben.

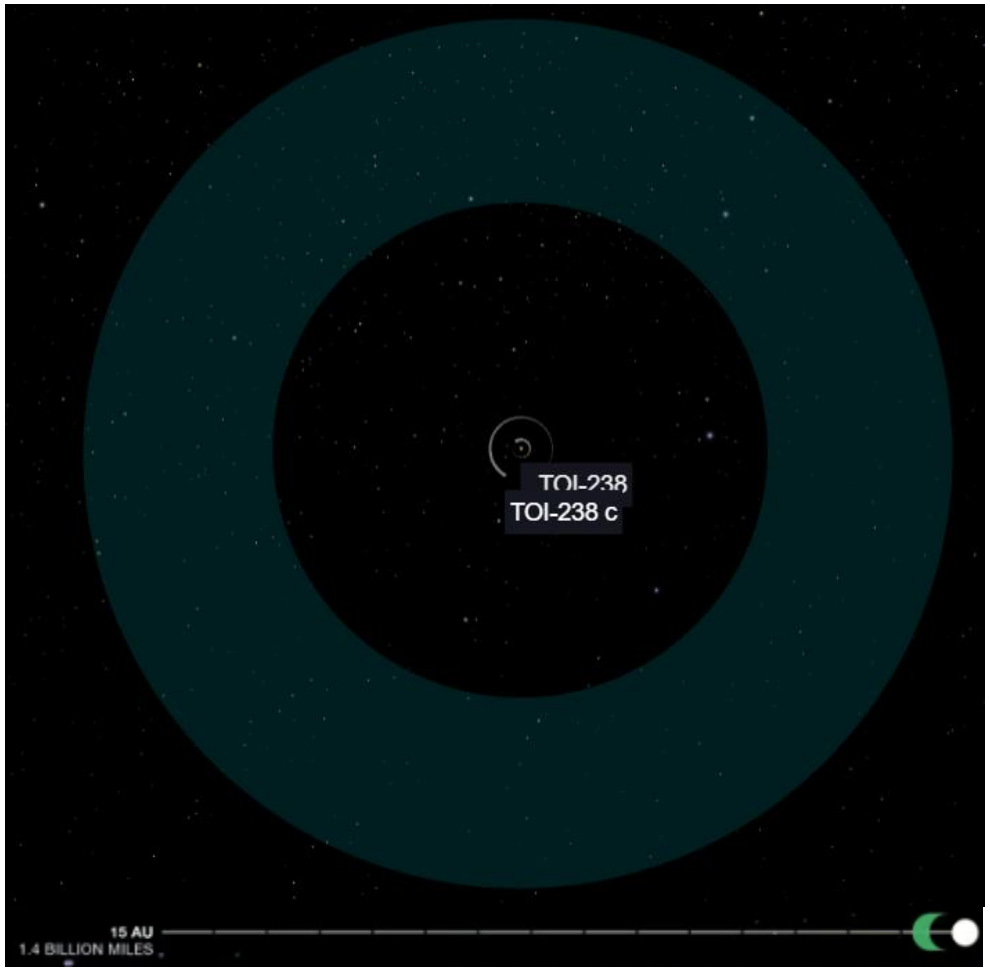


Zoektocht: leven

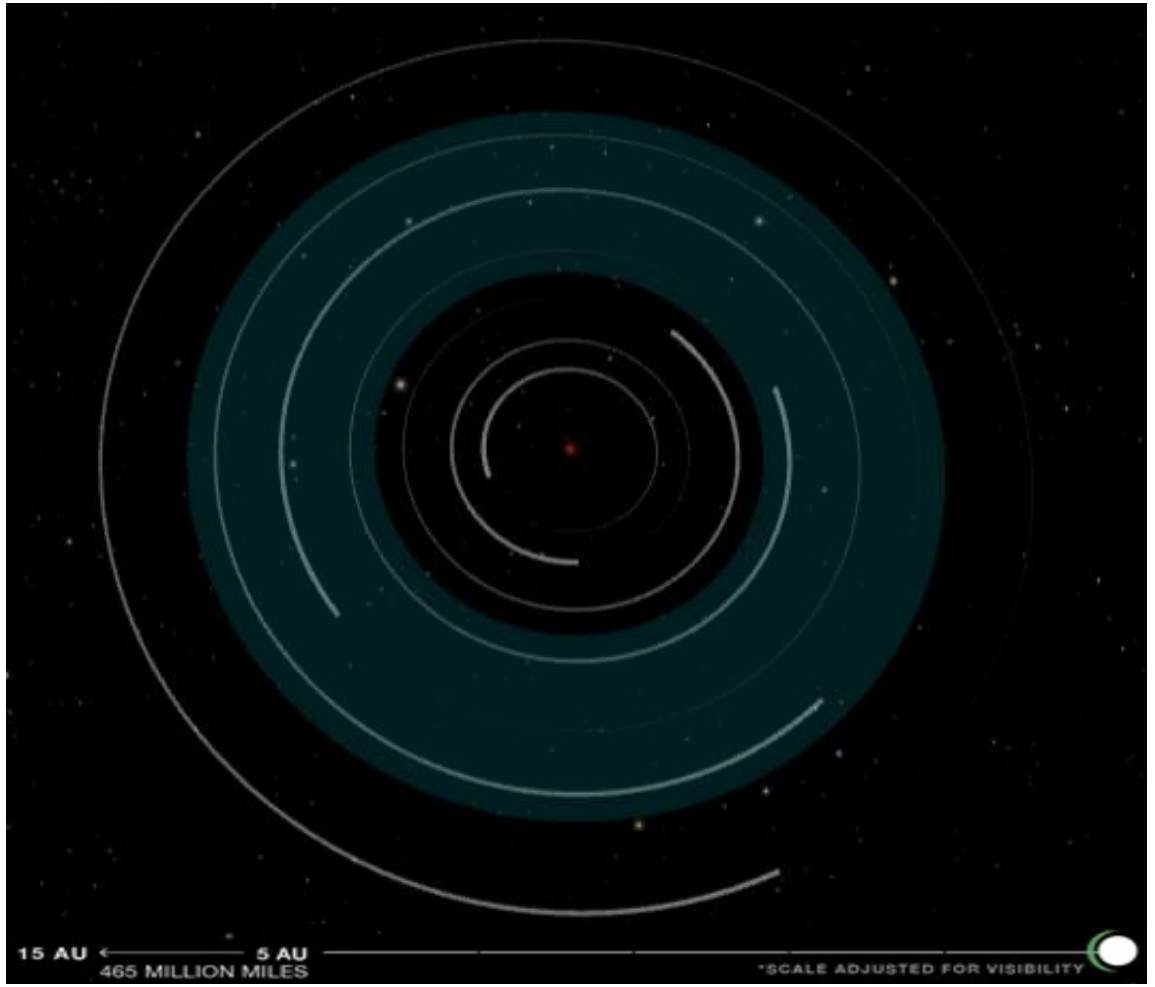


Zoektocht: leven



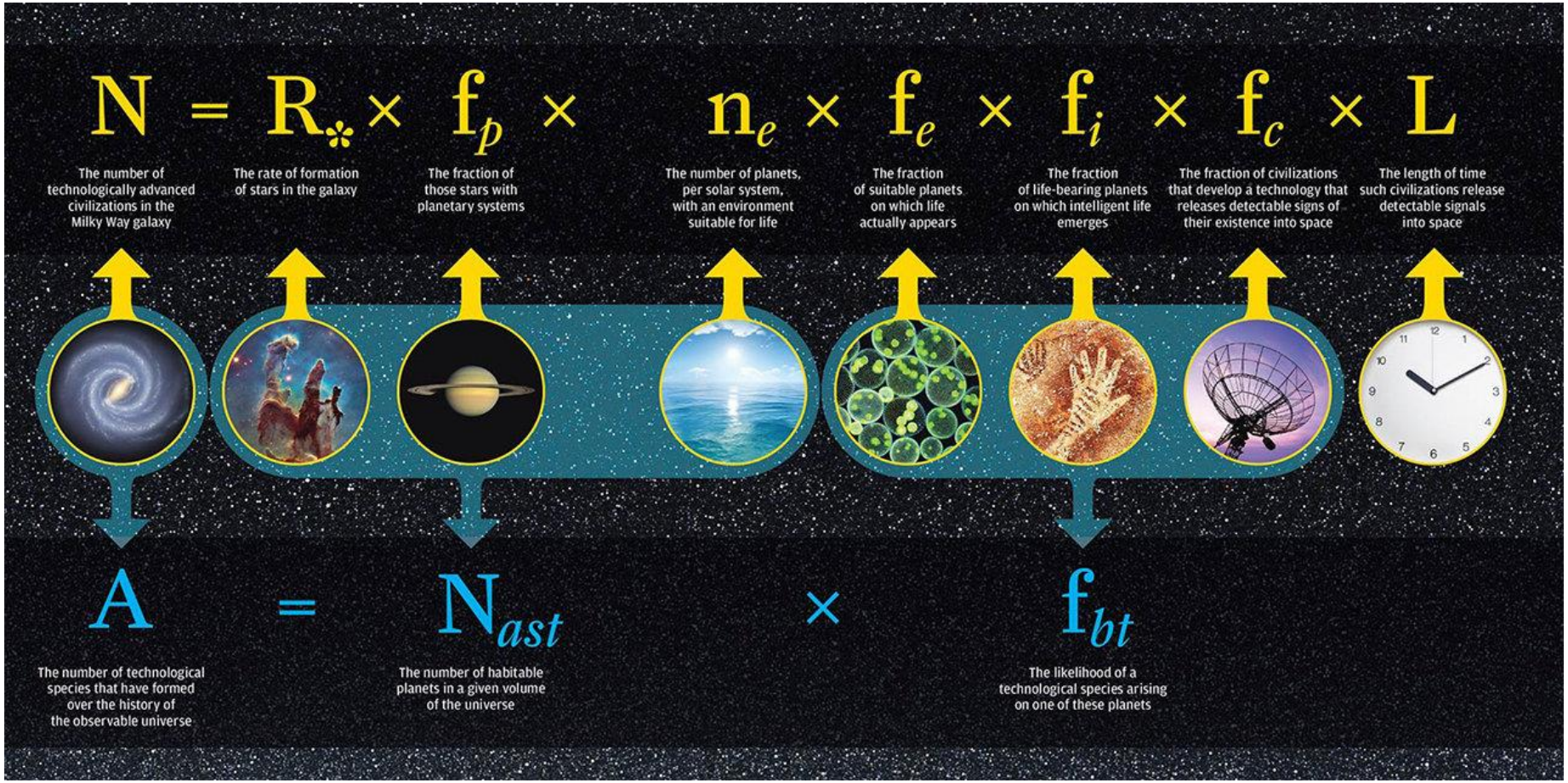


Zoektocht: leven



Zoektocht: leven

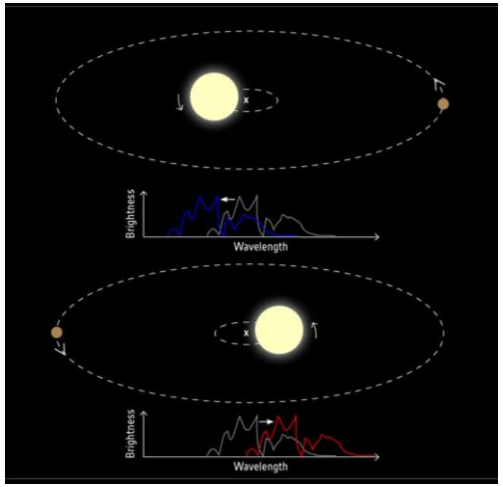
Drake vergelijking, 1961

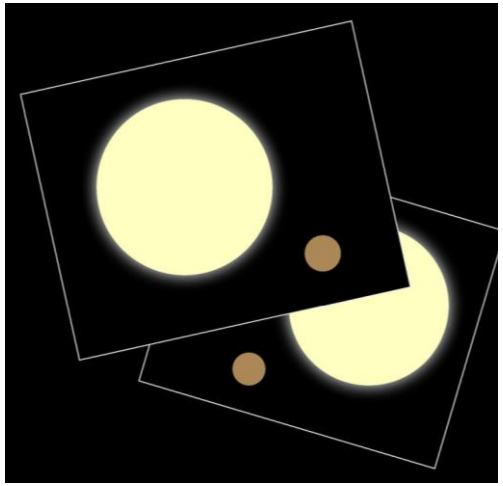


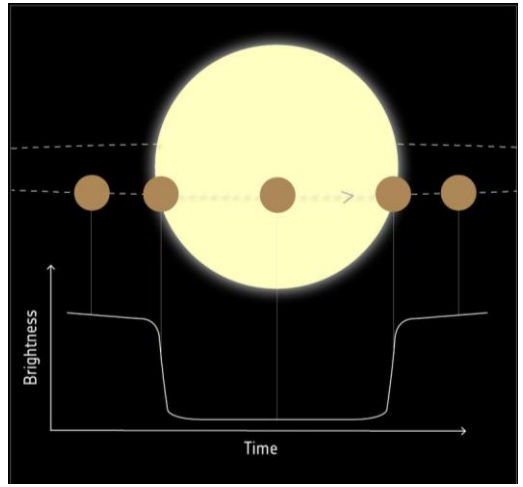
https://www.youtube.com/watch?v=HPQz-kdaxNo

Zoektocht: De tools, technieken

- Radiële snelheidsmethode
  - Wobbeling
  - Doppler
- Transitie methode
  - Dip
- Direct imaging
  - Sterlicht afblokken

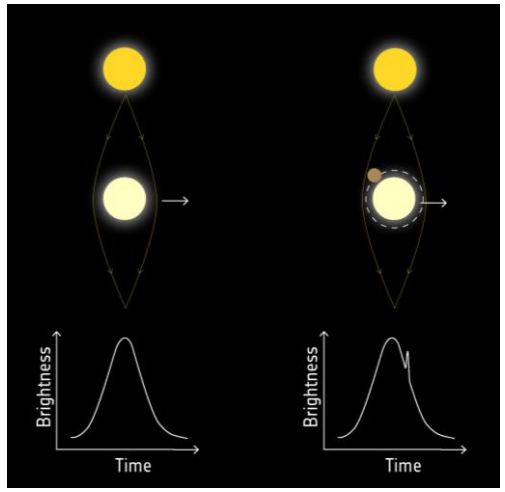




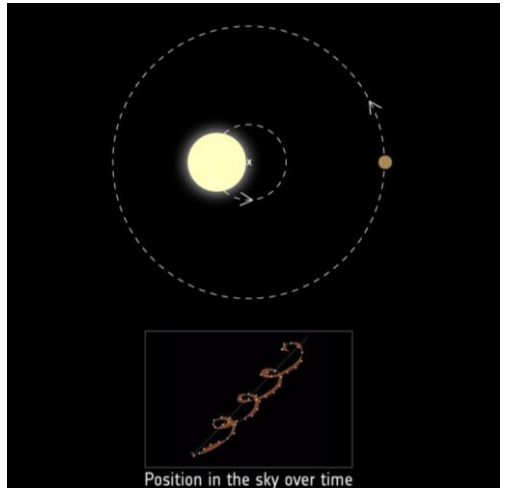


Zoektocht: De tools, technieken

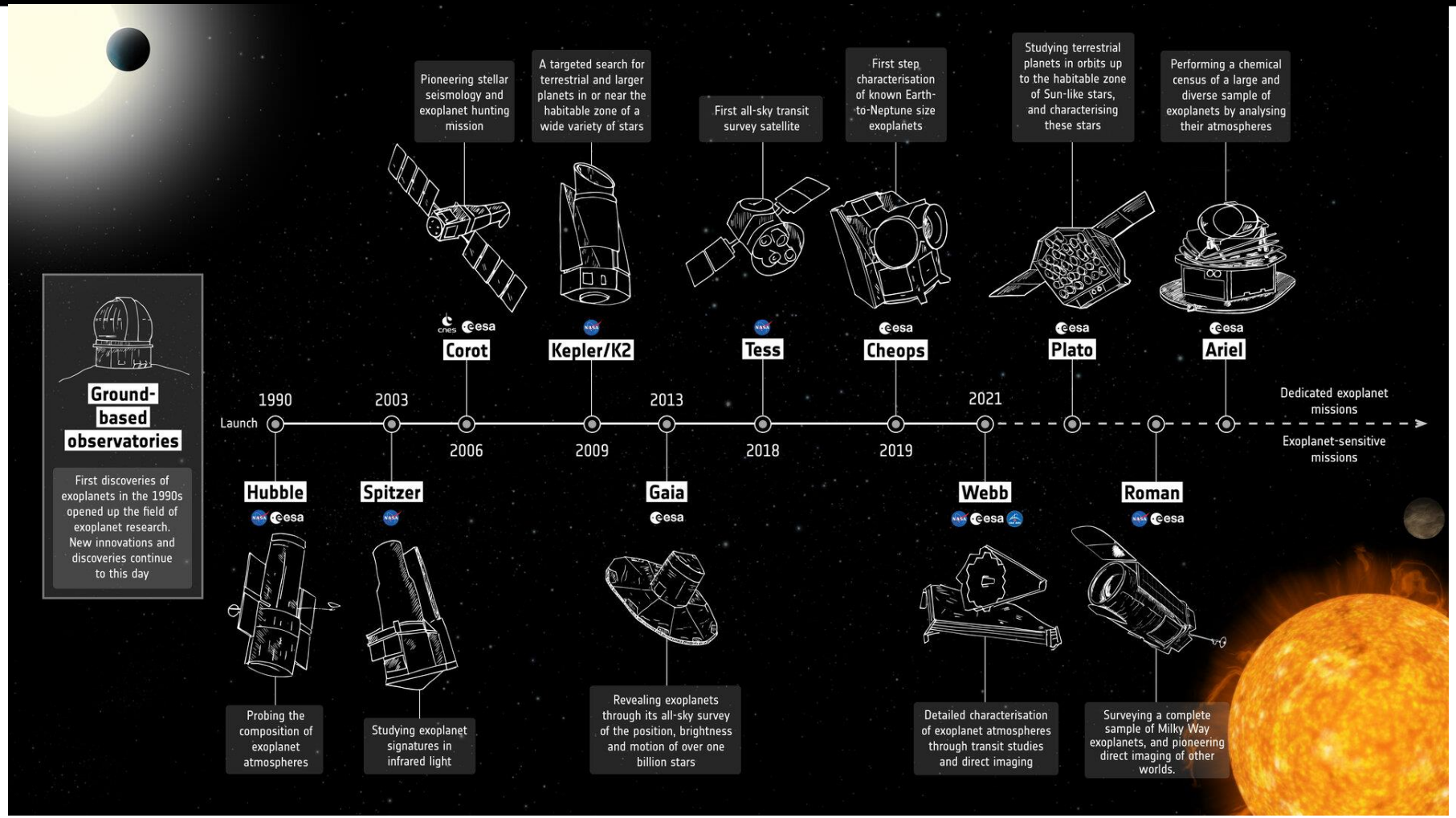
- Gravitationele microlensing
  - Einstein



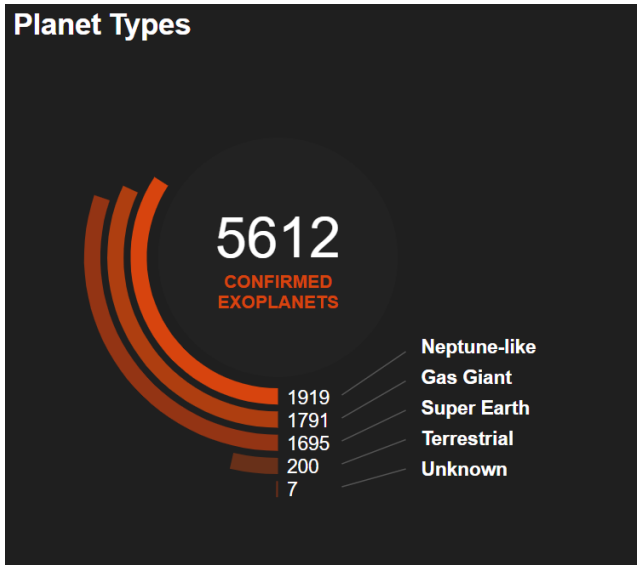
- Astrometrie
  - Wobbeling
  - Beweging

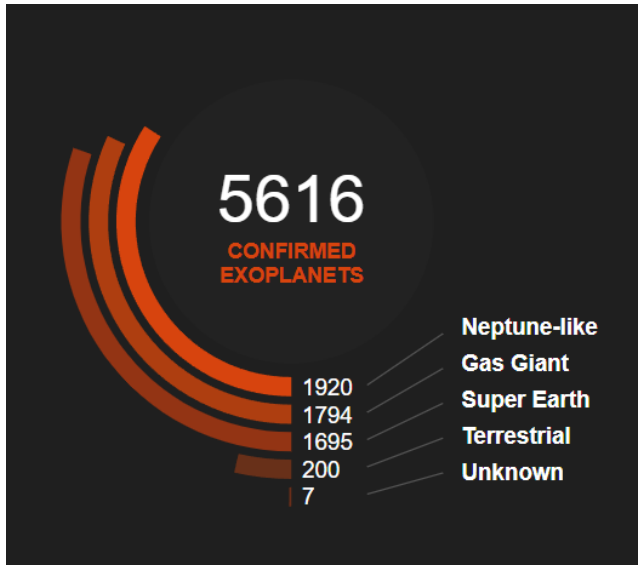


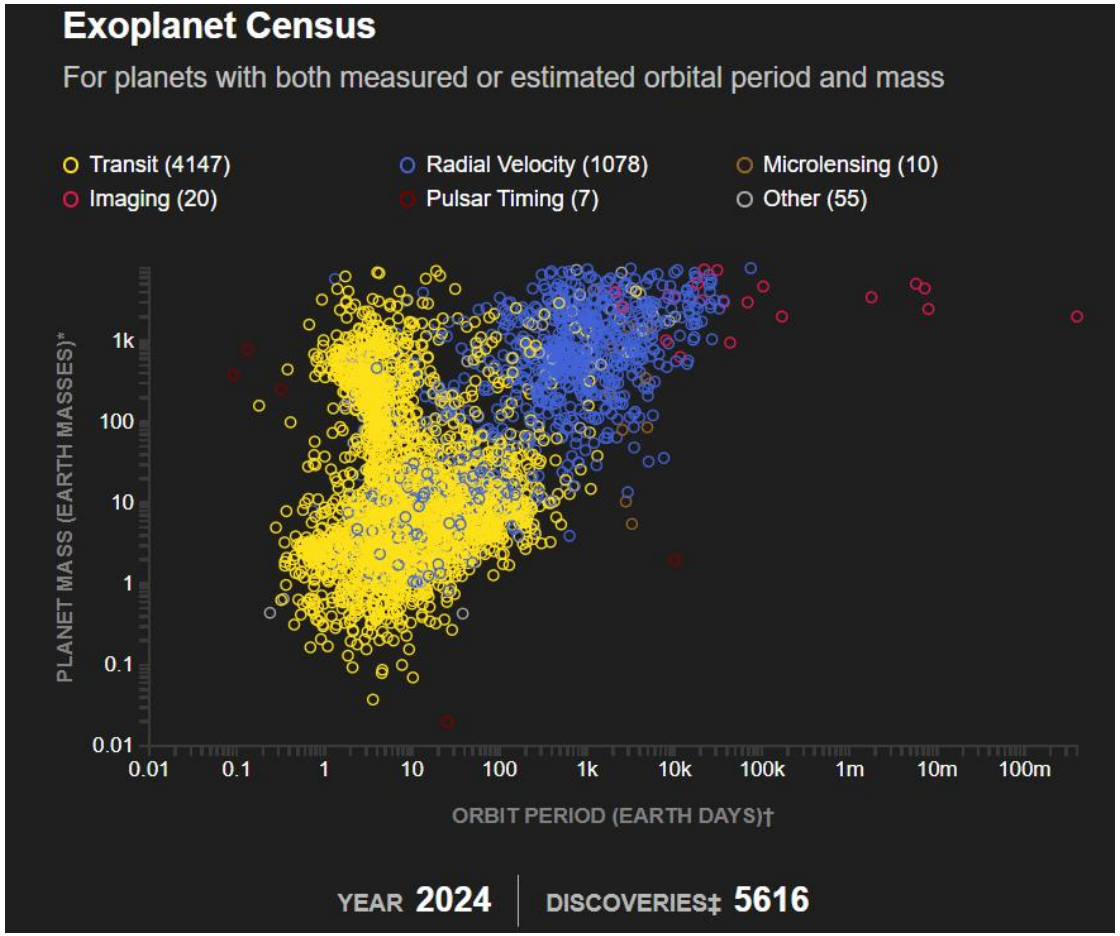
Zoektocht: De tools, telescopen



Zoektocht


Planet Types
5612
CONFIRMED EXOPLANETS
1919
1791
1695
200
7
Neptune-like
Gas Giant
Super Earth
Terrestrial
Unknown

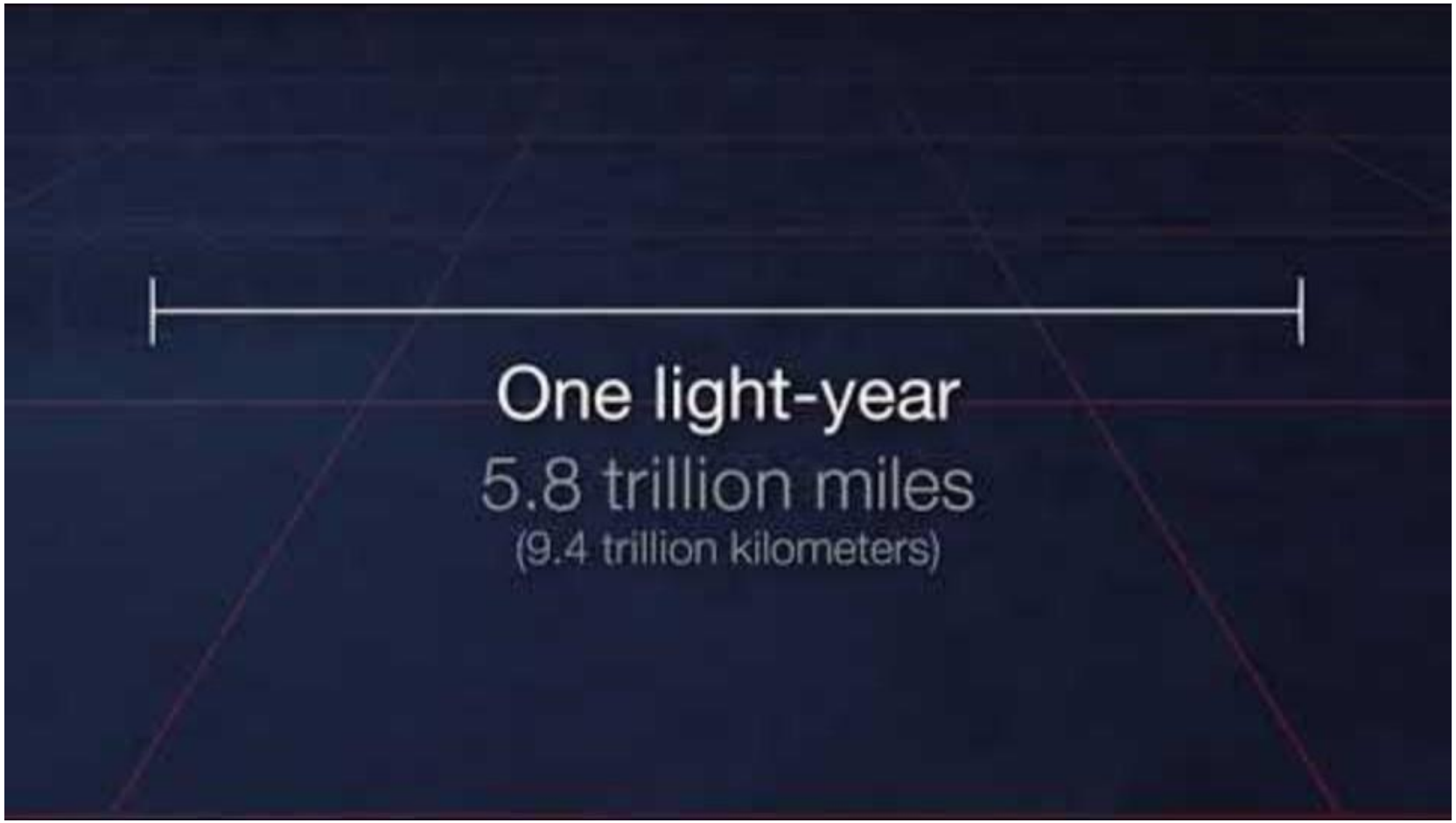

5616
CONFIRMED EXOPLANETS
1920
1794
1695
200
7
Neptune-like
Gas Giant
Super Earth
Terrestrial
Unknown


Exoplanet Census
For planets with both measured or estimated orbital period and mass
Transit (4147)
Radial Velocity (1078)
Microlensing (10)
Imaging (20)
Pulsar Timing (7)
Other (55)
PLANET MASS (EARTH MASSES)*
1k
100
10
1
0.1
0.01
0.01
0.1
1
10
100
1k
10k
100k
1m
10m
100m
ORBIT PERIOD (EARTH DAYS)†
YEAR 2024
DISCOVERIES‡ 5616

Overzicht

- Definitie en classificatie
  - Gasreuzen
  - Neptunus-achtige
  - Super aardes
  - Rotsachtige
- Zoektocht
  - Naar leven
  - De tools
- **Vervoer**

Vervoer



Vervoer: Hoe snel gaan we nu?

- Om aan de zon te ontsnappen

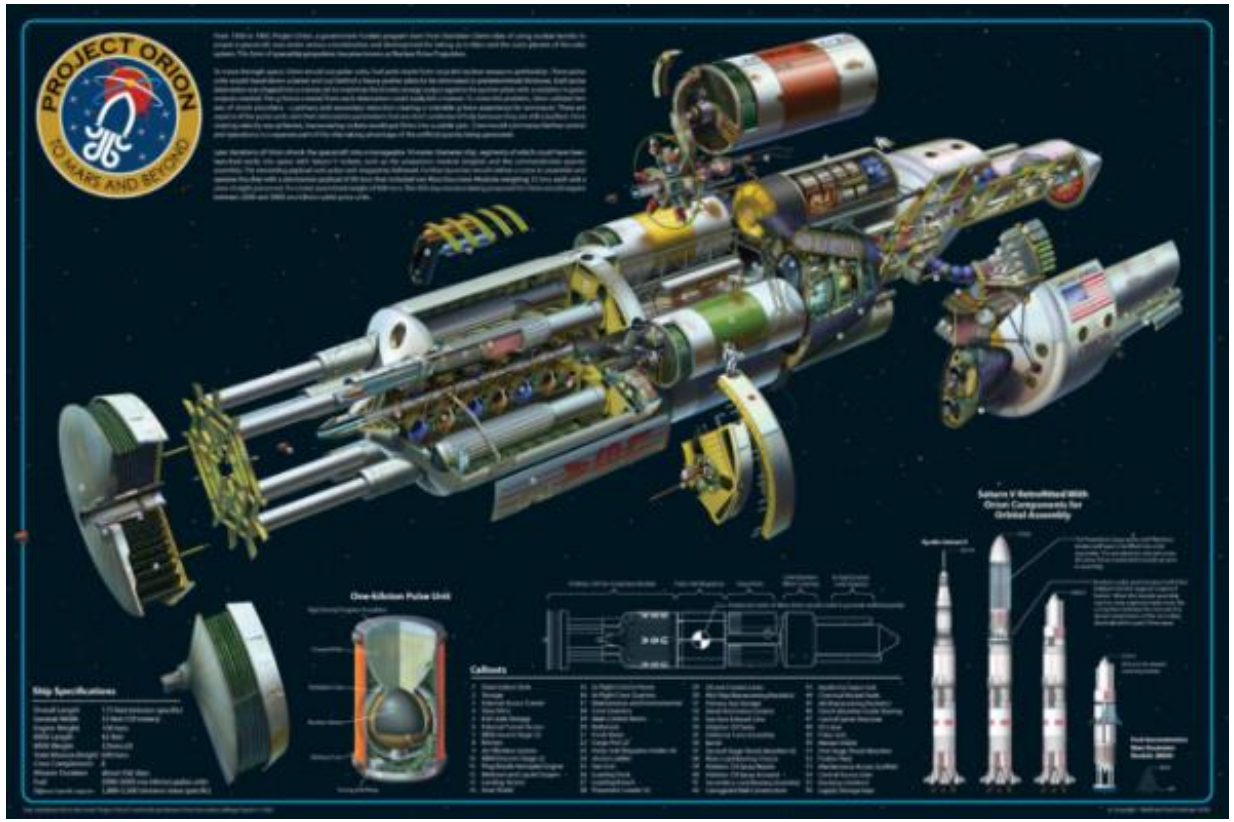
$$v_e = \sqrt{\frac{2GM_{sun}}{r}}$$

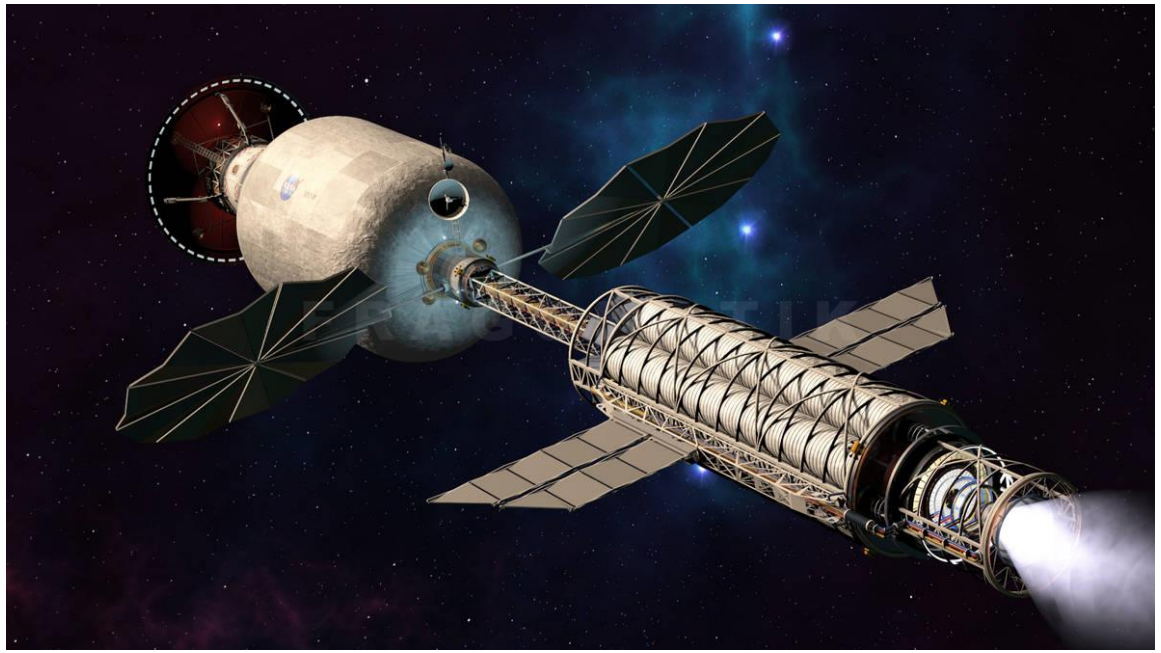
  - 42,1 km/s → 1,4% c

- Naar Proxima centauri b: 29 902 jaar
- Voor binnen mensen leven: 5,2% c halen

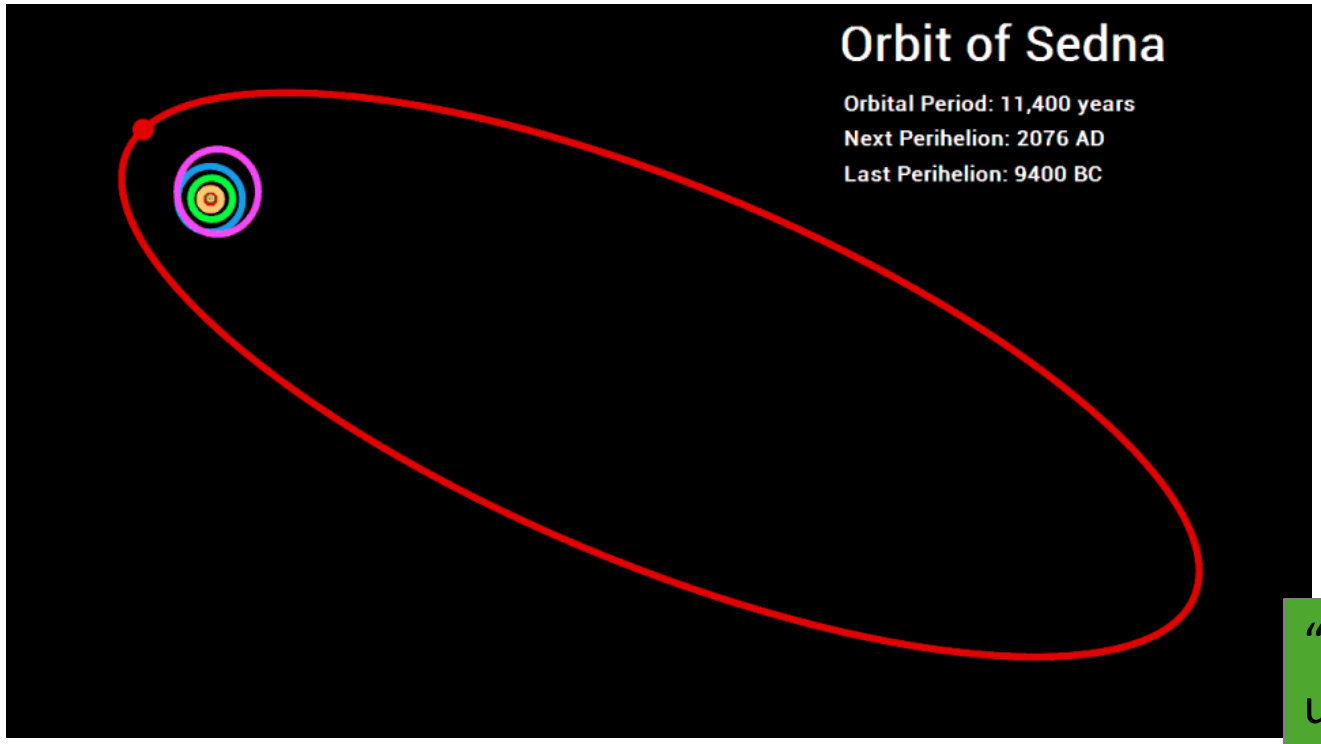
- Haalbaar ??

Vervoer: Hoe meer snelheid halen?



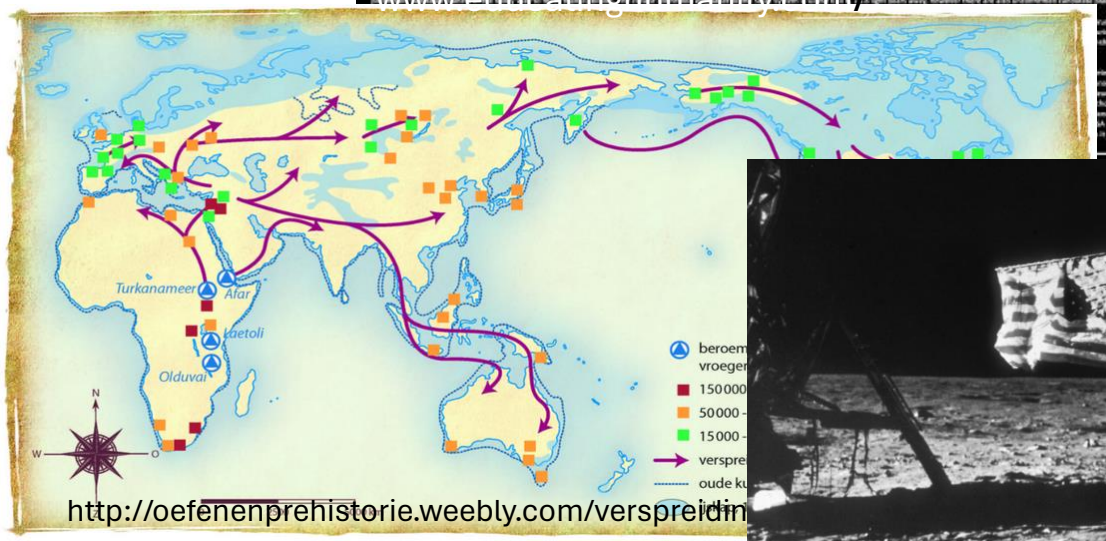


Vervoer: Andere mogelijkheden



"I propose that extraterrestrial civilizations may use free-floating planets as interstellar transportation to reach, explore and colonize planetary systems," Romanovskaya

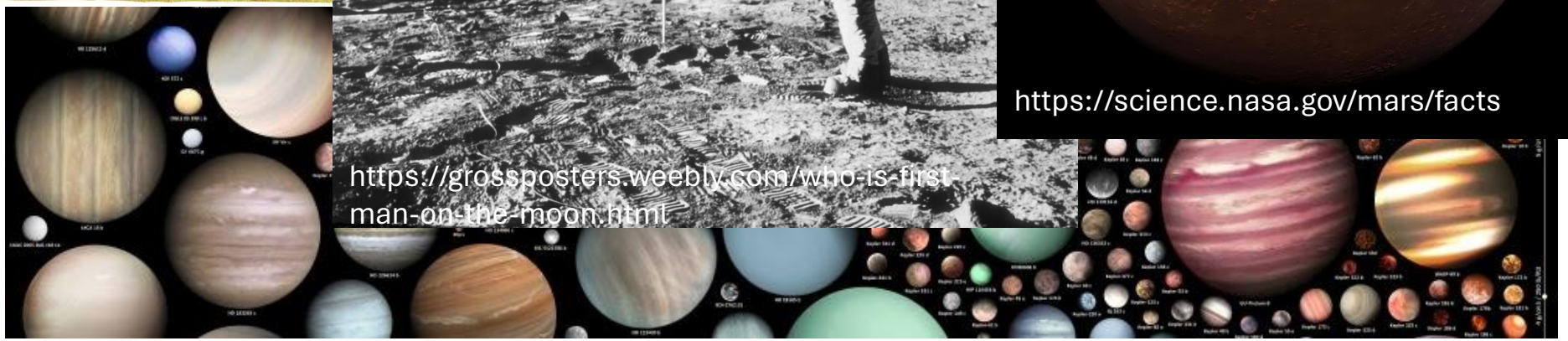
Dé vraag: waarom?



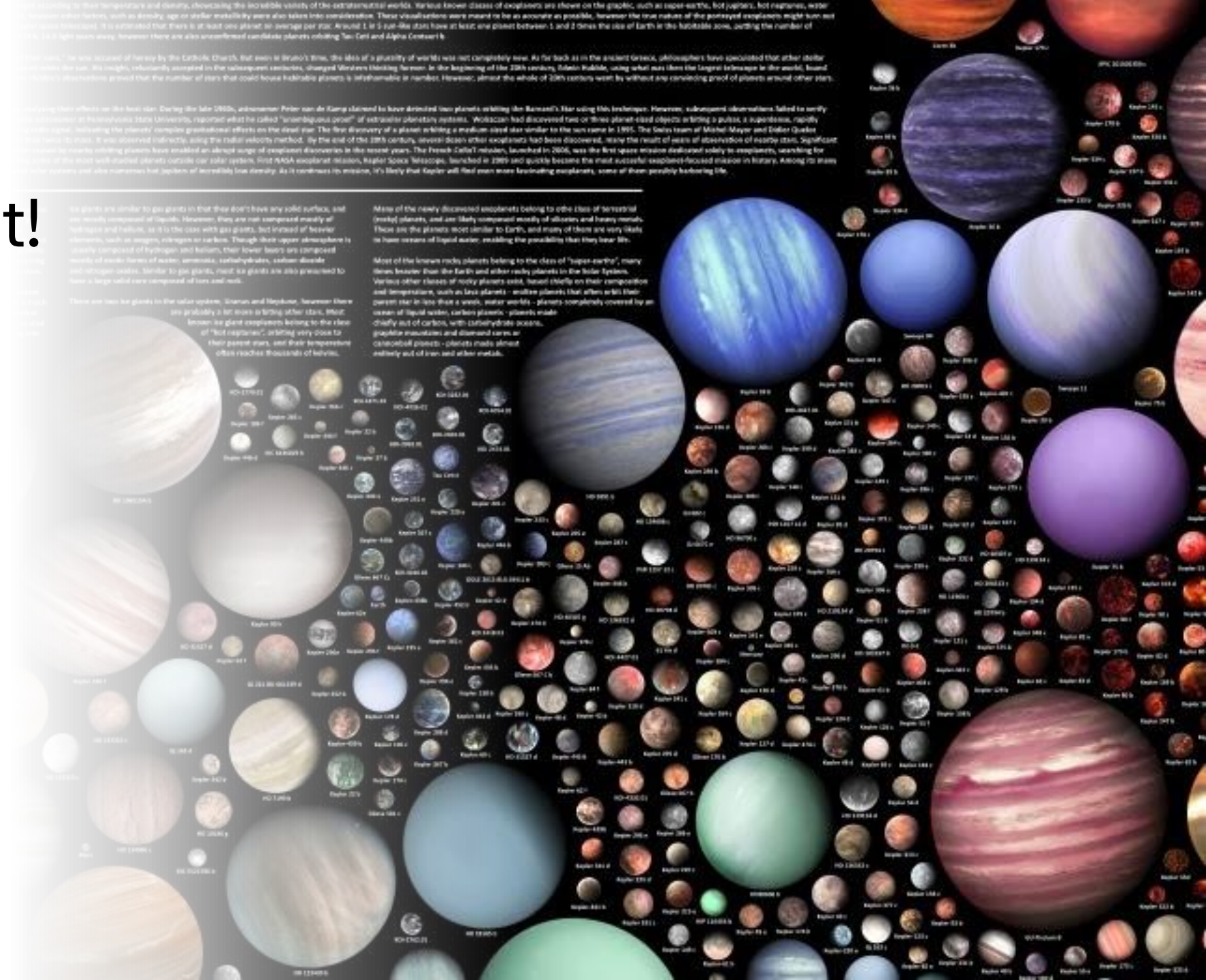
http://oefenenprehistorie.weebly.com/verspreidin

https://grossposters.weebly.com/who-is-first-man-on-the-moon.html

https://science.nasa.gov/mars/facts



Bedankt voor jullie aandacht!



Bronnen

- https://www.esa.int/Science_Exploration/Space_Science/Exoplanets
- https://www.leidensciencemagazine.nl/articles/exoplanets-here-we-come
- https://toughsf.blogspot.com/2021/01/moto-orion-mechanized-nuclear-pulse.html
- https://www.nationalgeographic.nl/ruimte/2020/07/exoplaneten-meer-planeten-dan-sterren-in-de-melkweg
- https://exoplanets.nasa.gov
- Fulton, B. J., Petigura, E. A., Howard, A. W., Isaacson, H., Marcy, G. W., Cargile, P. A., Hebb, L., Weiss, L. M., Johnson, J. A., Morton, T., Sinukoff, E., Crossfield, I. J. M., & Hirsch, L. A. (2017). The California-Kepler Survey. III. A gap in the radius distribution of small planets*. The Astronomical Journal, 154(3), 109. https://doi.org/10.3847/1538-3881/aa80eb
- Schmidt, G. R., Bonometti, J. A., & Morton, P. J. (2000). NUCLEAR PtrLSE PROPCLSION - ORIO:\f A.’I’D I3EYOND. American Institute of Aero Nautics and as Tronautics. Inc., 2000–3865.