

# Asteroidi in eksoplaneti

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Presekov seminar za matematiko, fiziko in astronomijo

DMFA

2022-23

# Nebularna teorija

- Kant, *Universal Natural History and Theory of the Heavens* (1755), 1796 Pierre Laplace
- veliki molekularni oblaki – vrsta meglic
- protoplanetarni disk
- zvezda glavne veje nastaja 1 Ma, protoplanetarni disk v planetni sistem v 10-100 Ma
- planetezimal, v gostem disku v 0,1 – 0,3 Ma nastanejo planetarni embriji (Mars-Luna), ki se blizu zvezde združujejo v 0,1-1 Ga
- velikani nastanejo za mejo zmrzišča, če so dovolj masivni začnejo privlačiti plin







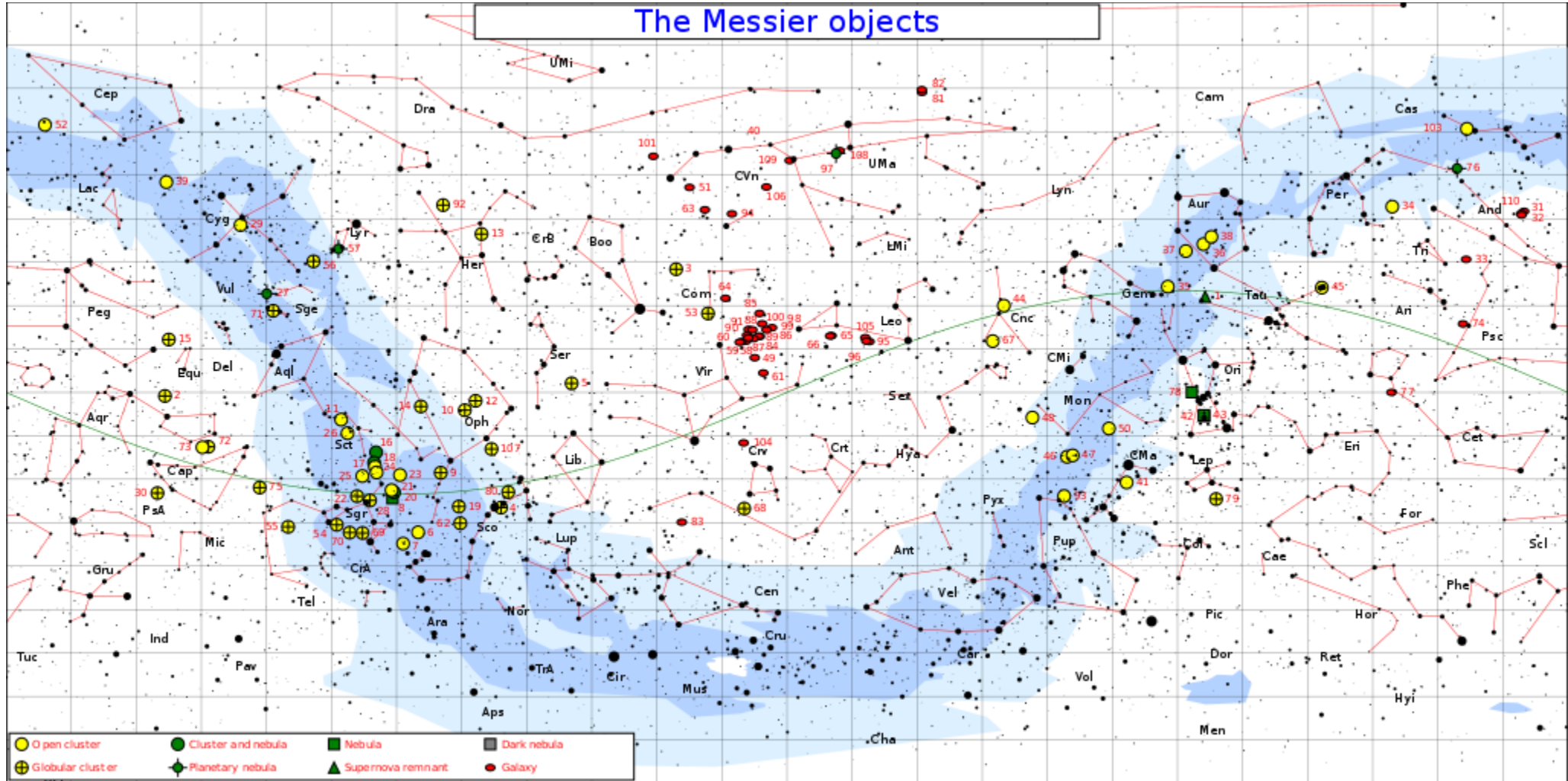


# Messierov katalog

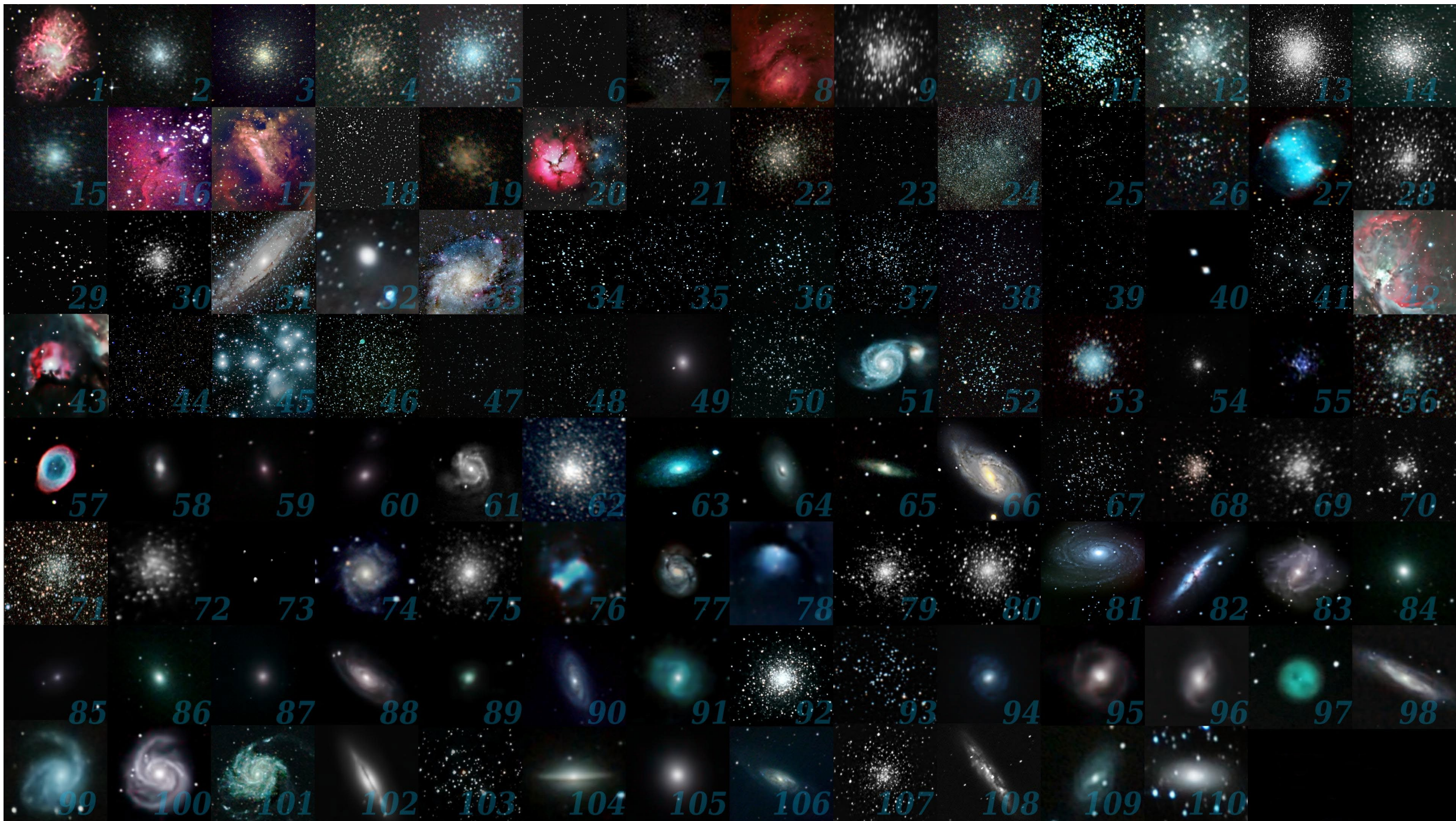
- 110 astronomskih teles,
- francoski astronom Charles Messier
- ~ 1780



# The Messier objects



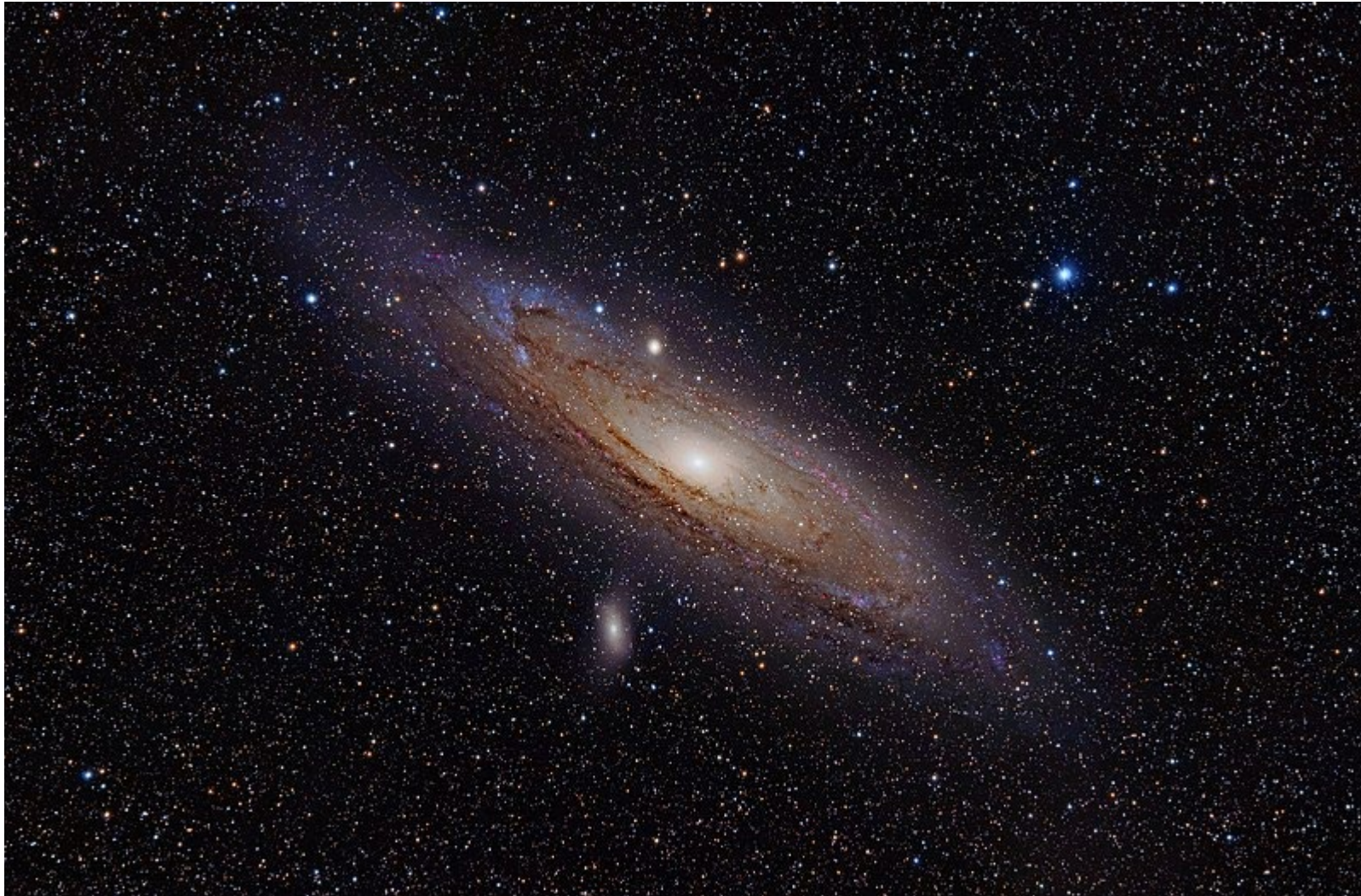




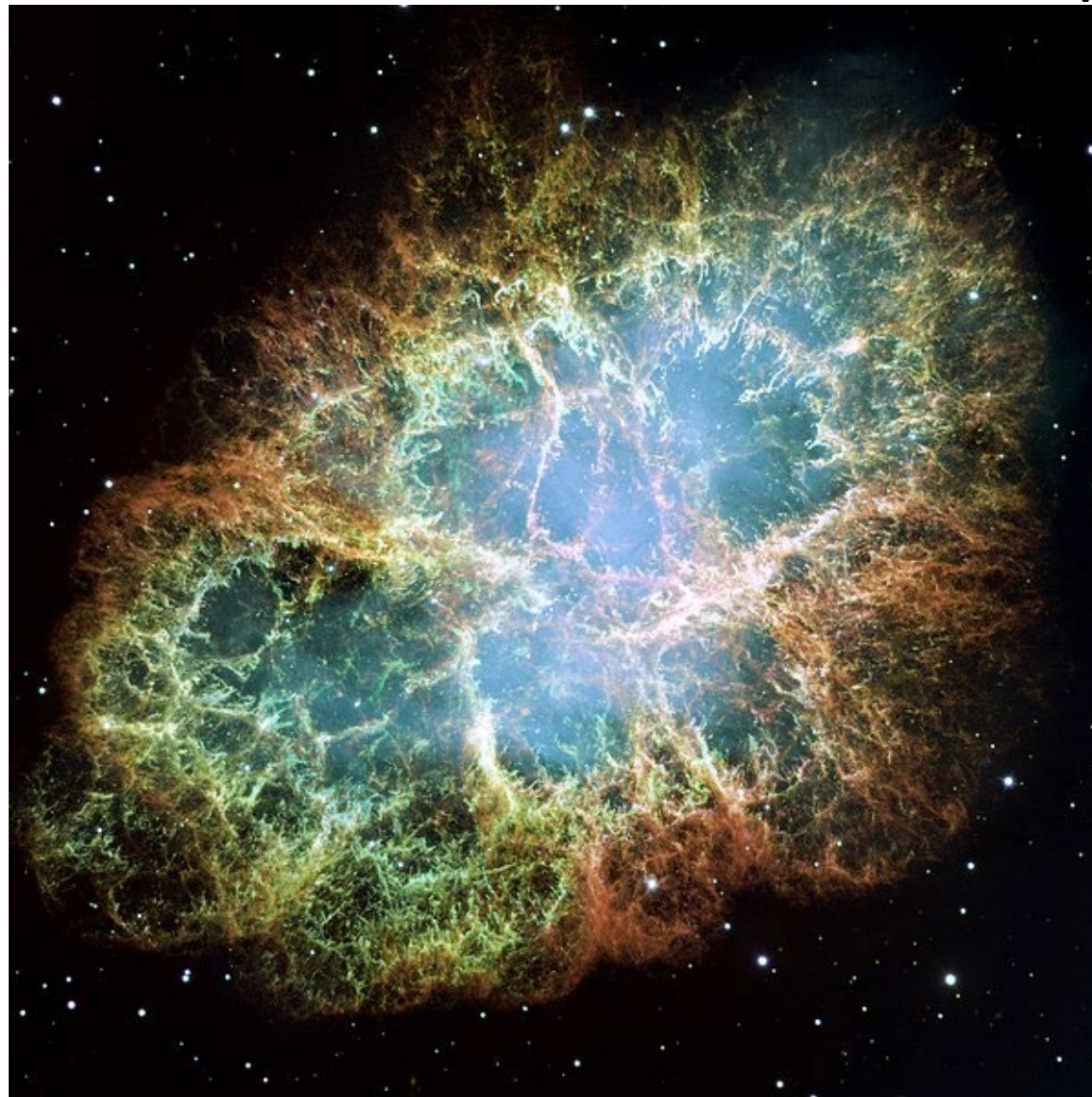
# M45 – Gostosevci, Plejade, odprta zvezdna kopica



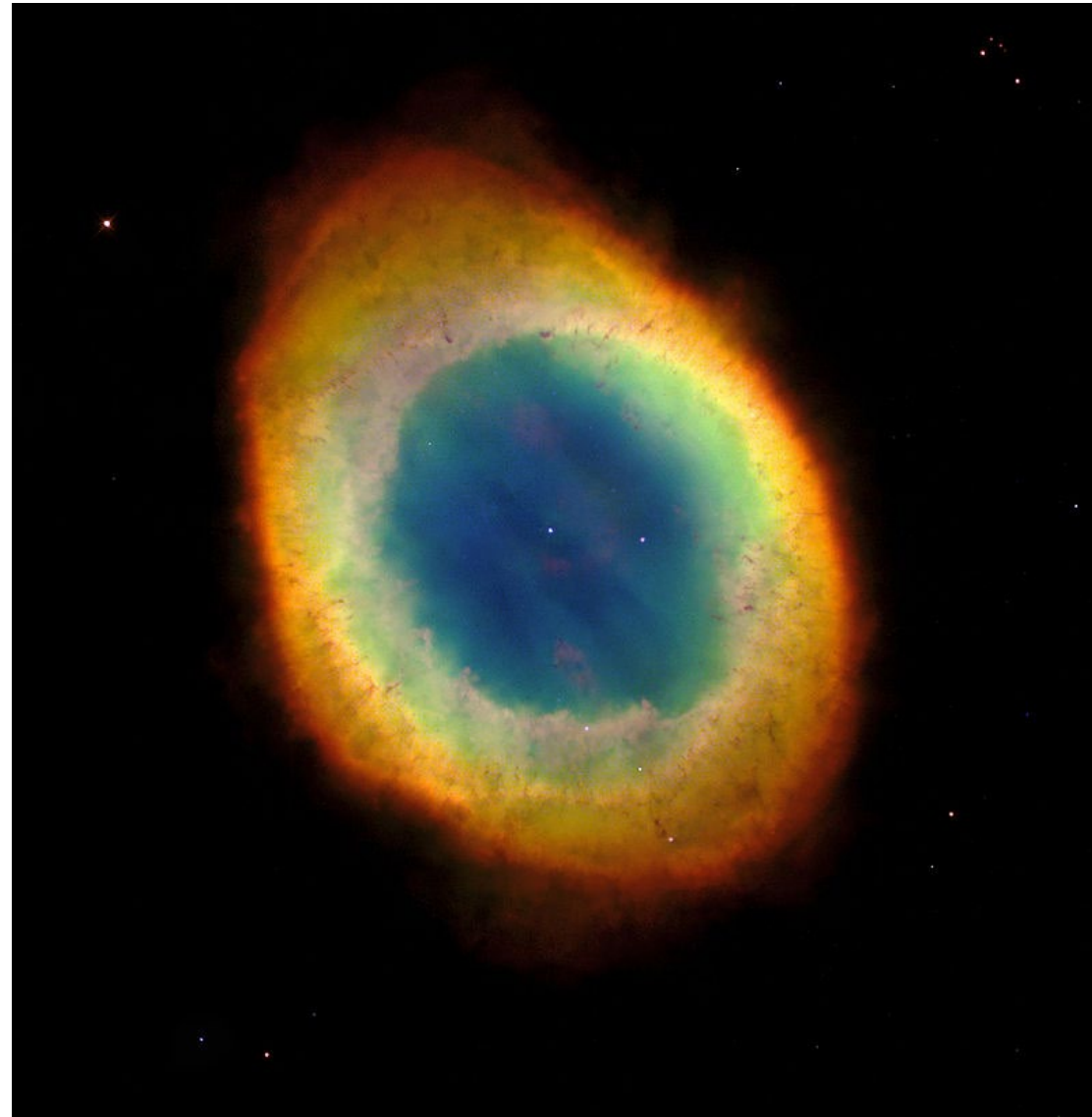
# M31 – Andromeda, spiralna galaksija



M1 – meglica Rakovica, ostanek supernove

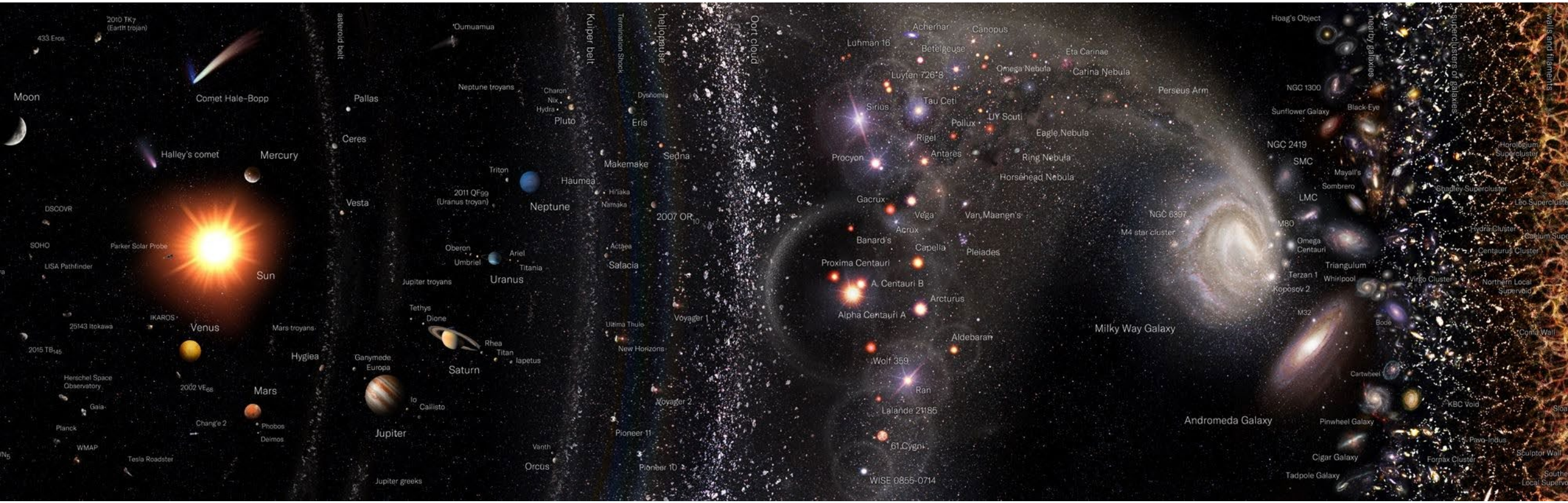


M57 – Obročasta meglica, planetarna meglica



# M42 – Orionova meglica, meglica H II





# Meglica

- medzvezdni oblak prašnih delcev in plinov
- difuzne meglice so osvetljene
  - emisijske meglice so oblaki ioniziranega plina, osvetljeni od znotraj,
  - refleksijske meglice so osvetljene z odbojem svetlobe bližnjih zvezd,
- temne meglice so neosvetljene. Lahko jih zaznamo, ker zakrivajo zvezde ali druge meglice,
- planetarne meglice so okrogle, sestavljene iz ioniziranega plina.



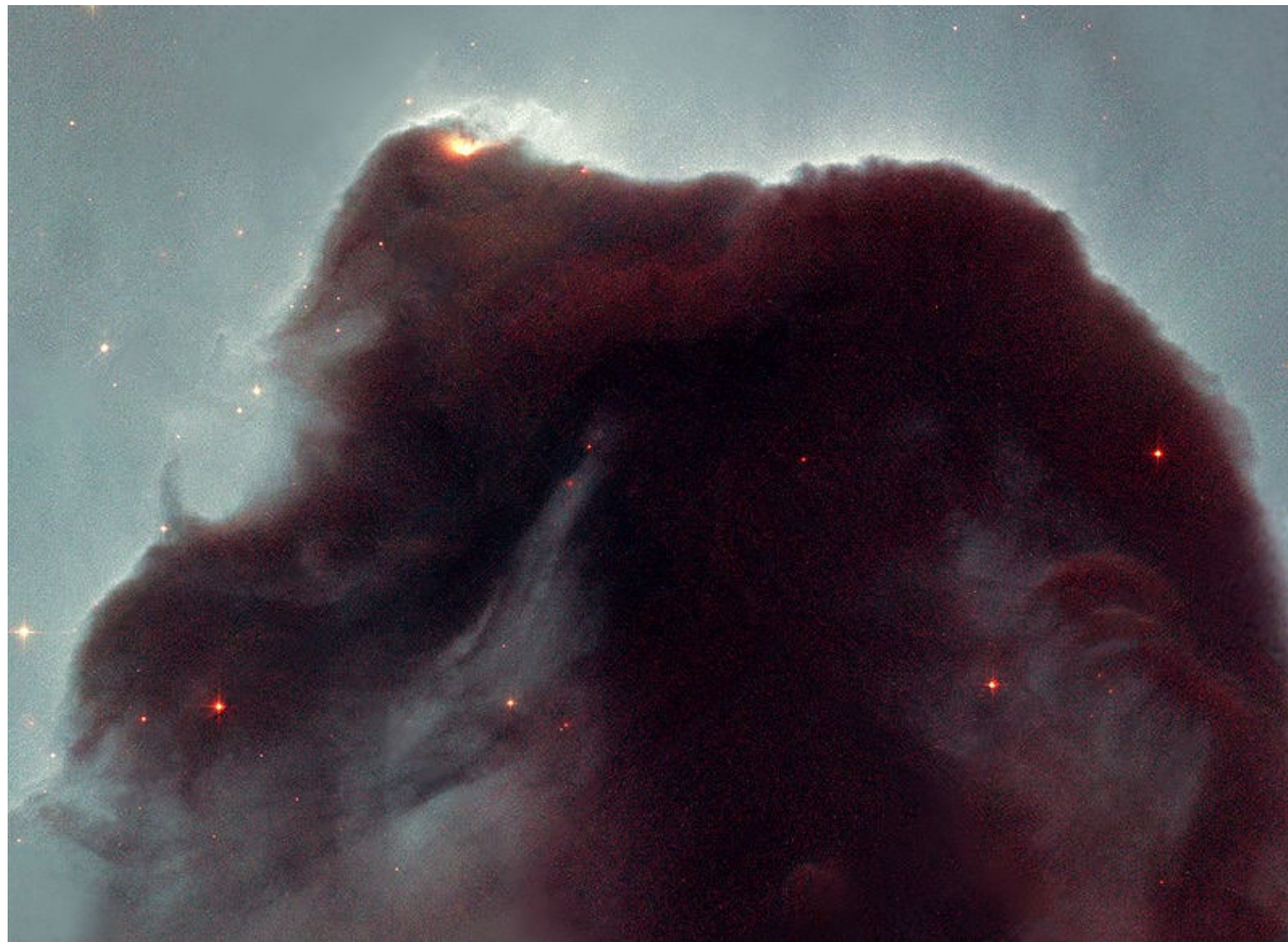
# Trifid (trodelna) meglica (M20)



# emisijska meglica Omega



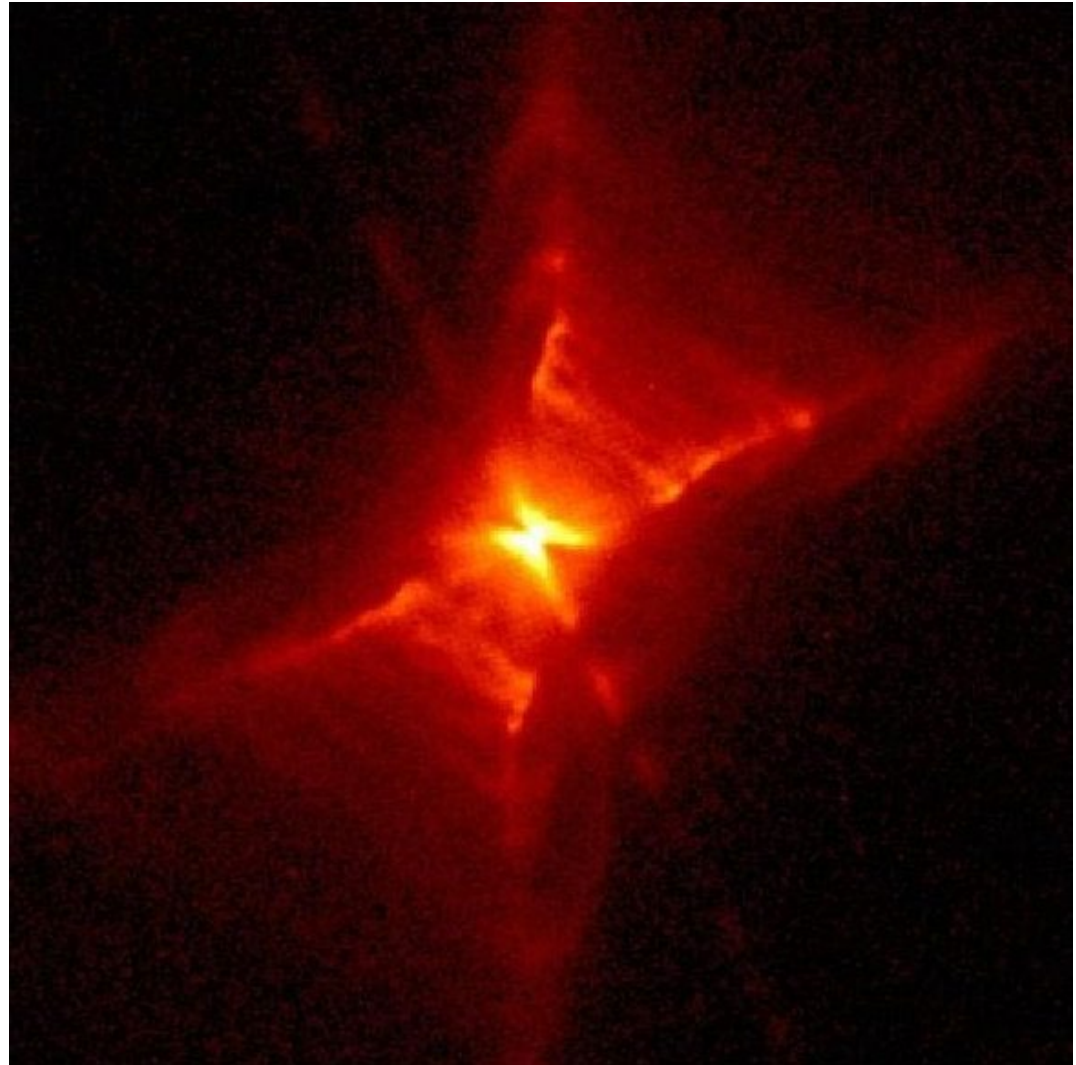
temna meglica – Konjska glava



planetarna meglica Mačje oko



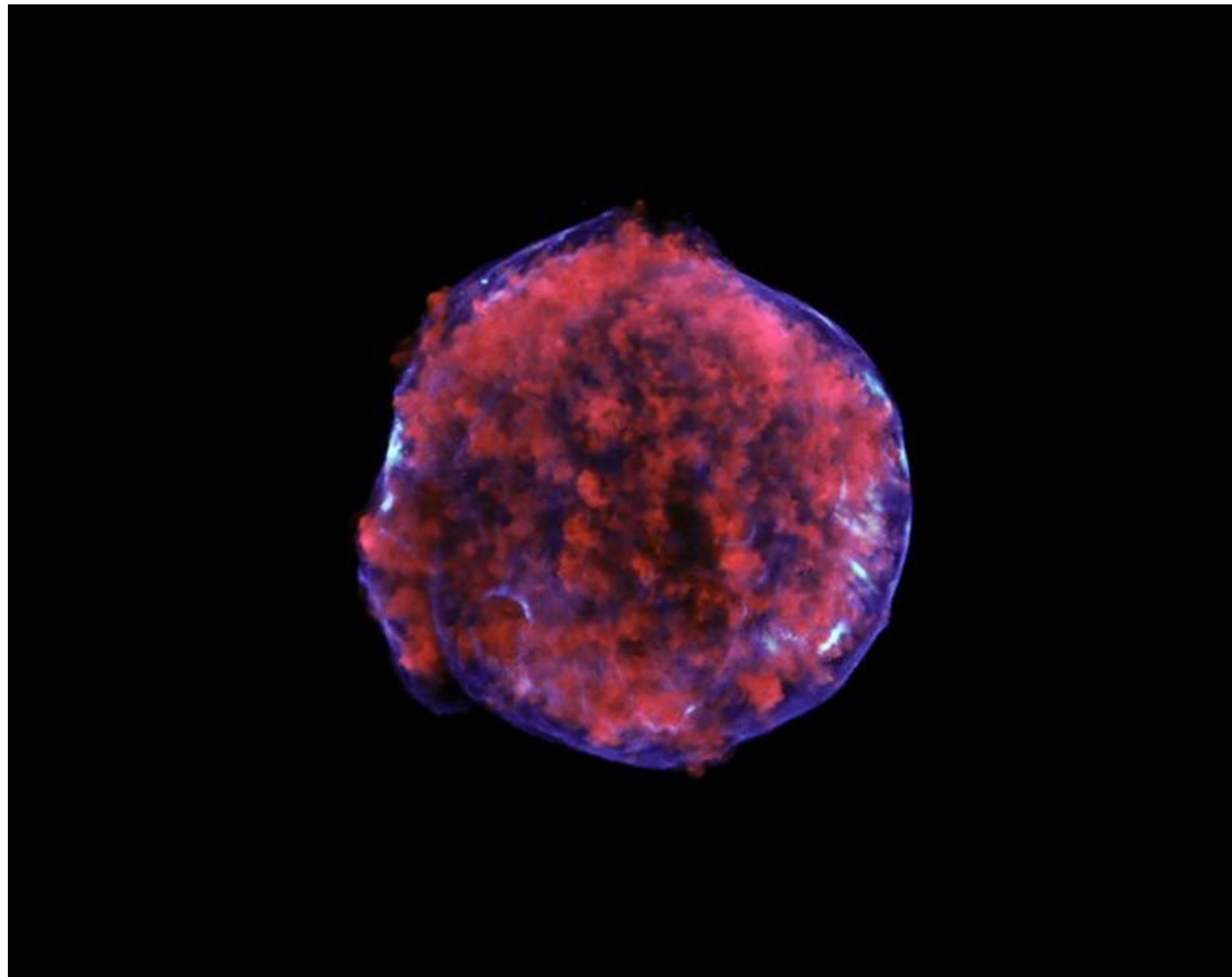
protoplanetarna meglica Rdeči pravokotnik



SNR B0509-67.5



# SNR Tycho v rentgenski svetlobi



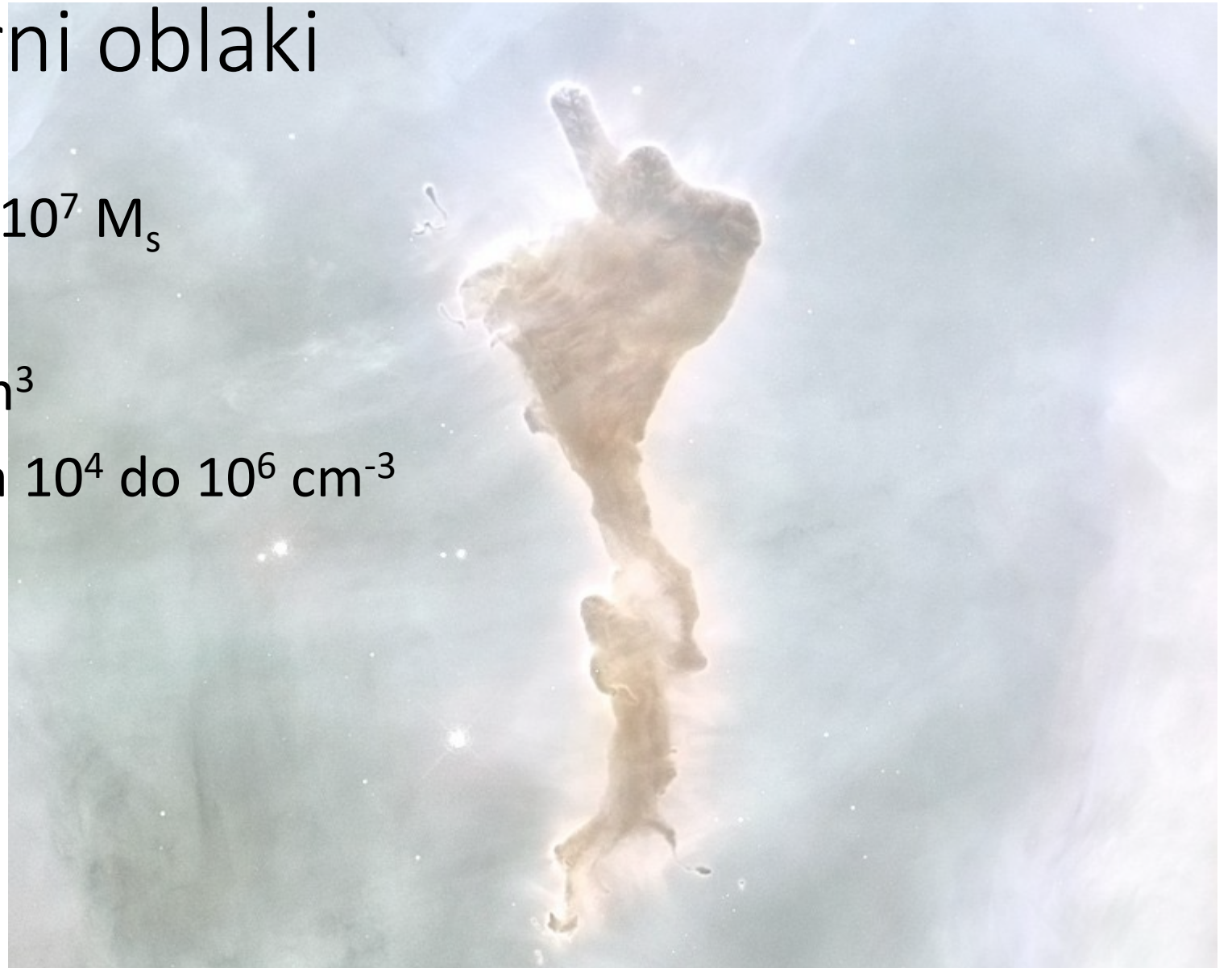
# planetarna meglica Južni obroč





# veliki molekularni oblaki

- molekularni vodik  $10^4$ - $10^7 M_s$
- 15 do 600 sv. let
- 100-1000 delcev na  $\text{cm}^3$
- nehomogena struktura  $10^4$  do  $10^6 \text{ cm}^{-3}$
- temne meglice

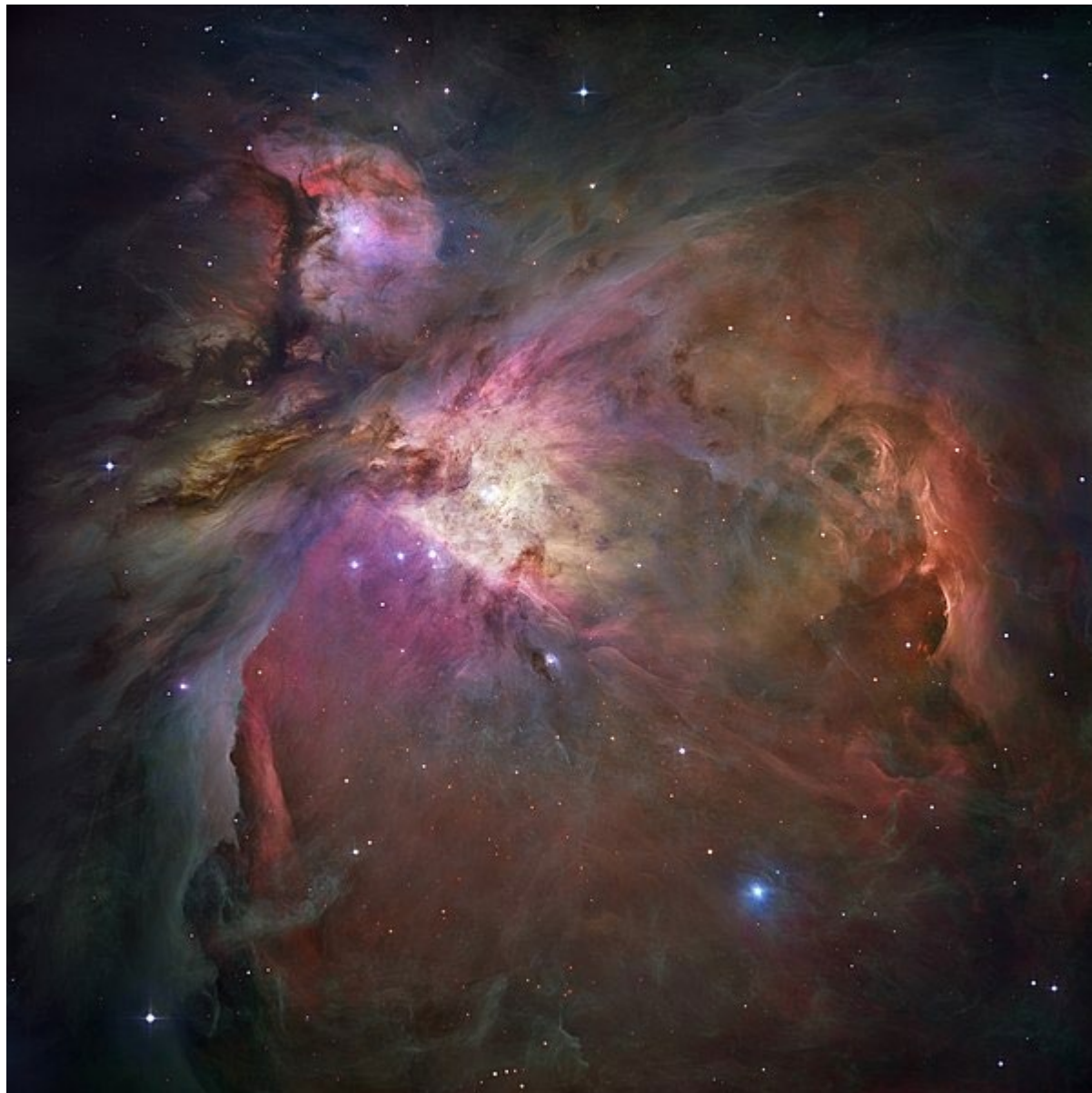


# Stebri stvarjenja

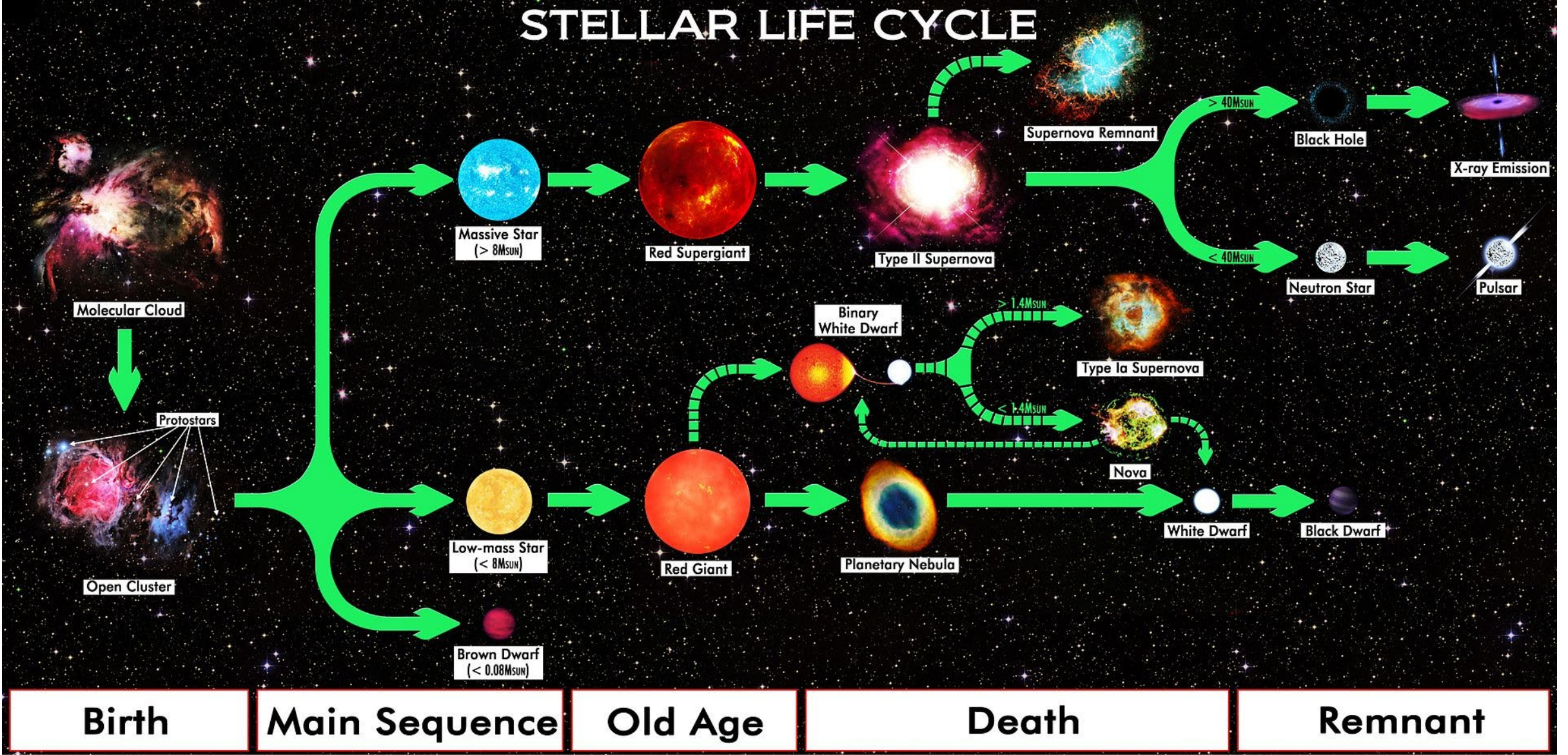
- zvezdna porodnišnica
- Hubble Space Telescope  
rilci medzvezdnega plina in prahu
- meglica Orel
- 6,500–7,000 sv. let od Zemlje
- plin in prah tvorita nove zvezde
- del plina so odpihnile/posrkale  
nove zvezde v bližini



# Orionova meglica



# STELLAR LIFE CYCLE



Birth

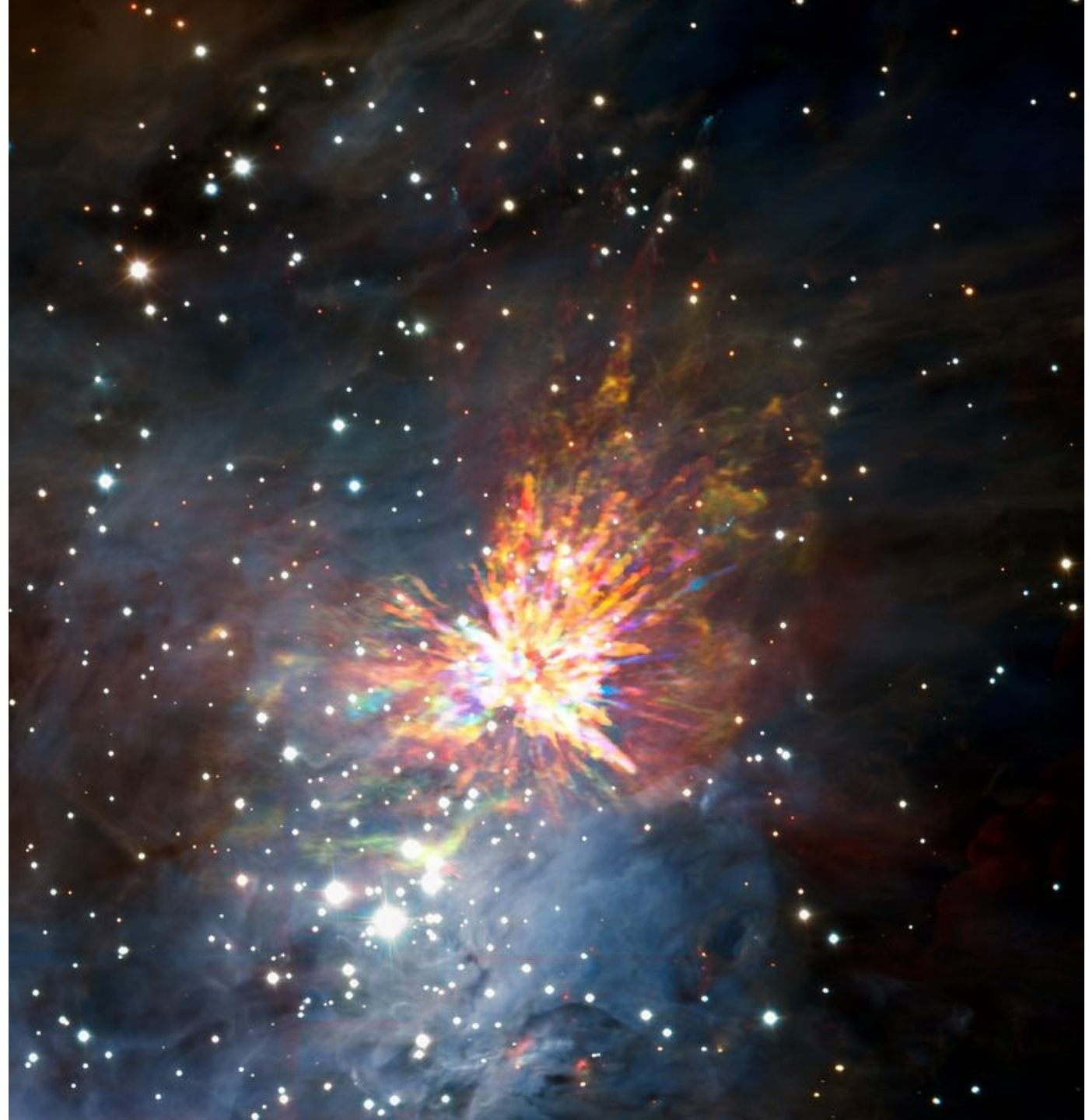
Main Sequence

Old Age

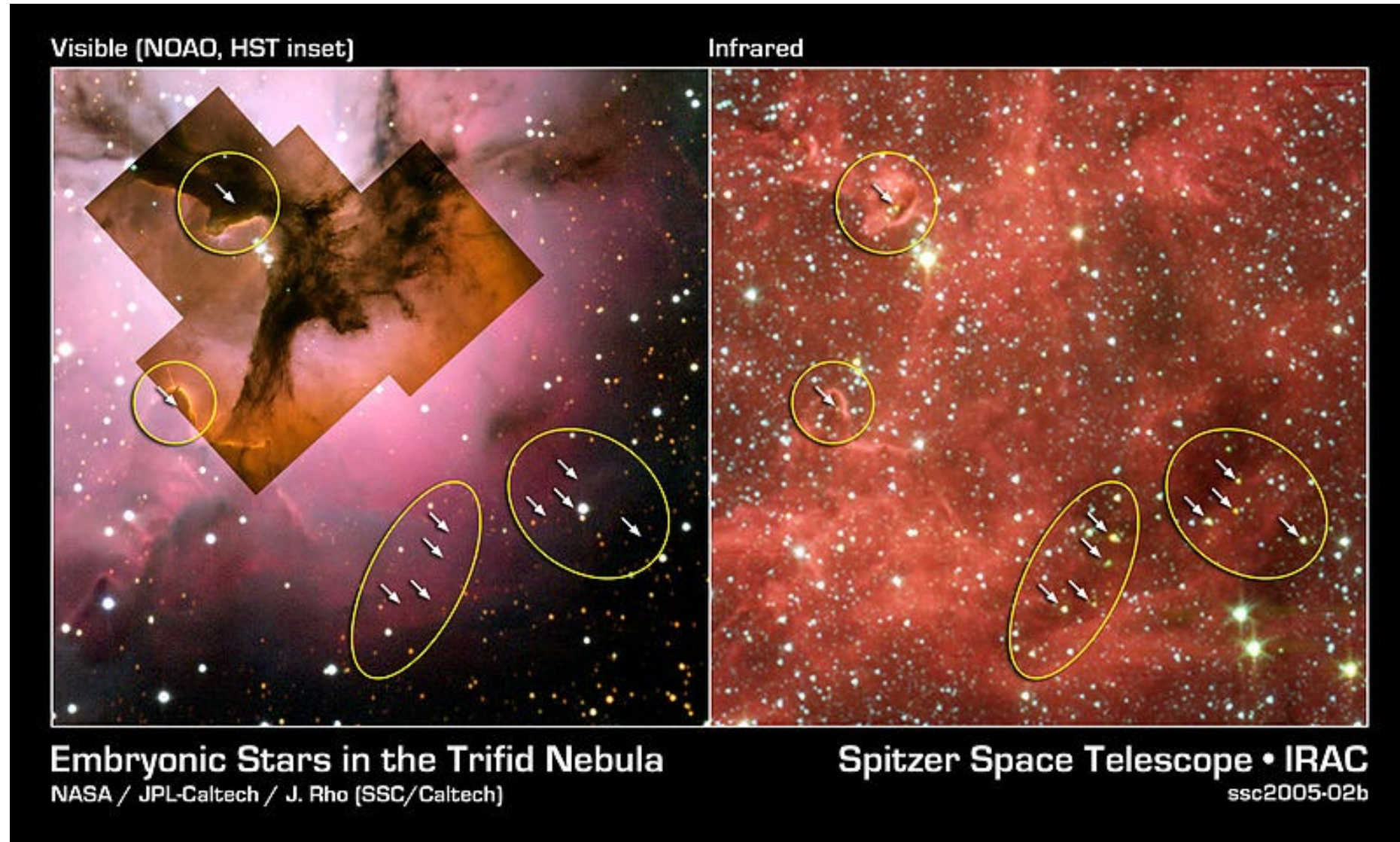
Death

Remnant

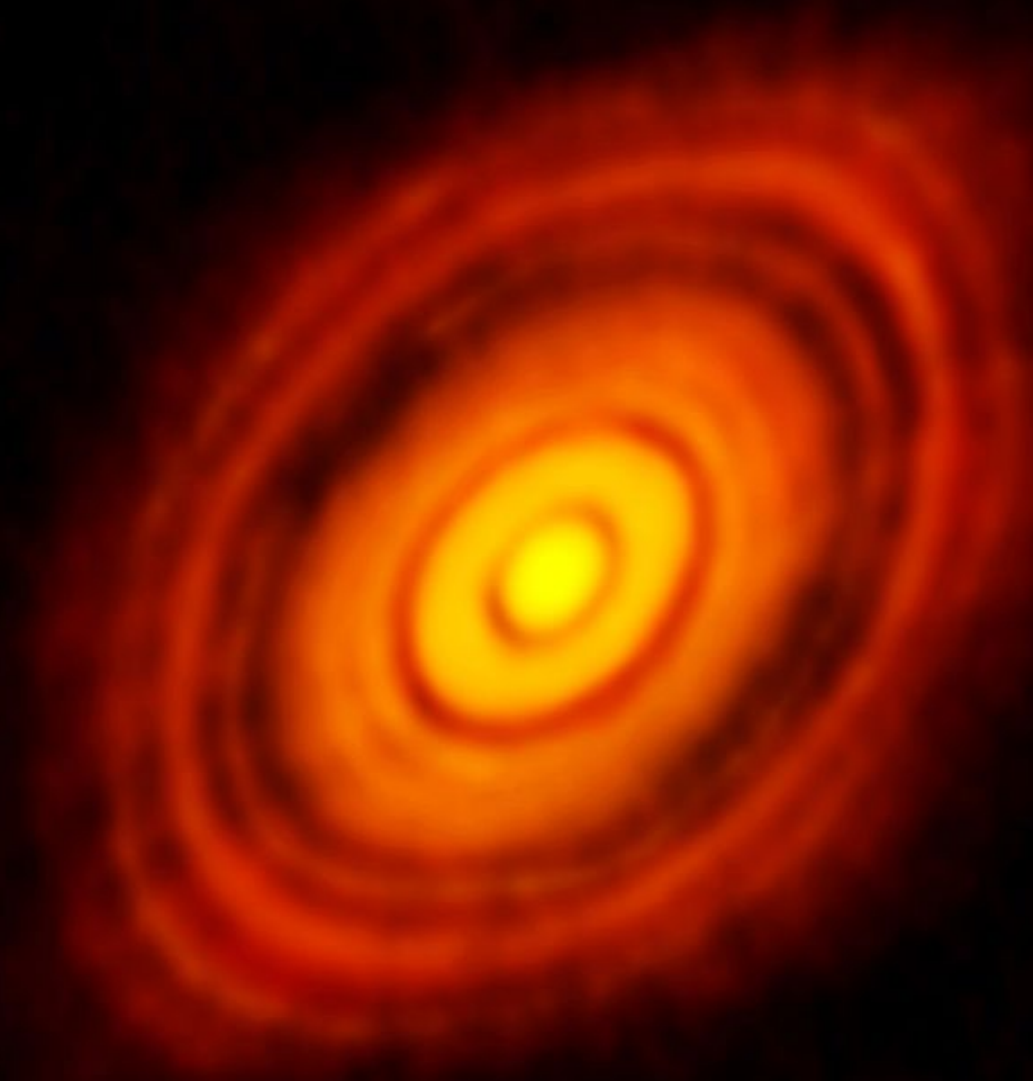
sesdanje oblaka



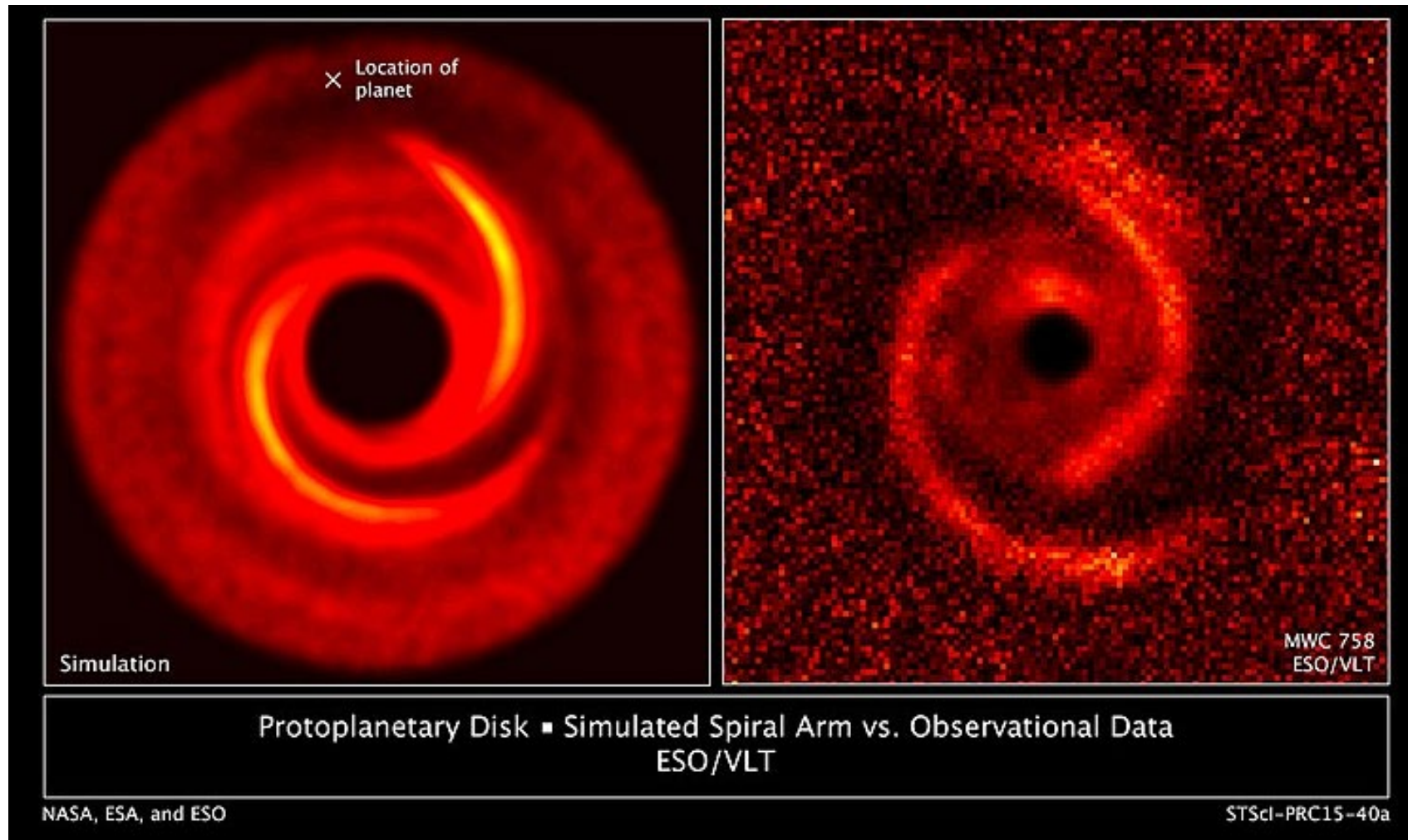
# protozvezde



akrecijski disk

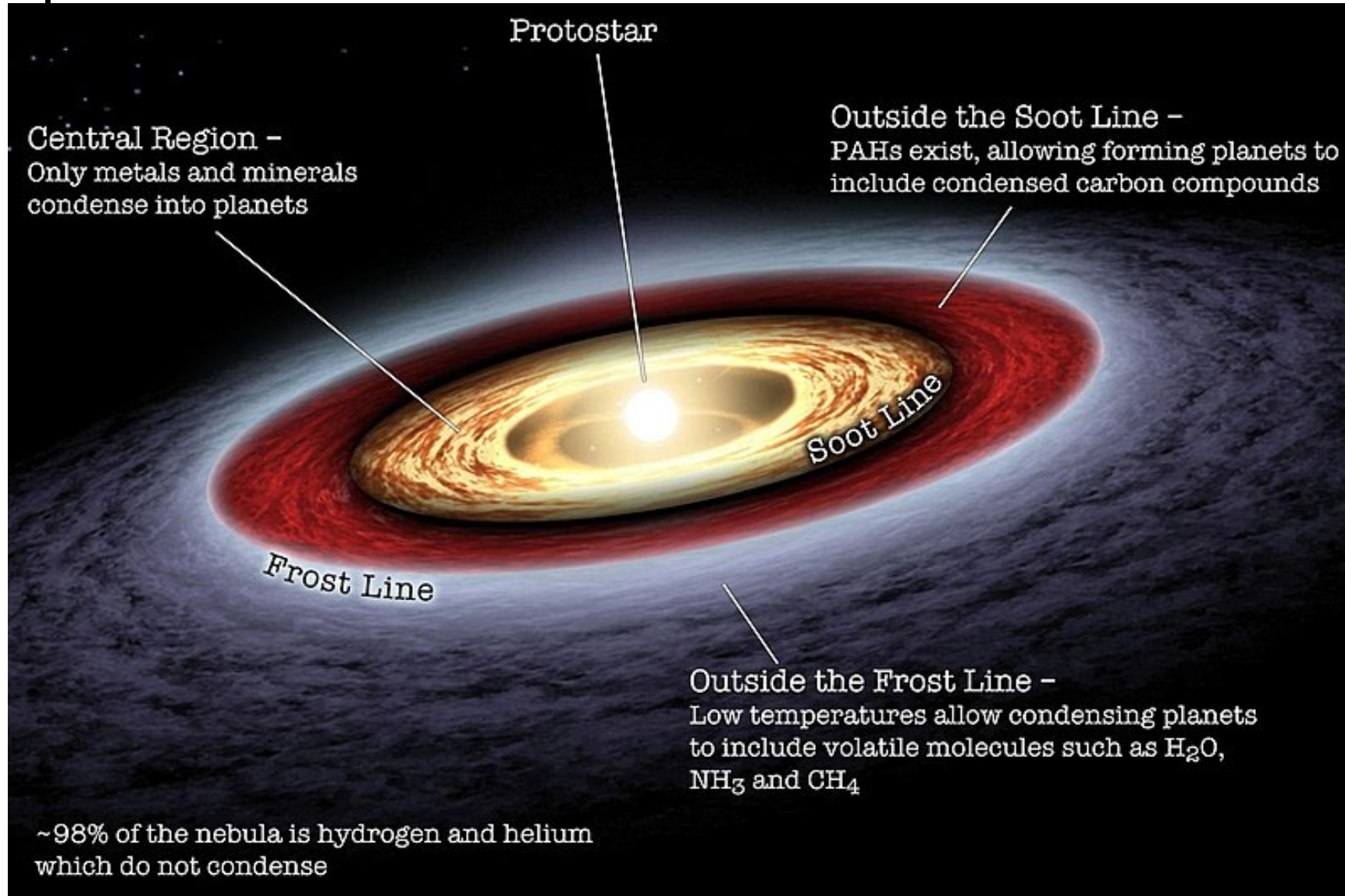


# protoplanetarni disk





# protoplanetarni disk



# Proto-planetary disk

Proto Sun

(Sub)millimeter:  
dust continuum+ molecular rot-lines

Radial mixing

Hot ionized region

Warm molecular region

Comet formation region

Cold midplane

Outer disk

Near-IR: continuum  
+ atomic and molecular lines

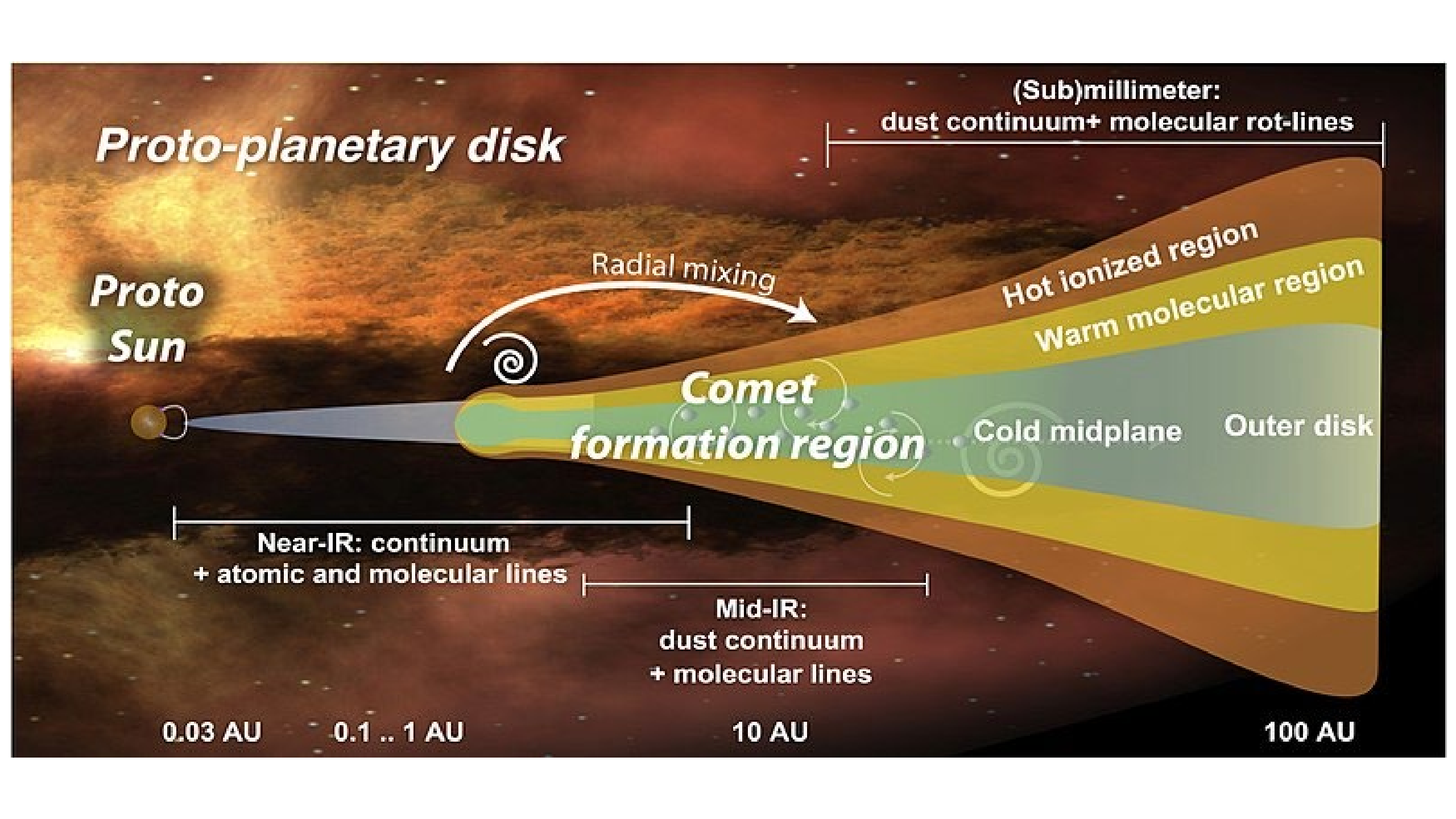
Mid-IR:  
dust continuum  
+ molecular lines

0.03 AU

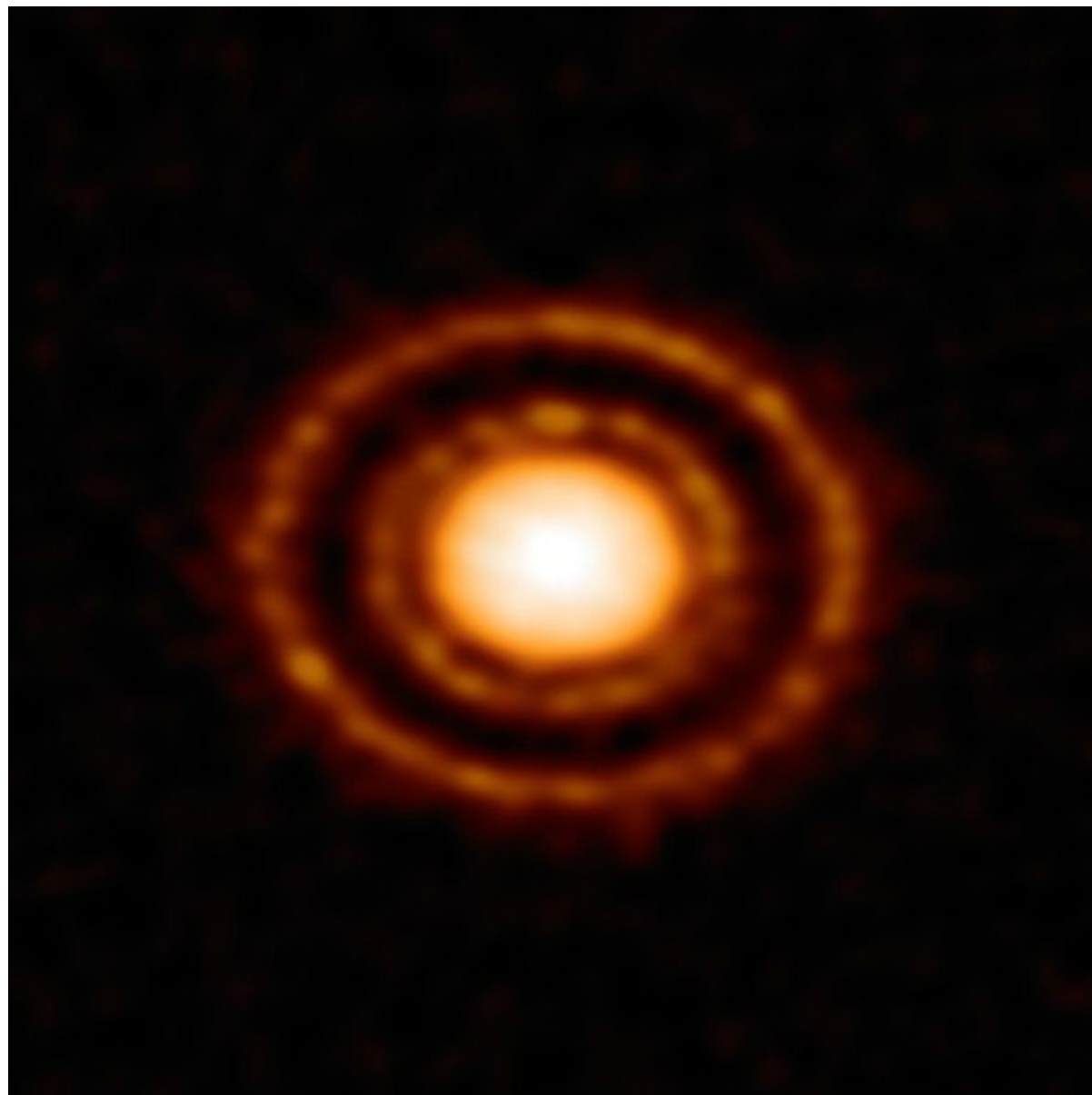
0.1 .. 1 AU

10 AU

100 AU



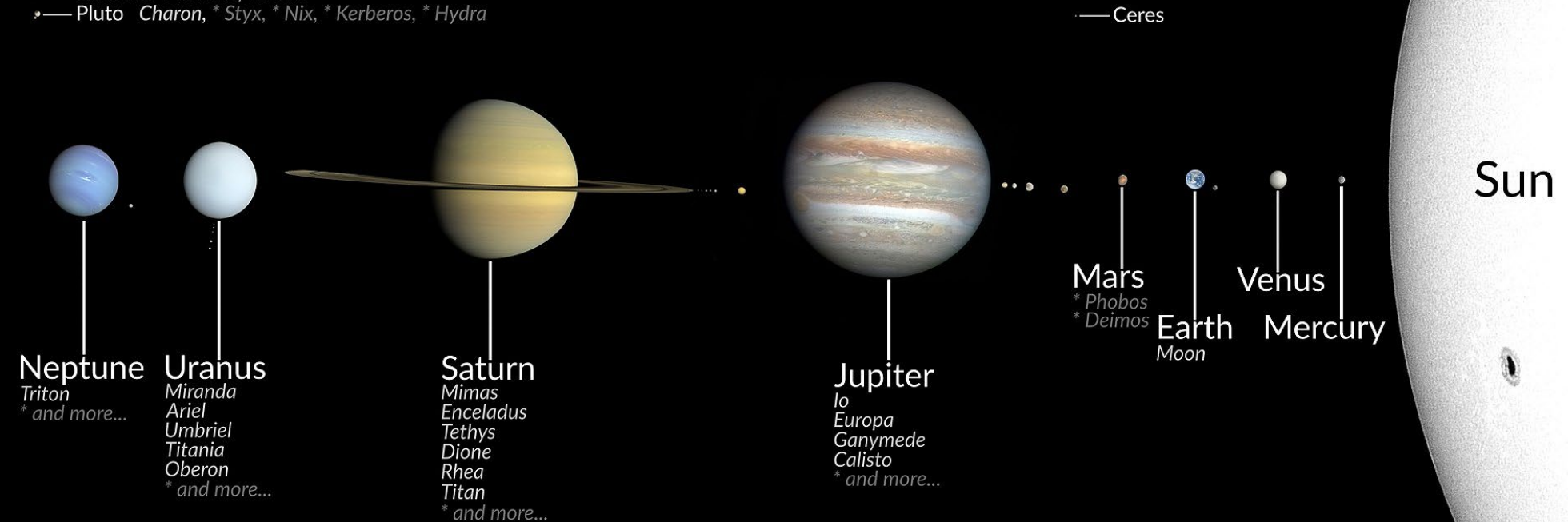
AS 209, 410 sv.l.



# Osončje

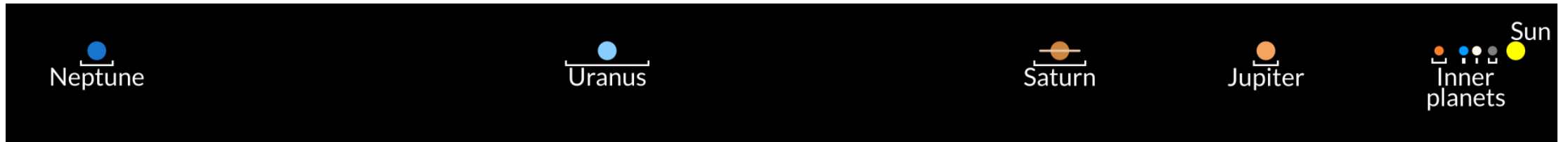
## Solar System in true imagery, color and size

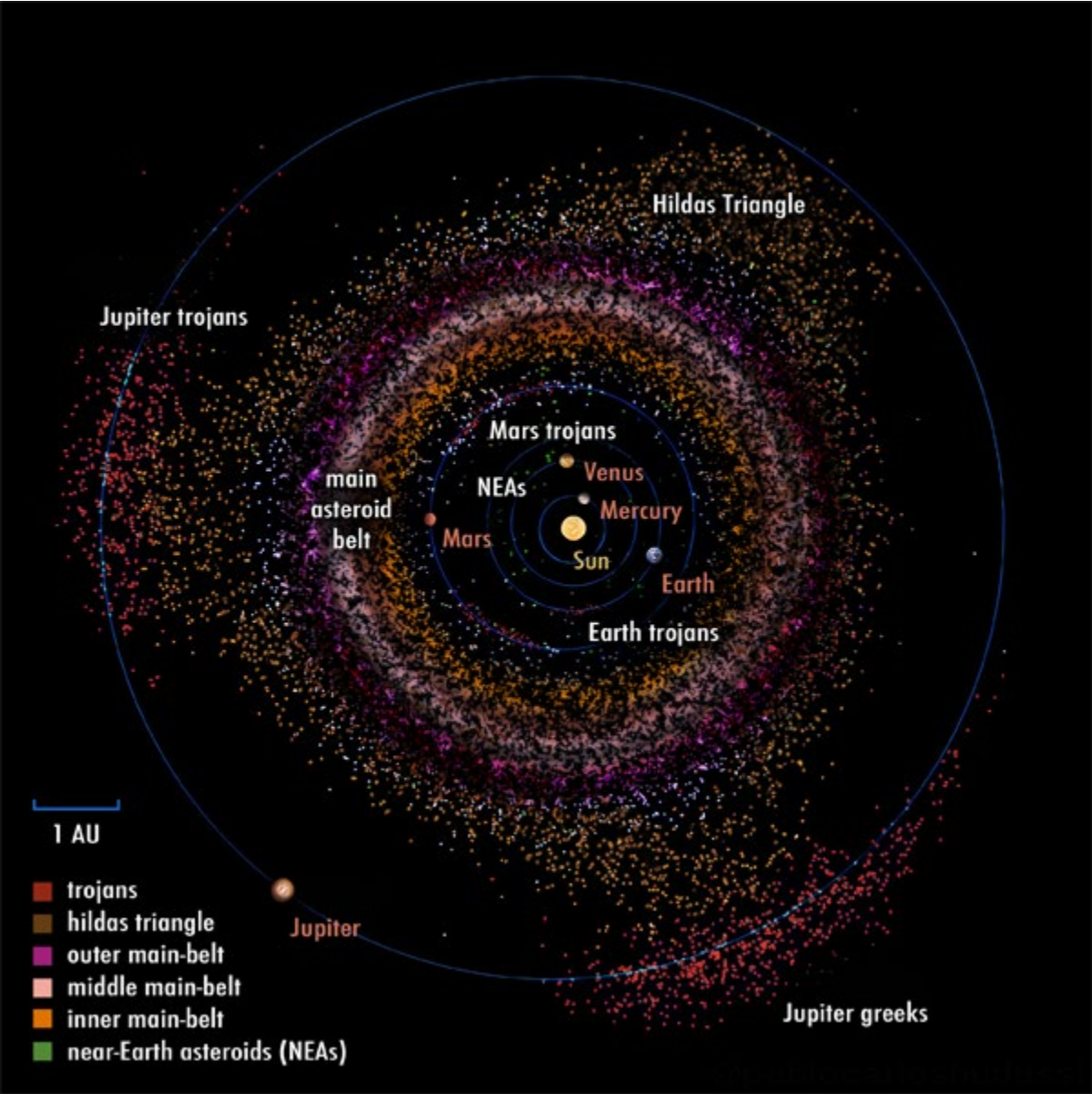
- Sedna
- — Gonggong Xiangliu
- — Eris Dysnomia
- — Orcus Vanth
- — Quaoar Weywot
- — Makemake S/2015 (136472) 1
- — Haumea Namaka, Hi'iaka
- — Pluto Charon, \* Styx, \* Nix, \* Kerberos, \* Hydra

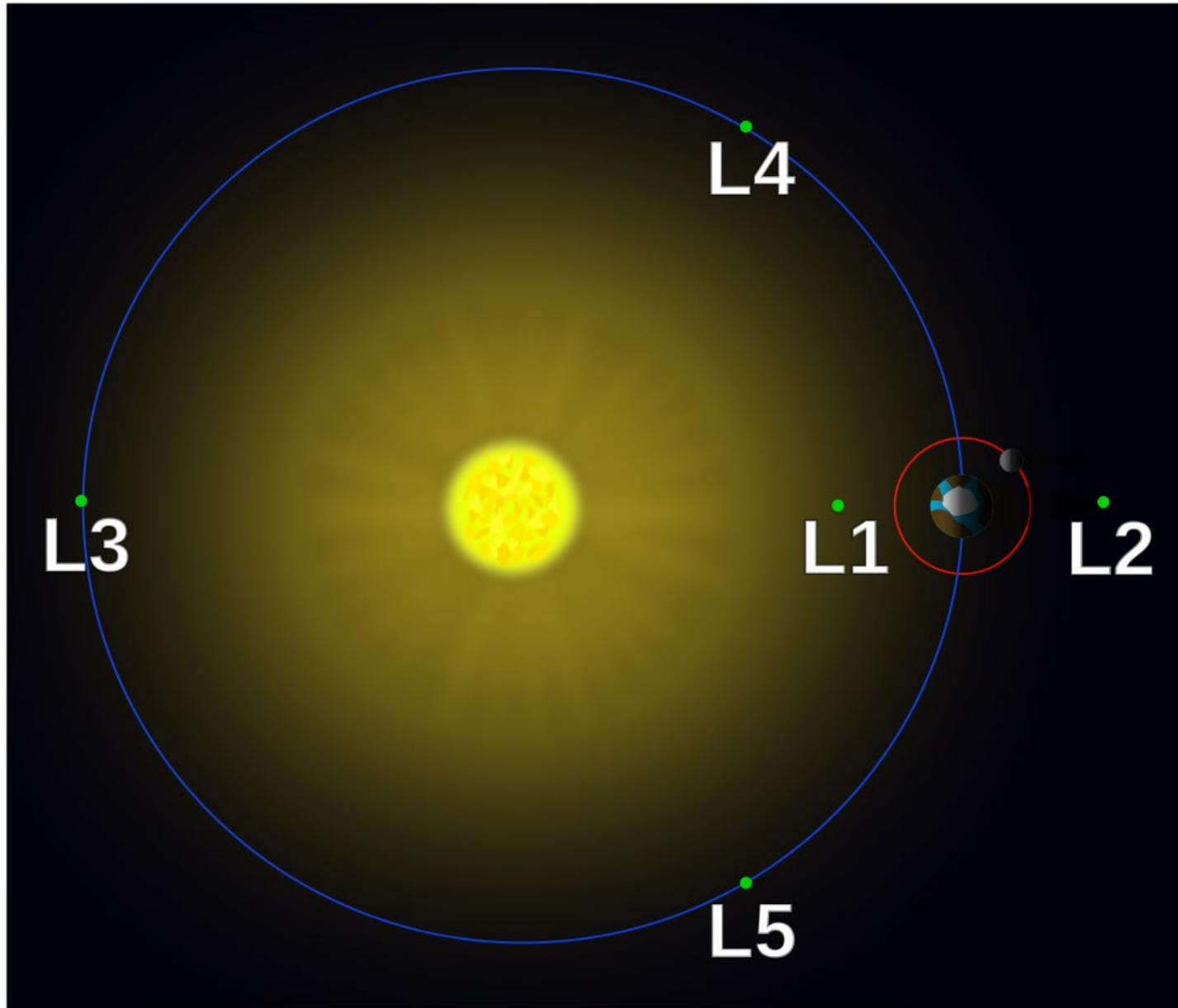


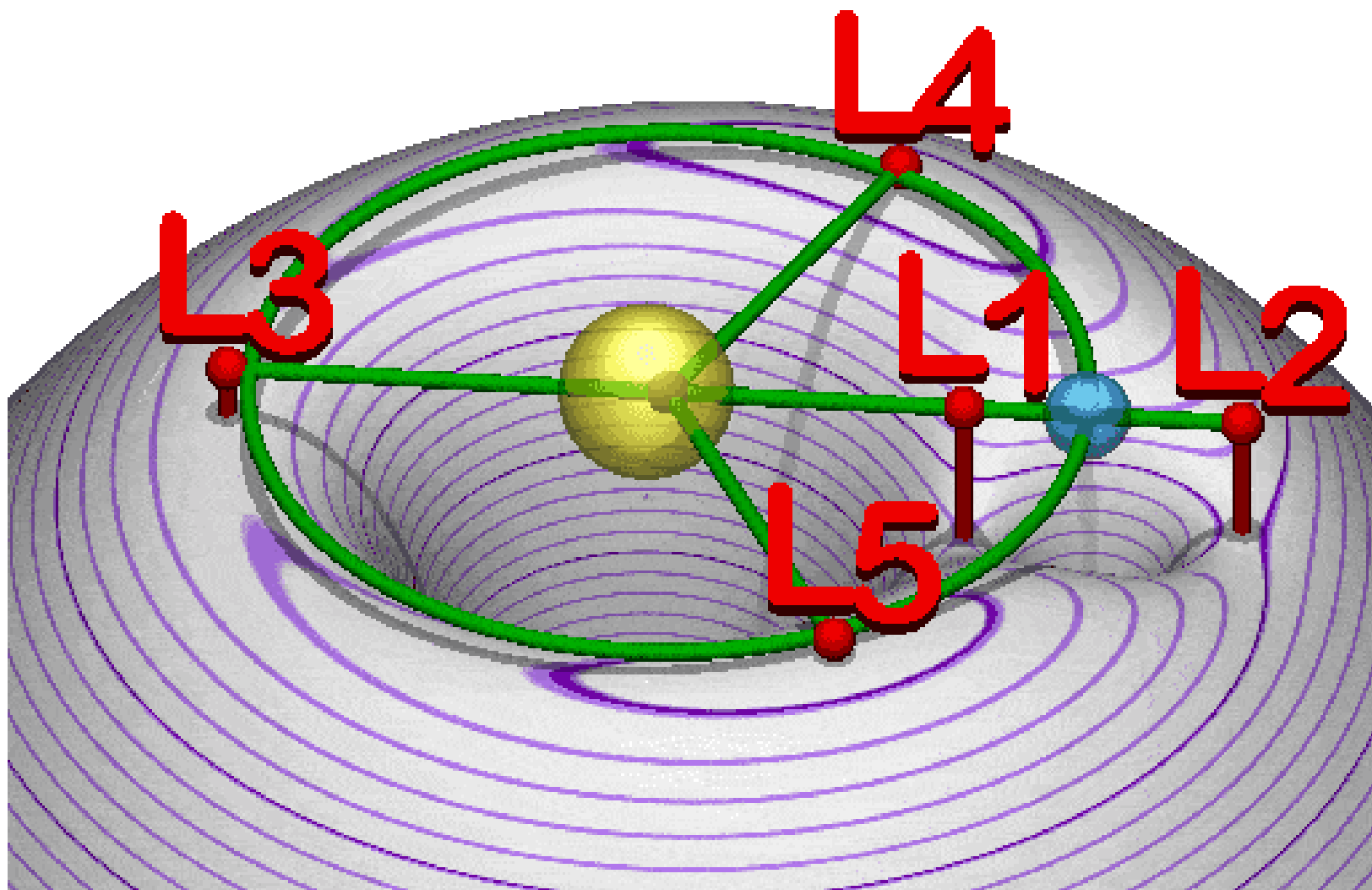
\* Moons that are not shown

# Osončje



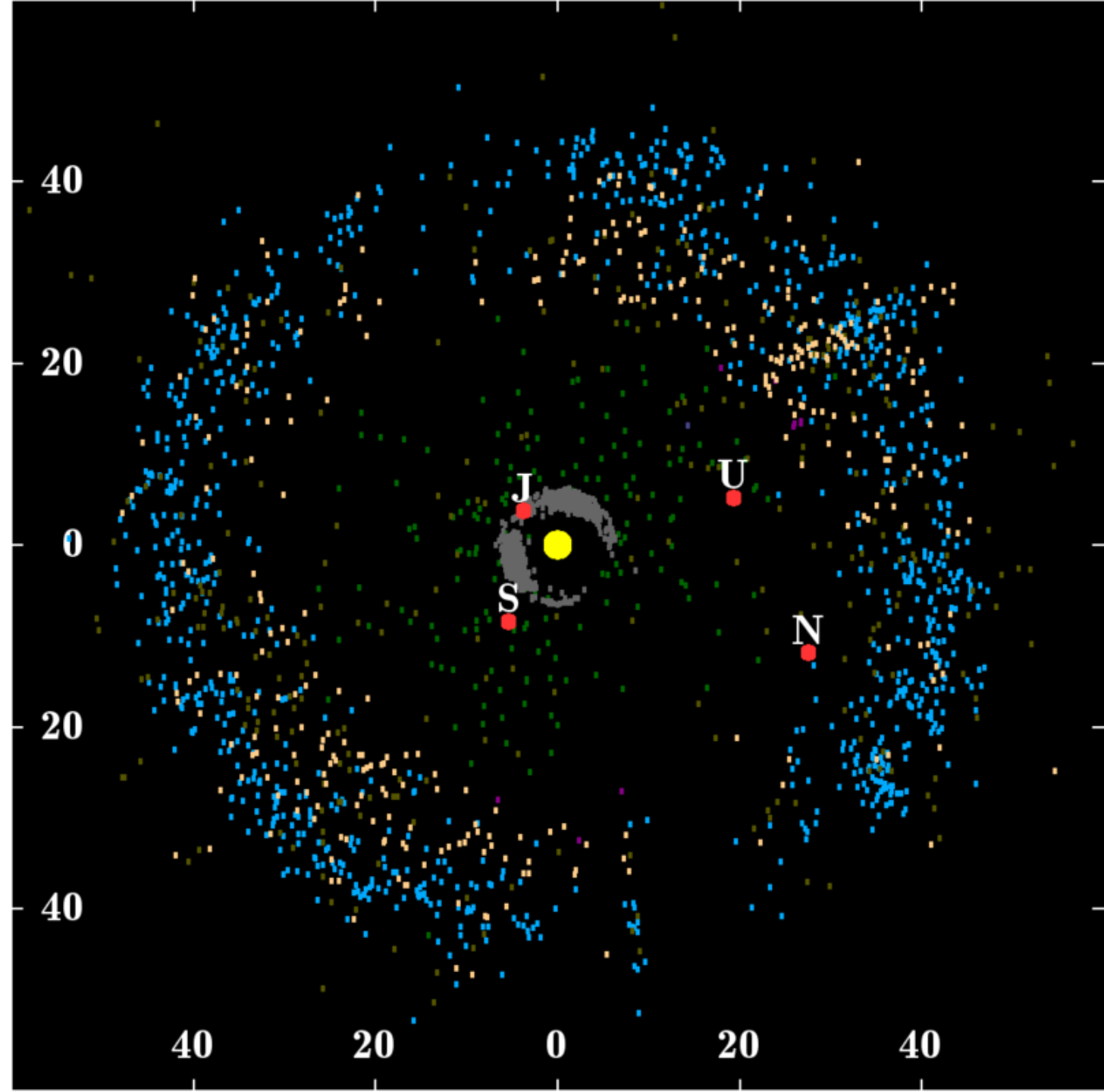






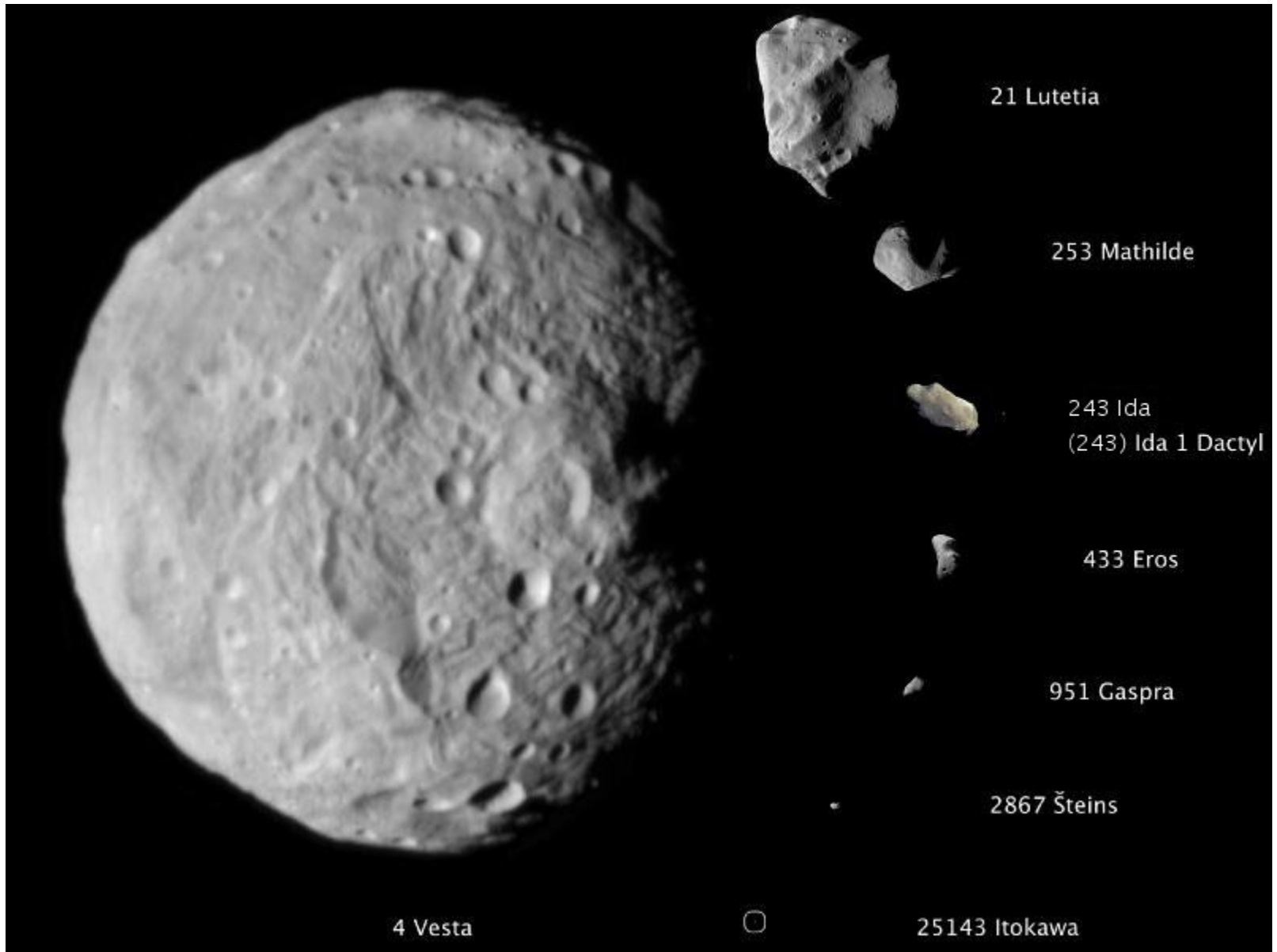


# Kuiperjev pas



# obiskani asteroidi: Ida, Eros, Ceres





4 Vesta

21 Lutetia

253 Mathilde

243 Ida  
(243) Ida 1 Dactyl

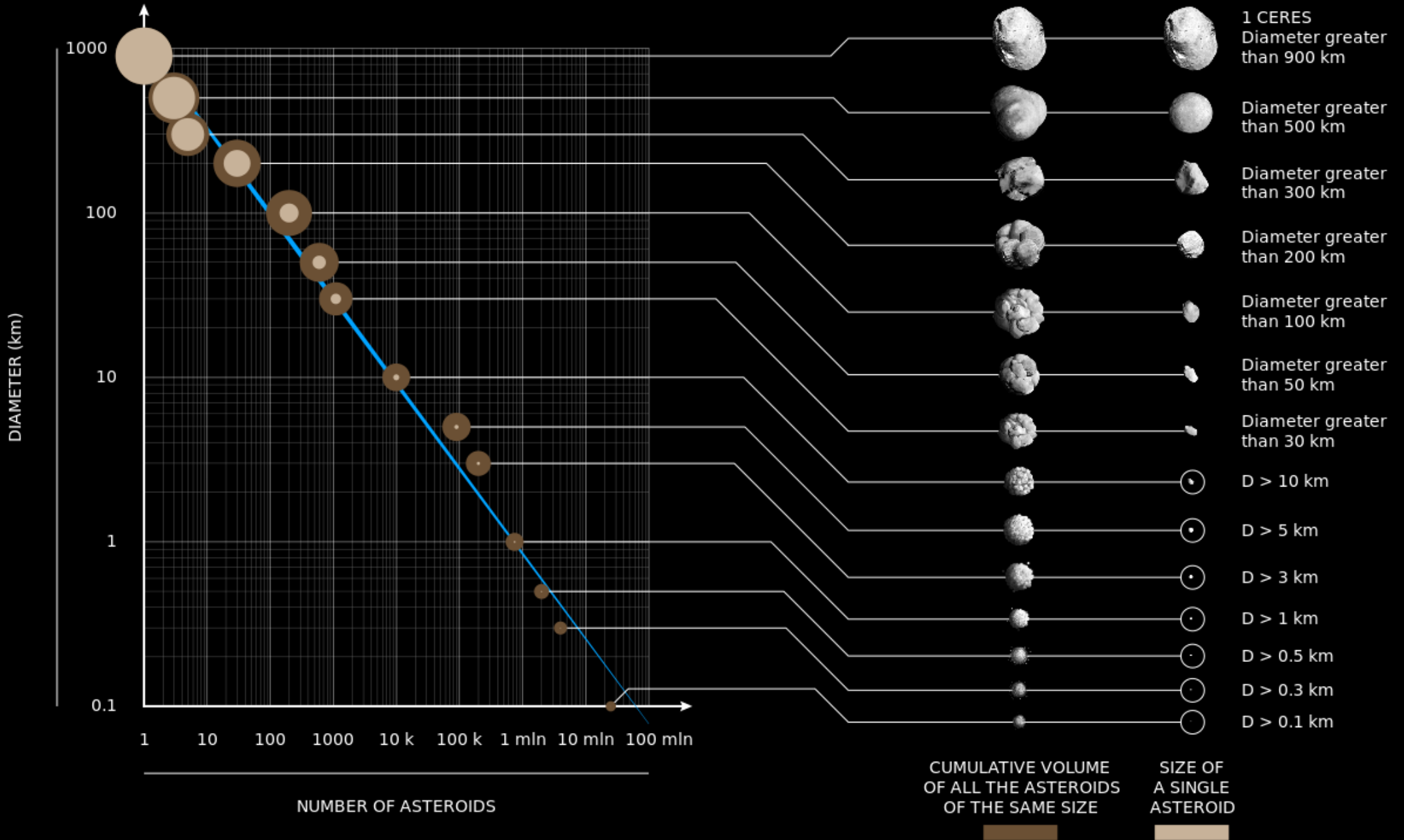
433 Eros

951 Gaspra

2867 Šteins

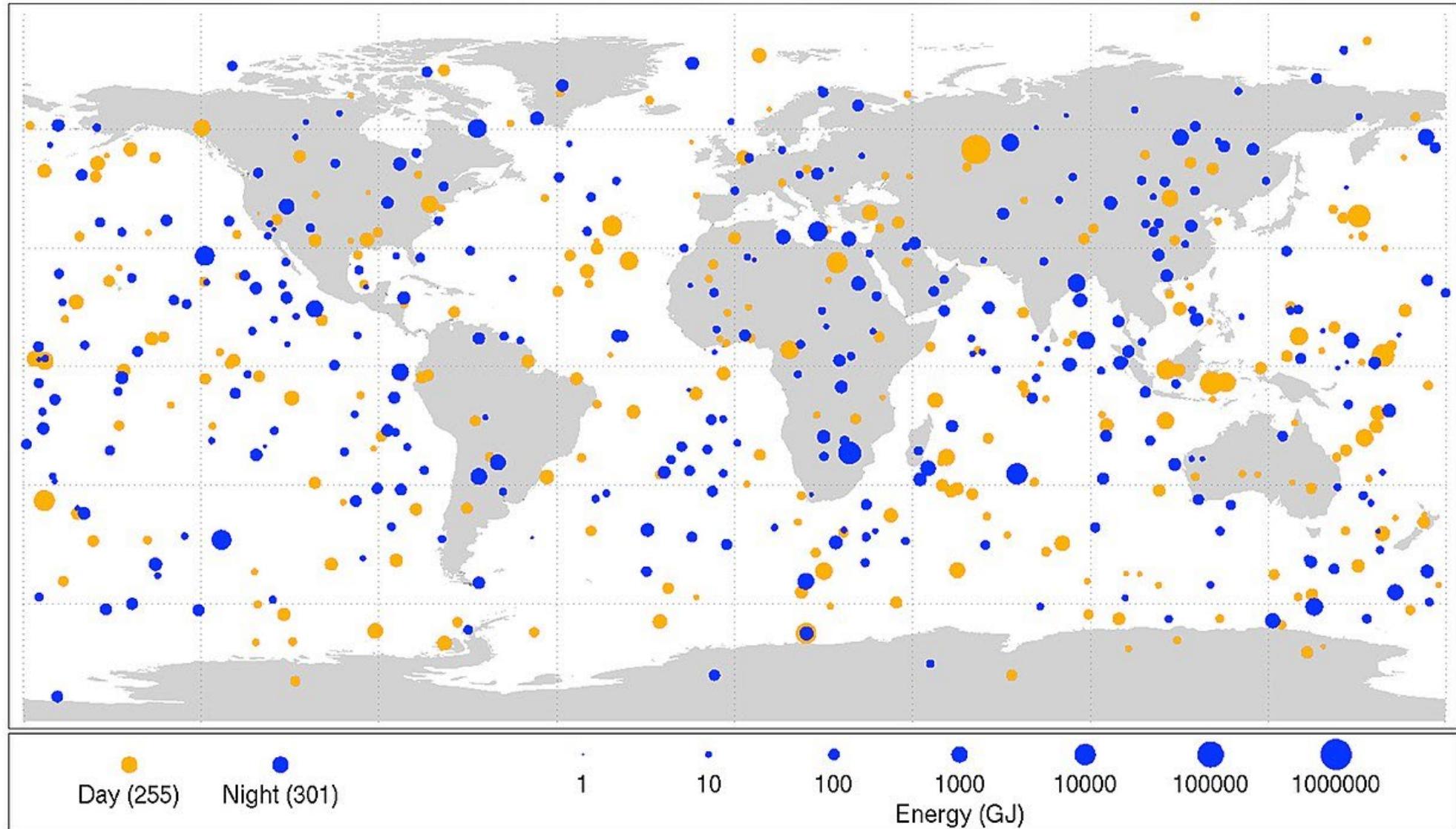


25143 Itokawa



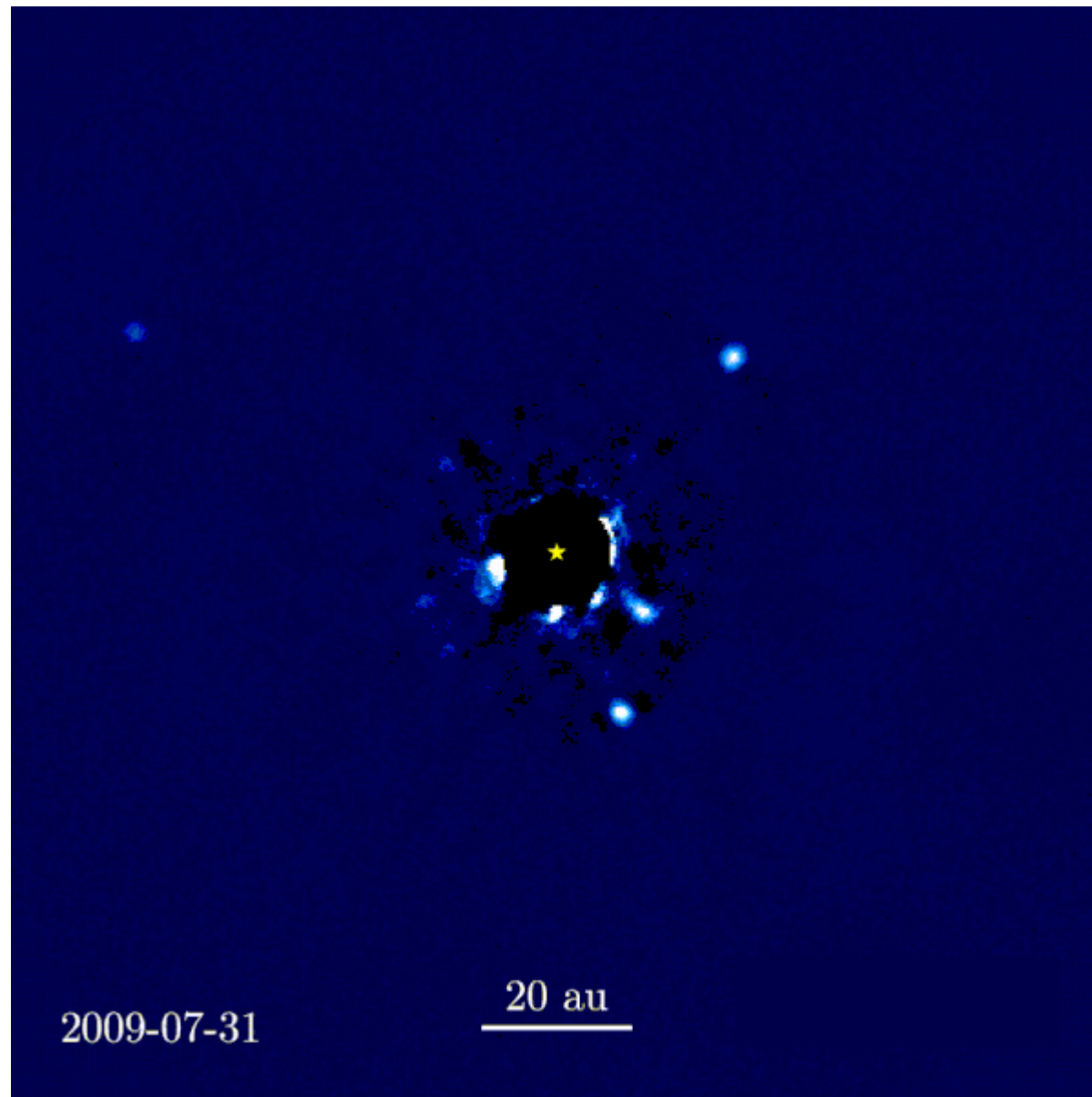
# Bolide events 1994-2013

(Small asteroids that disintegrated in the Earth's atmosphere)



# Eksoplanet

- HR 8799



# Planét (grško πλανήτης: planétes - pohajkovalci), IAU

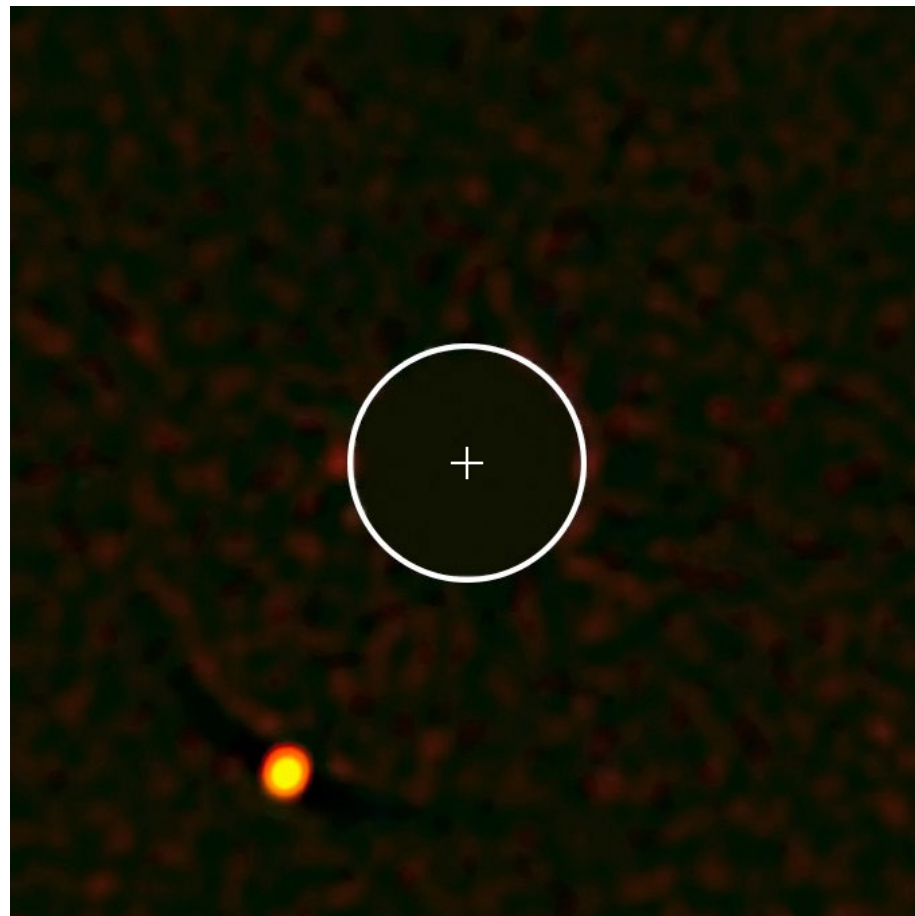
- je masivno nebesno telo, ki kroži okrog zvezde v svoji tirnici
- ne proizvajajo energije s pomočjo jedrskega zlivanja
- dovolj masivno da
  - ga lastna gravitacija oblikuje v kroglasto obliko
  - počisti drobne v območju svoje tirnice

# eksoplanet

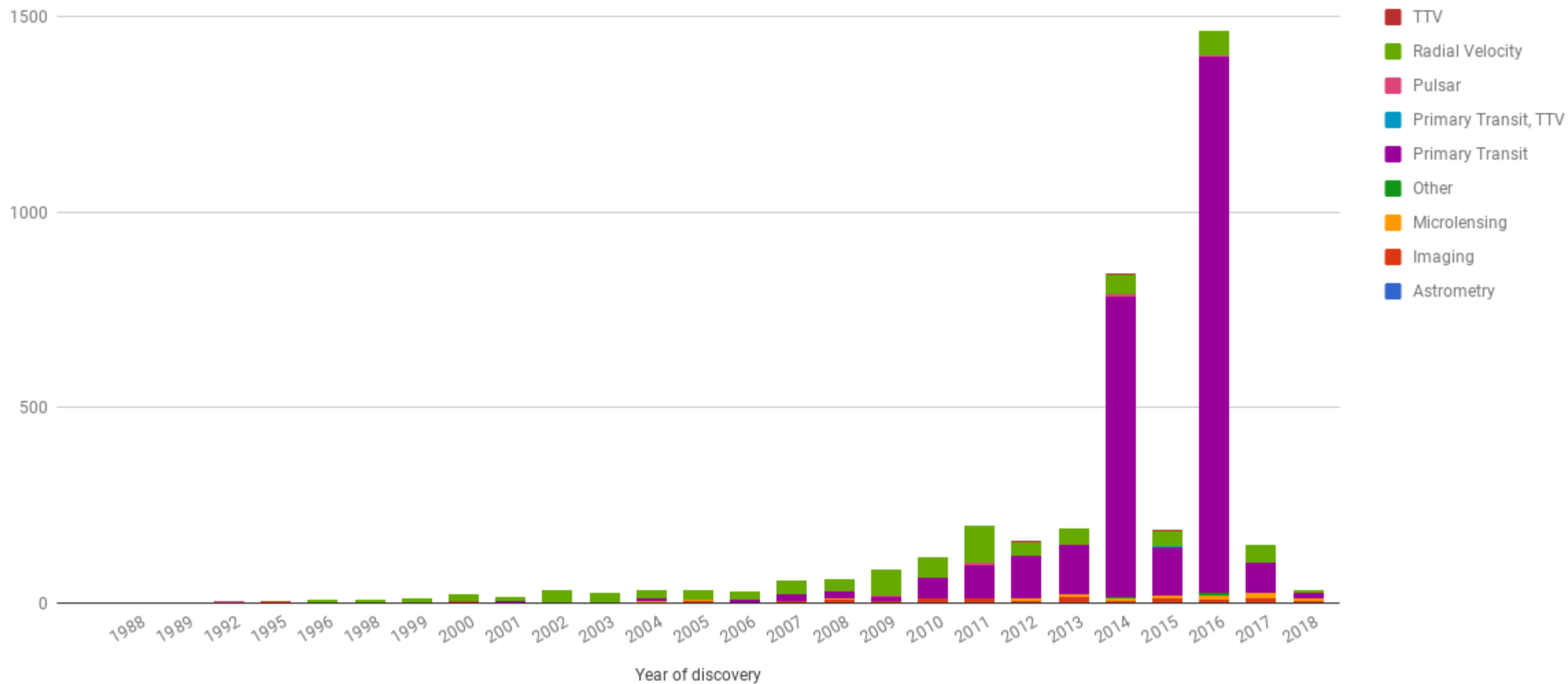
- Uradna opredelitev pojma planet, ki ga uporablja Mednarodna astronomska unija (IAU), zajema le Osončje in tako ne velja za eksoplanete
- Telesa z maso premajhno za termonuklearno fuzijo devterija (13 Jupitrovih mas), v orbiti okoli zvezde ali zvezdnega ostanka. Najmanjša masa definirana tako kot za planete Osončja
- Telesa z večjo maso so rjave pritlikavke
- Lažja telesa brez orbite so sub-rjave pritlikavke



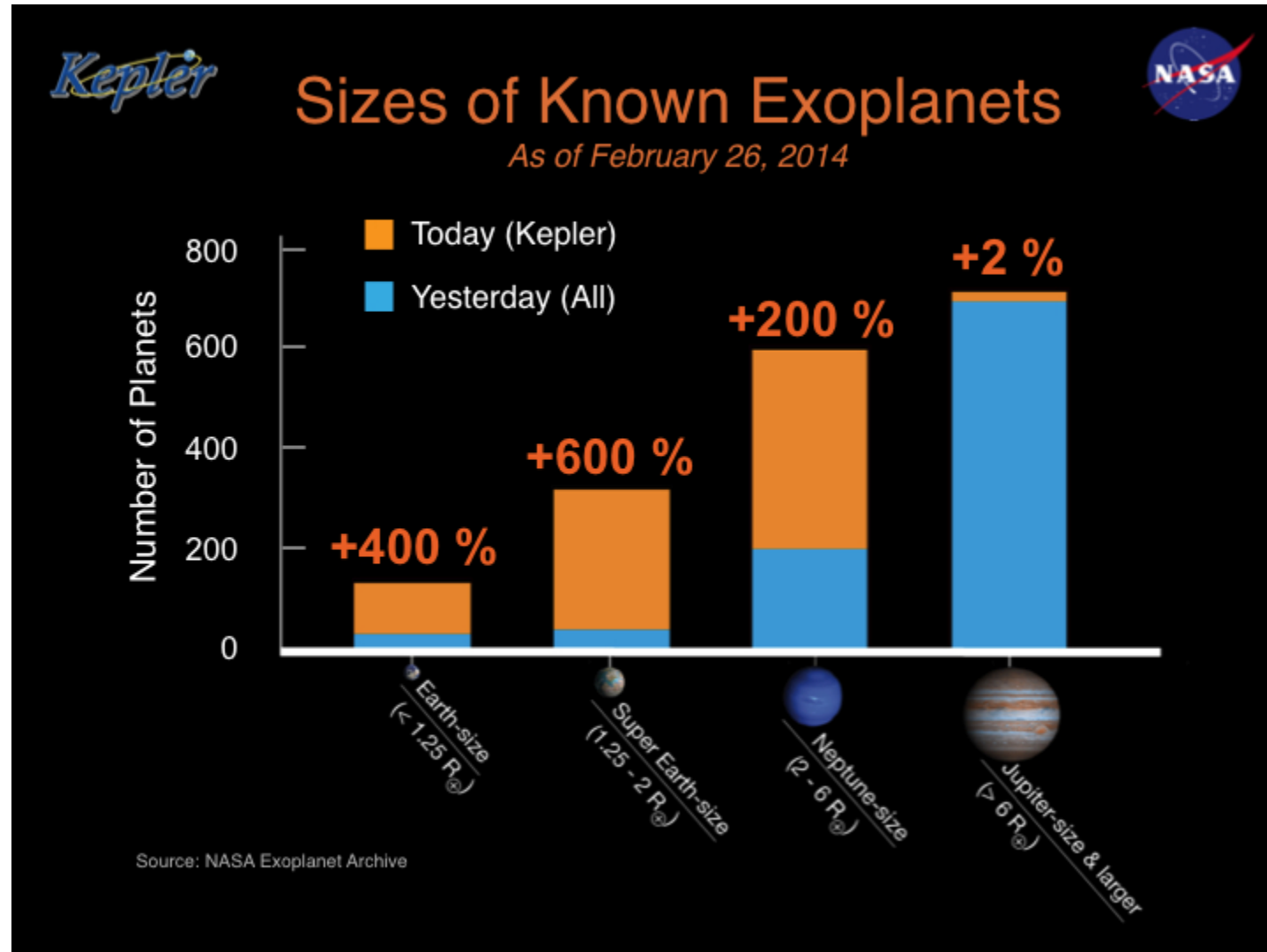
HIP 65426 b



# število



# velikosti



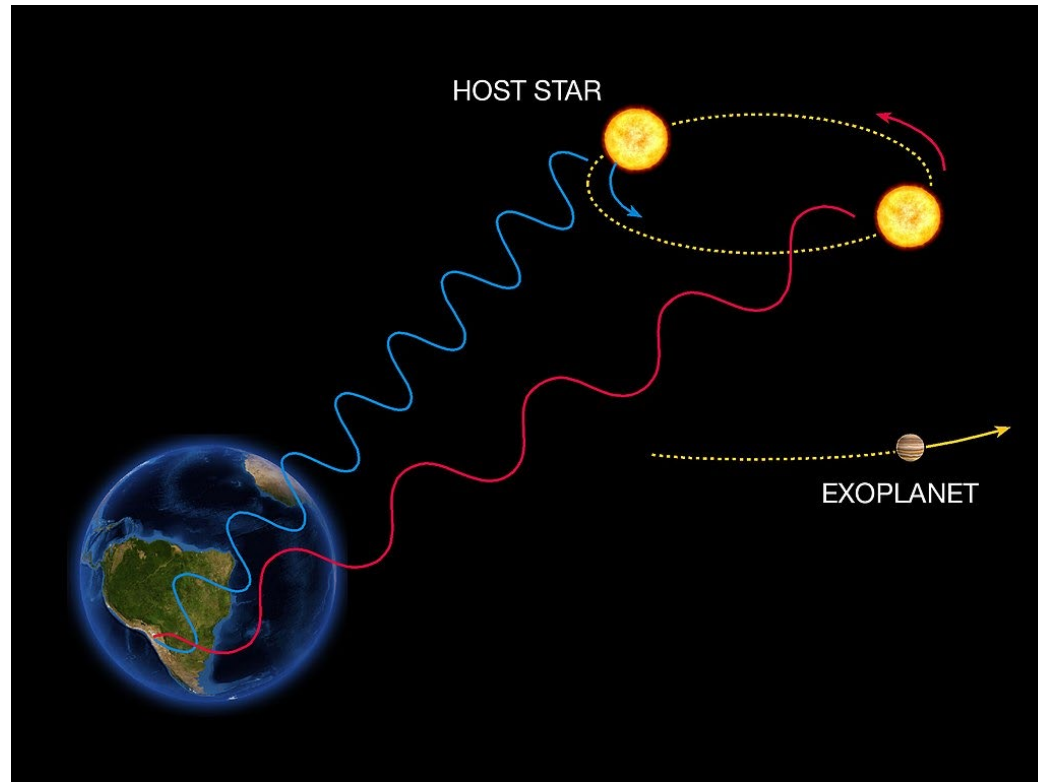
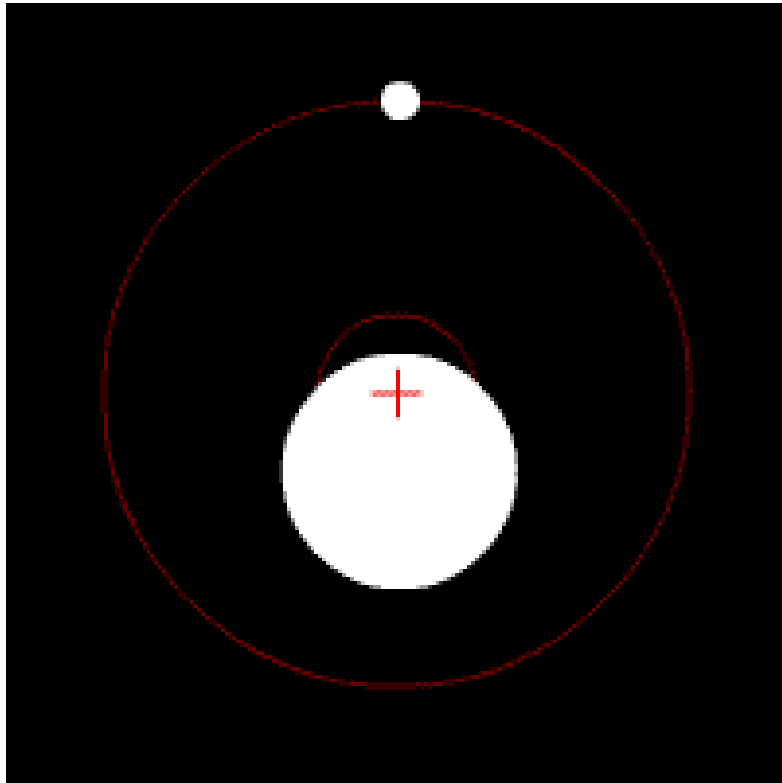
lege



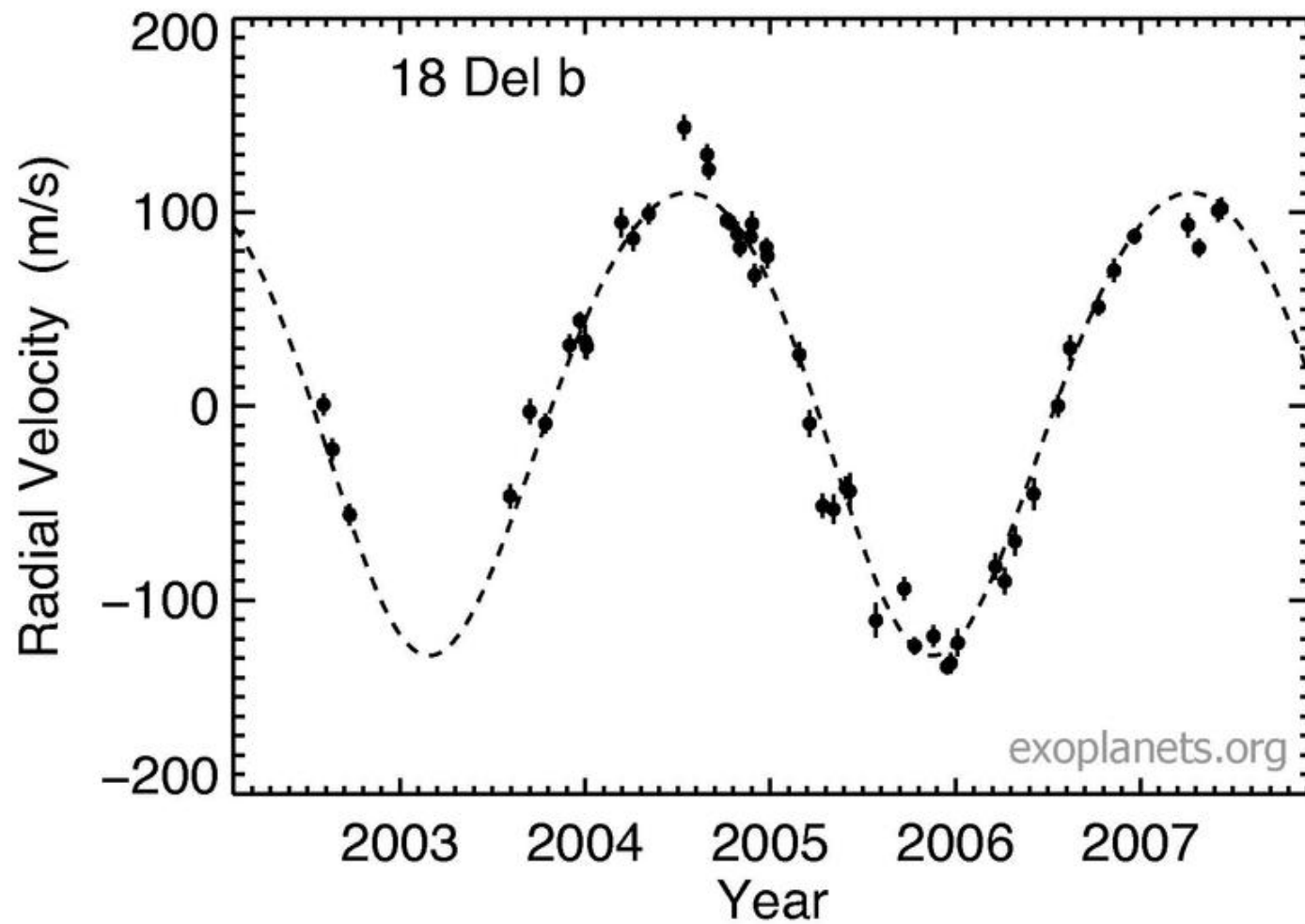
# opazovanje

- neposredno opazovanje
- posredno opazovanje
  - metoda prehoda
  - radialna hitrost, Dopplerska metoda
  - čas prehoda (TTV)
  - trajanje prehoda (TDV)
  - gravitacijsko mikrolečenje
  - astrometrija
  - pulzarski čas
  - perioda spremenljivke
  - modulacije reflektivnosti/emisivnosti
  - relativistično žarčenje
  - elipsoidne variacije
  - polarimetrija
  - zvezdni disk

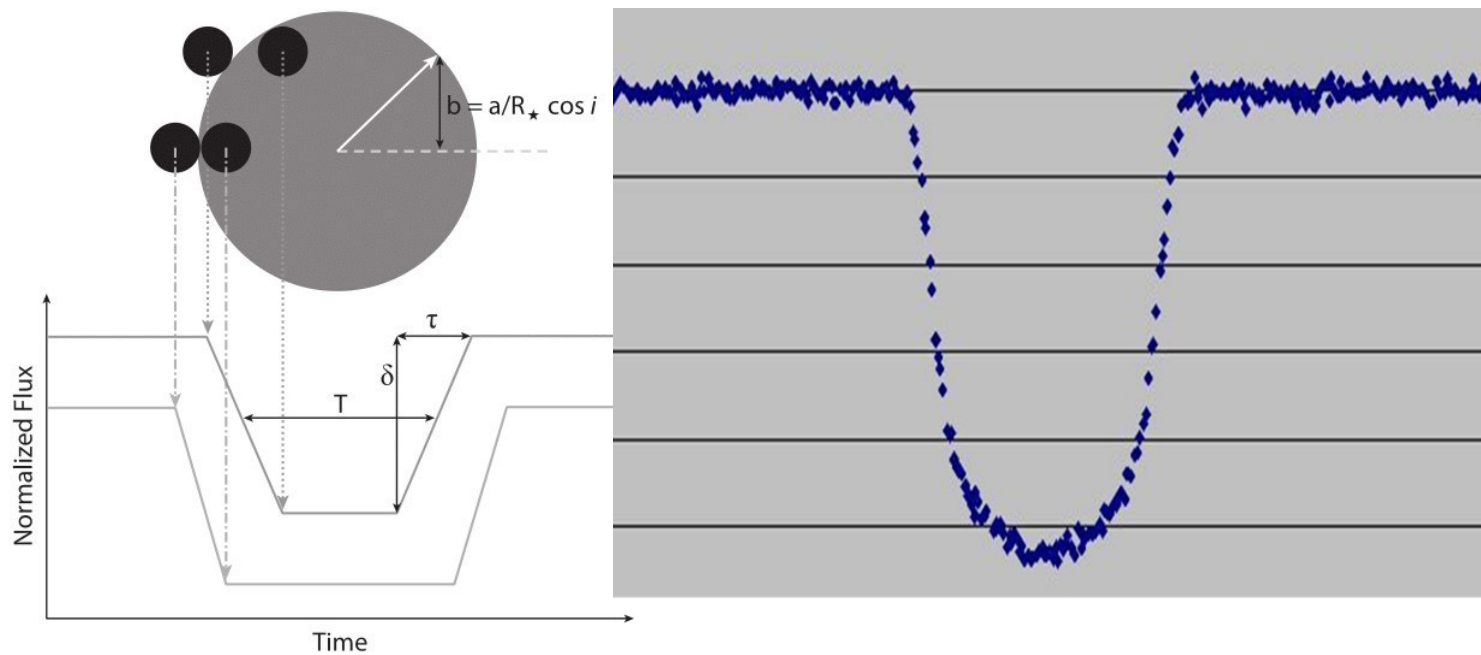
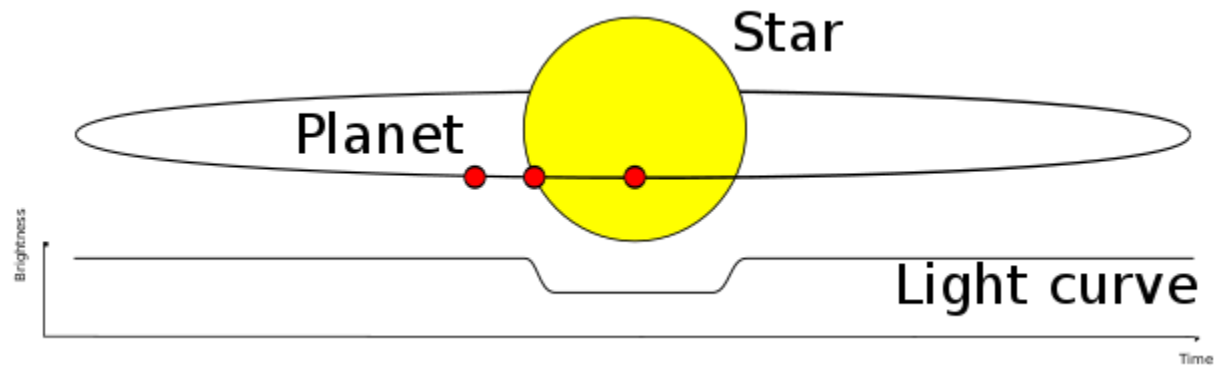
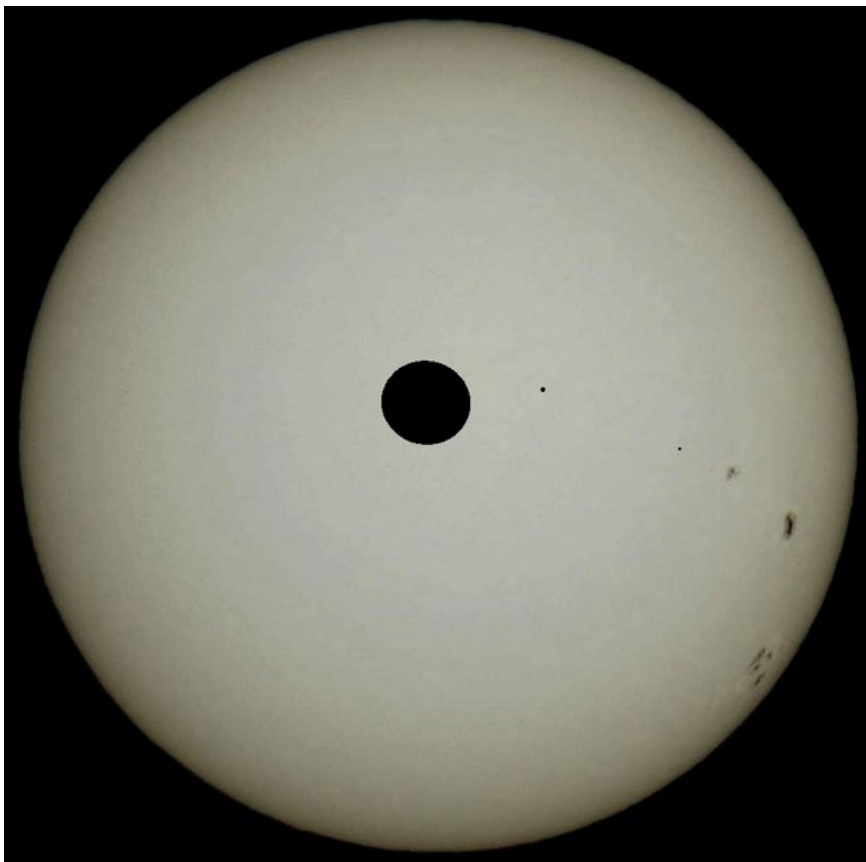
# radialna hitrost



radialna hitrost

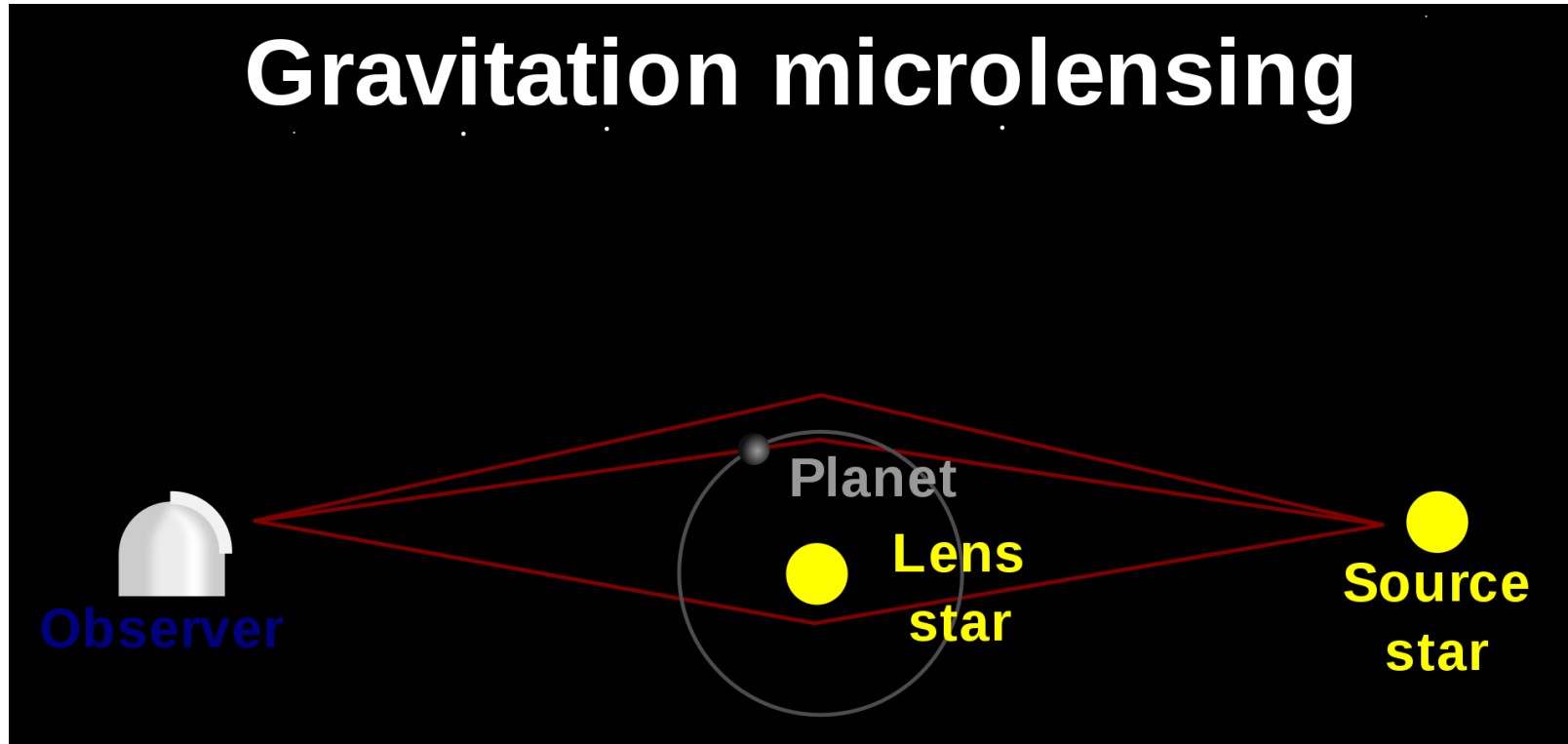


# fotometrija prehoda





# gravitacijsko mikrolečenje



# neposredno opazovanje

