

Drakova enačba

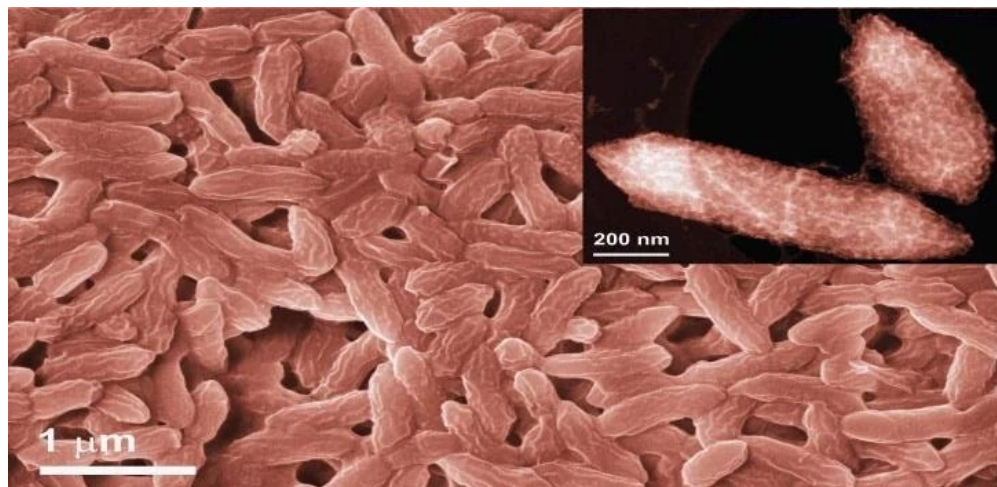
Aleš Mohorič

Presekov seminar za matematiko, fiziko in astronomijo

DMFA

2022-23

Kaj je življenje?

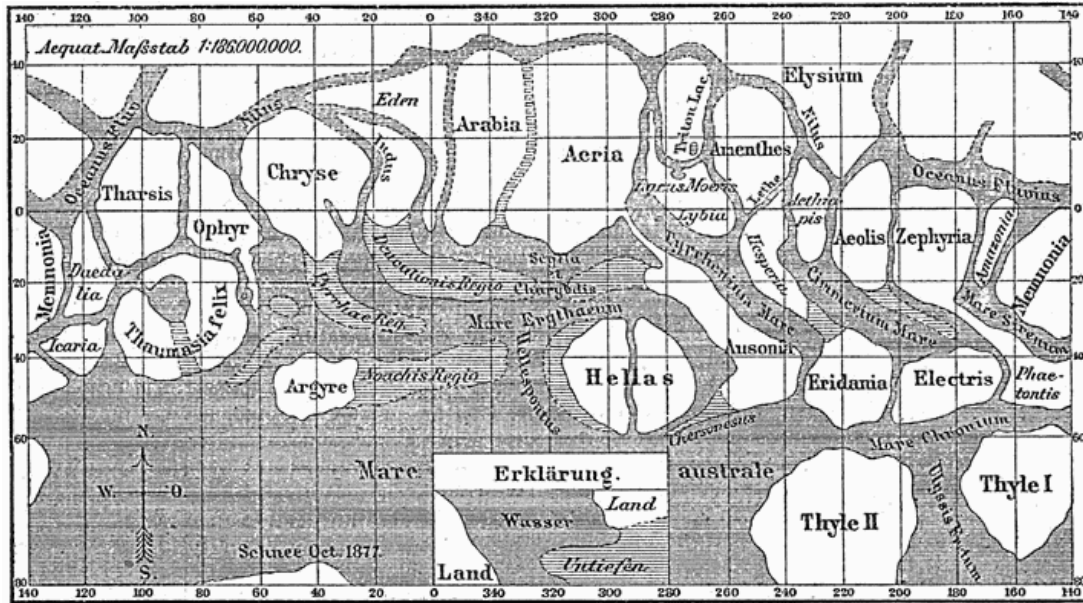


vodikove anaerobne bakterije

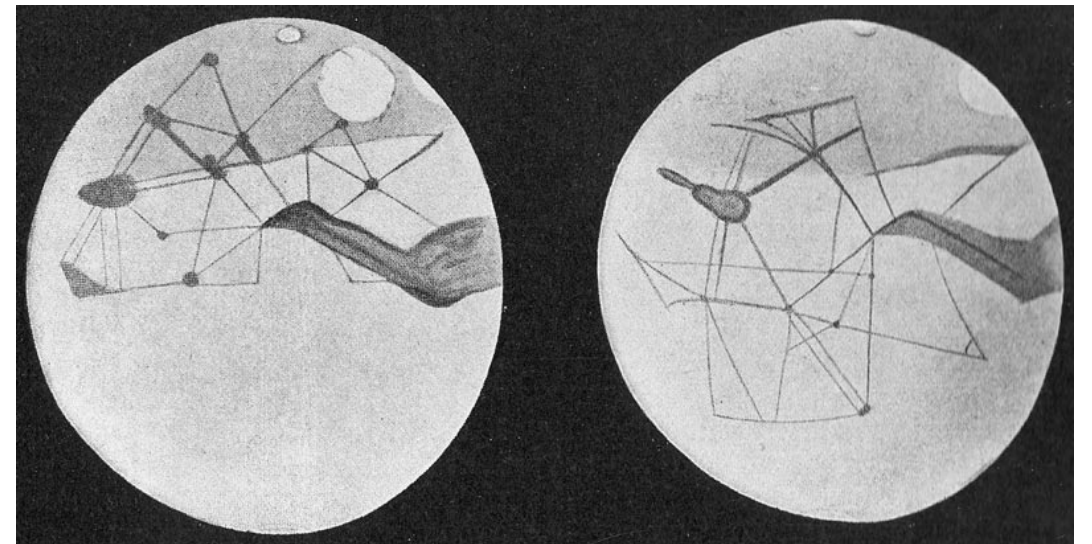


sodobni stromatoliti, Shark Bay, naredijo jih fotosintezirajoče cianobakterije

kanali na Marsu

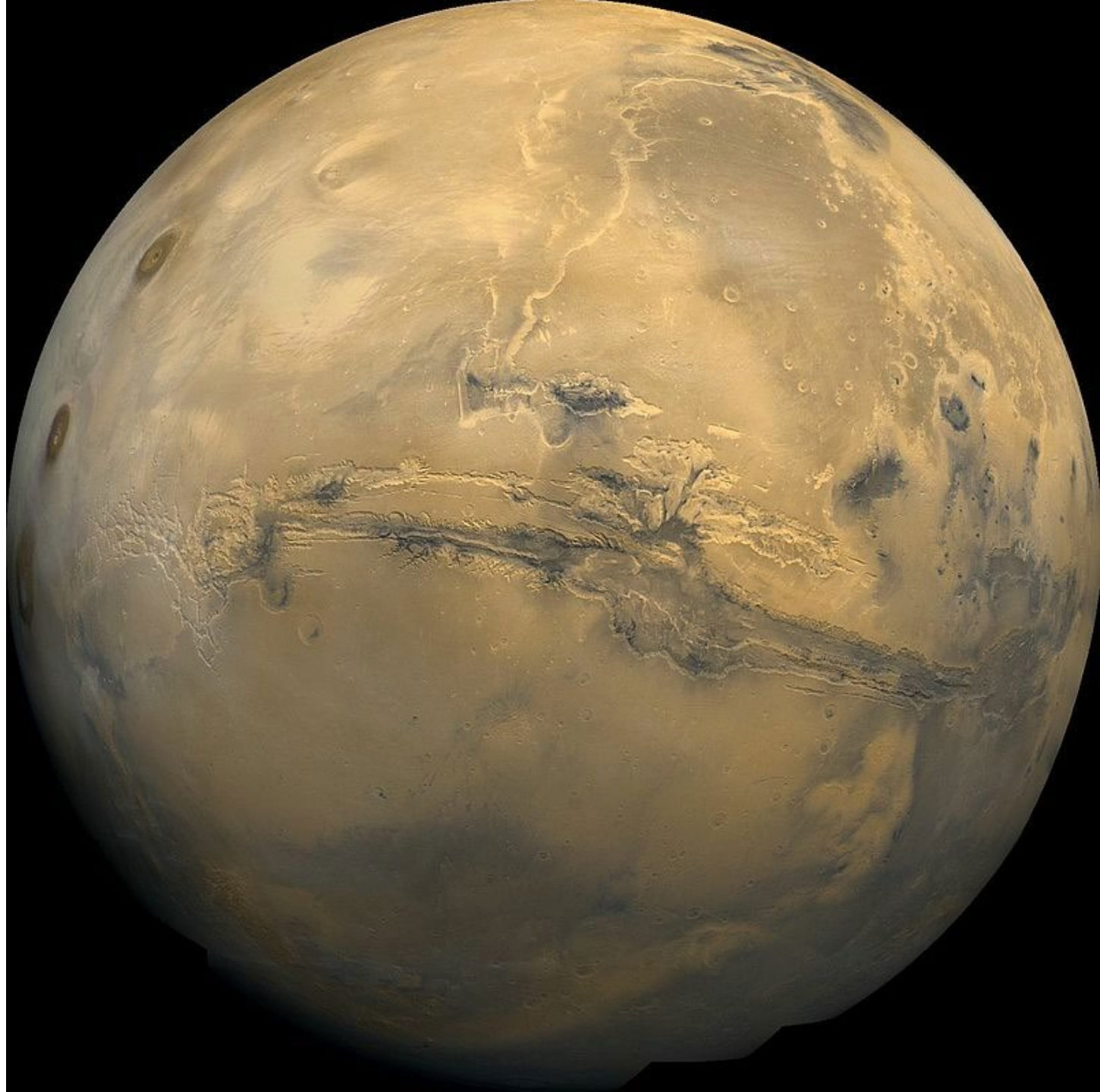


Giovanni Schiaparelli, 1877



Percival Lowell, 1906

Valles Marineris,
Viking 1,
1980



vesoljci



Roswell, Area
51 (1947)

Haredevil Hare
(1948)



vesoljci



Roswell, Area
51 (1947)



Haredevil Hare
(1948)



vesoljci

klingsoni, Star Trek (1967)



ET (1982)

klingsoni, Star Trek (1979)



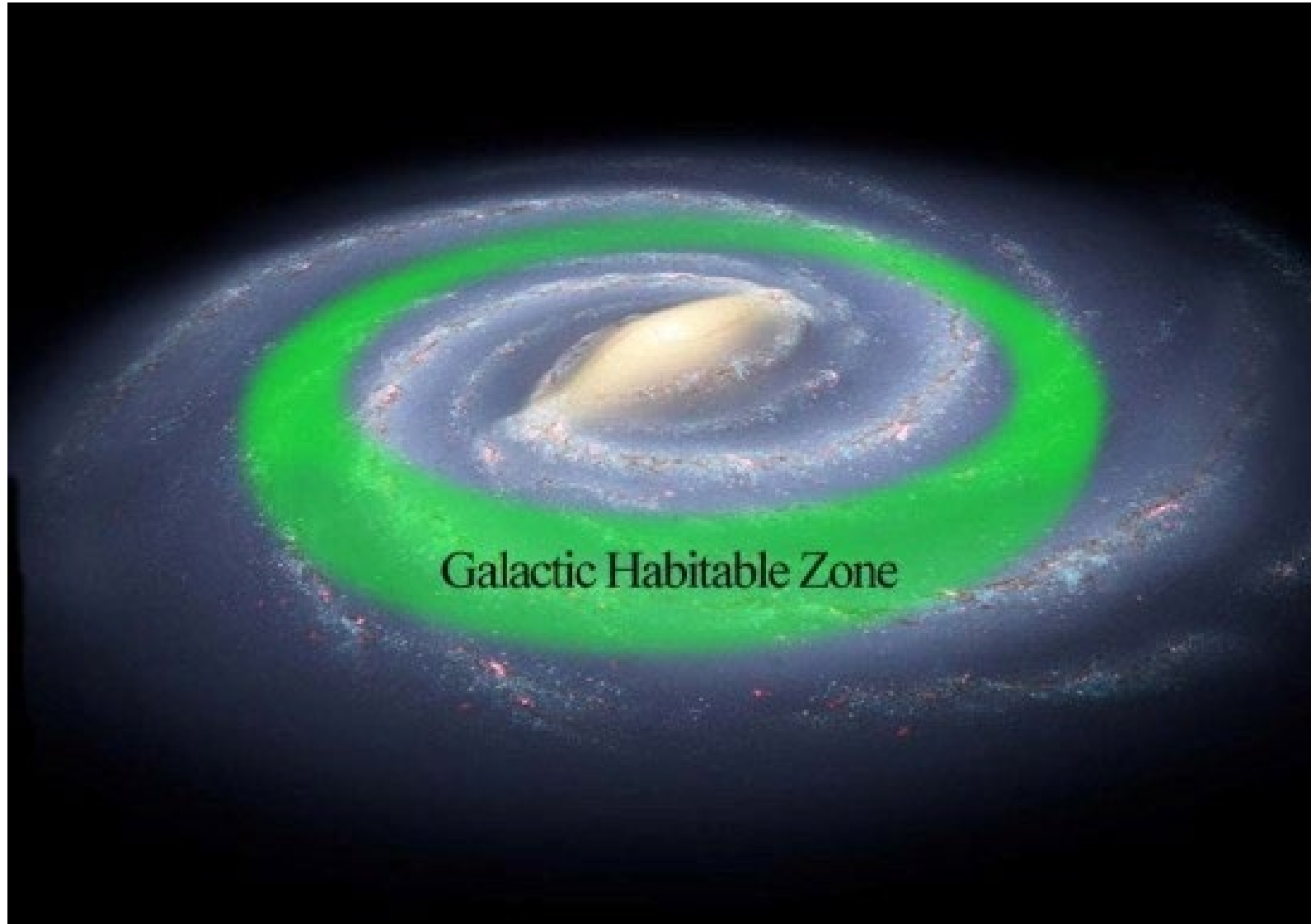
Life (2017)

kako zaznati življenje?

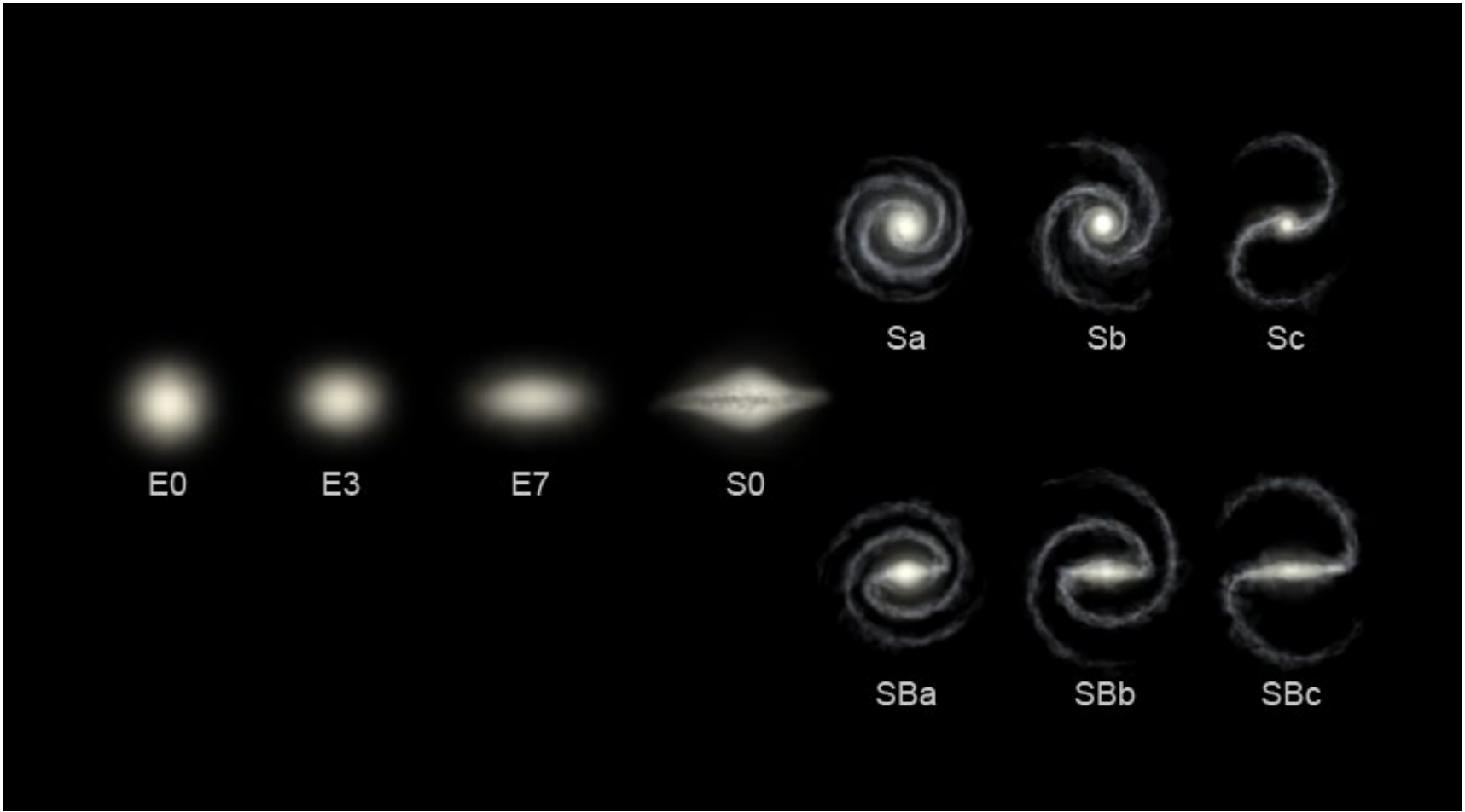
- metan
- voda
- kisik oziroma ozon
- klorofil



habitabilno območje galaksije



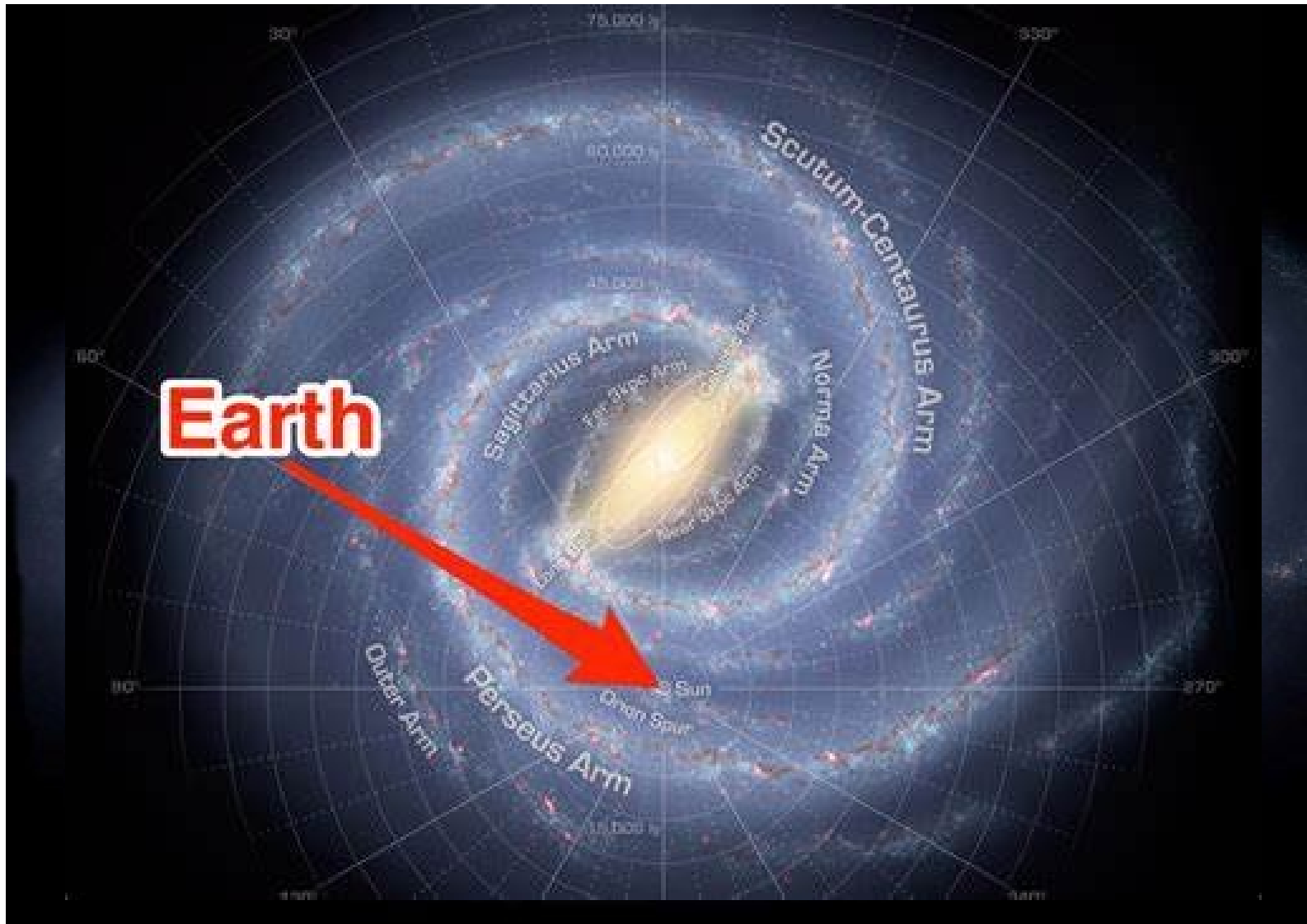
galaksija



- Deep view
- JWST



habitabilno območje galaksije



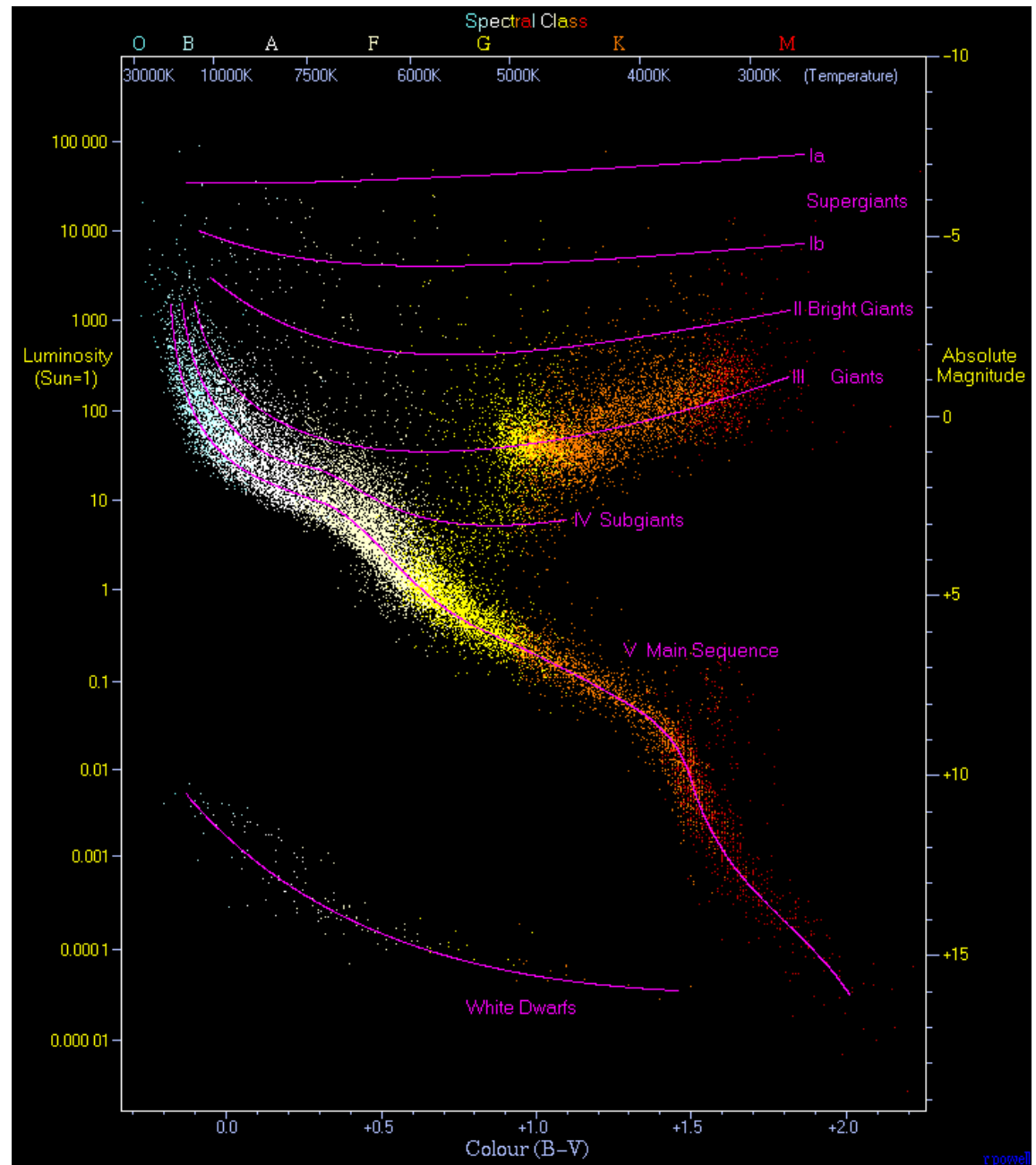
glavna veja

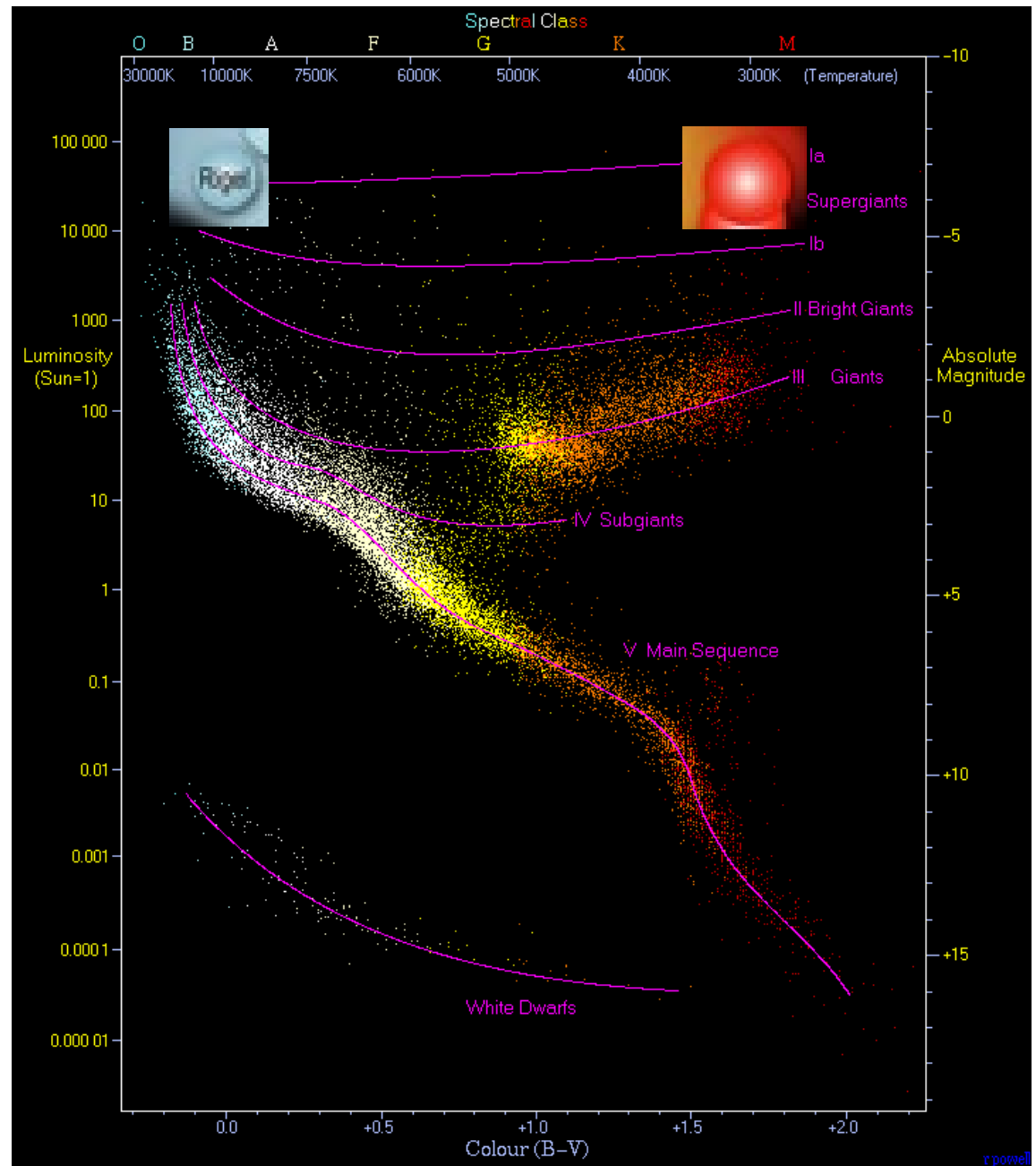


Orion:
modrobeli Rigel,
rdeča Betelgeza

glavna veja

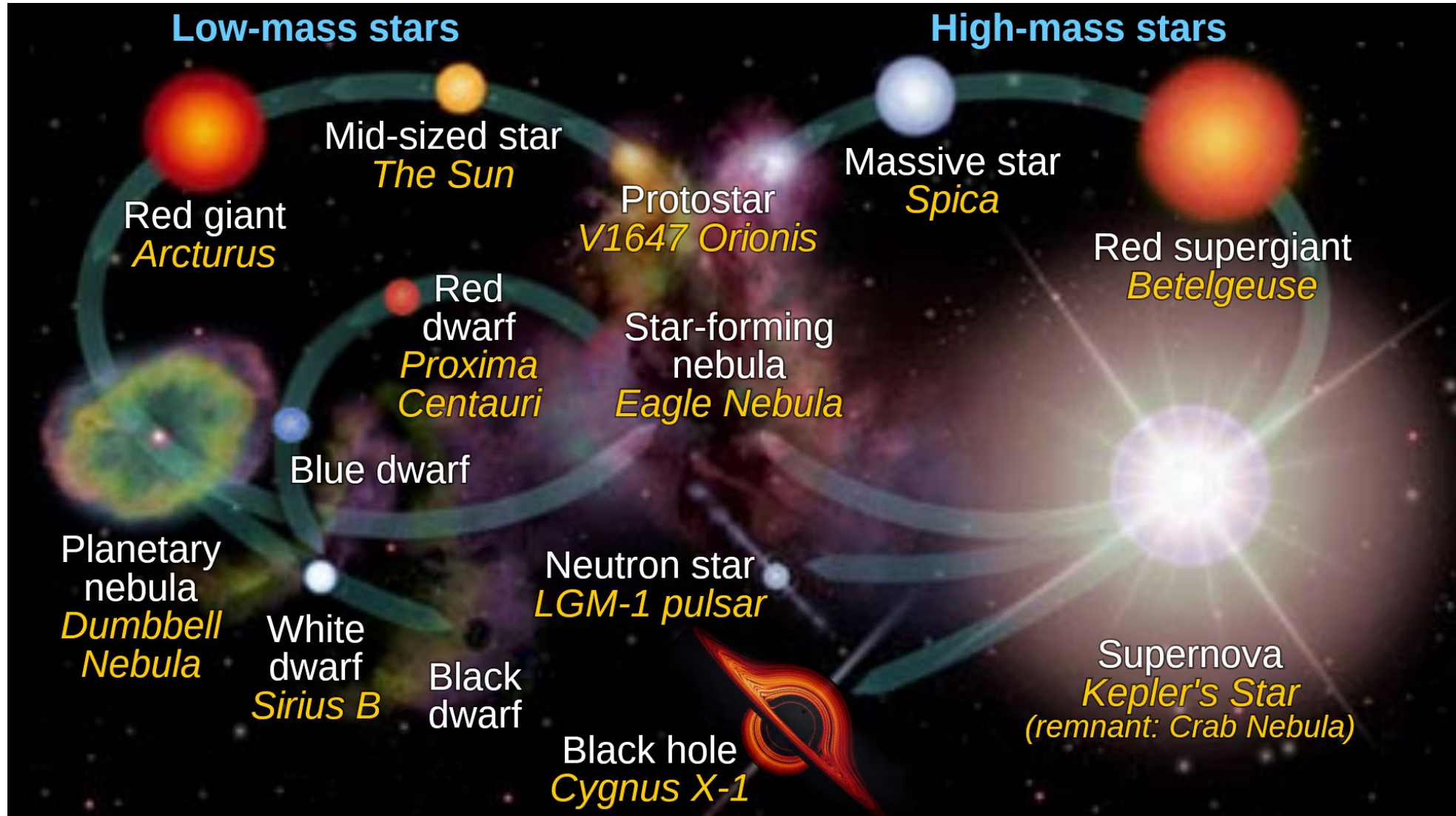
Hertzsprung–Russell diagram



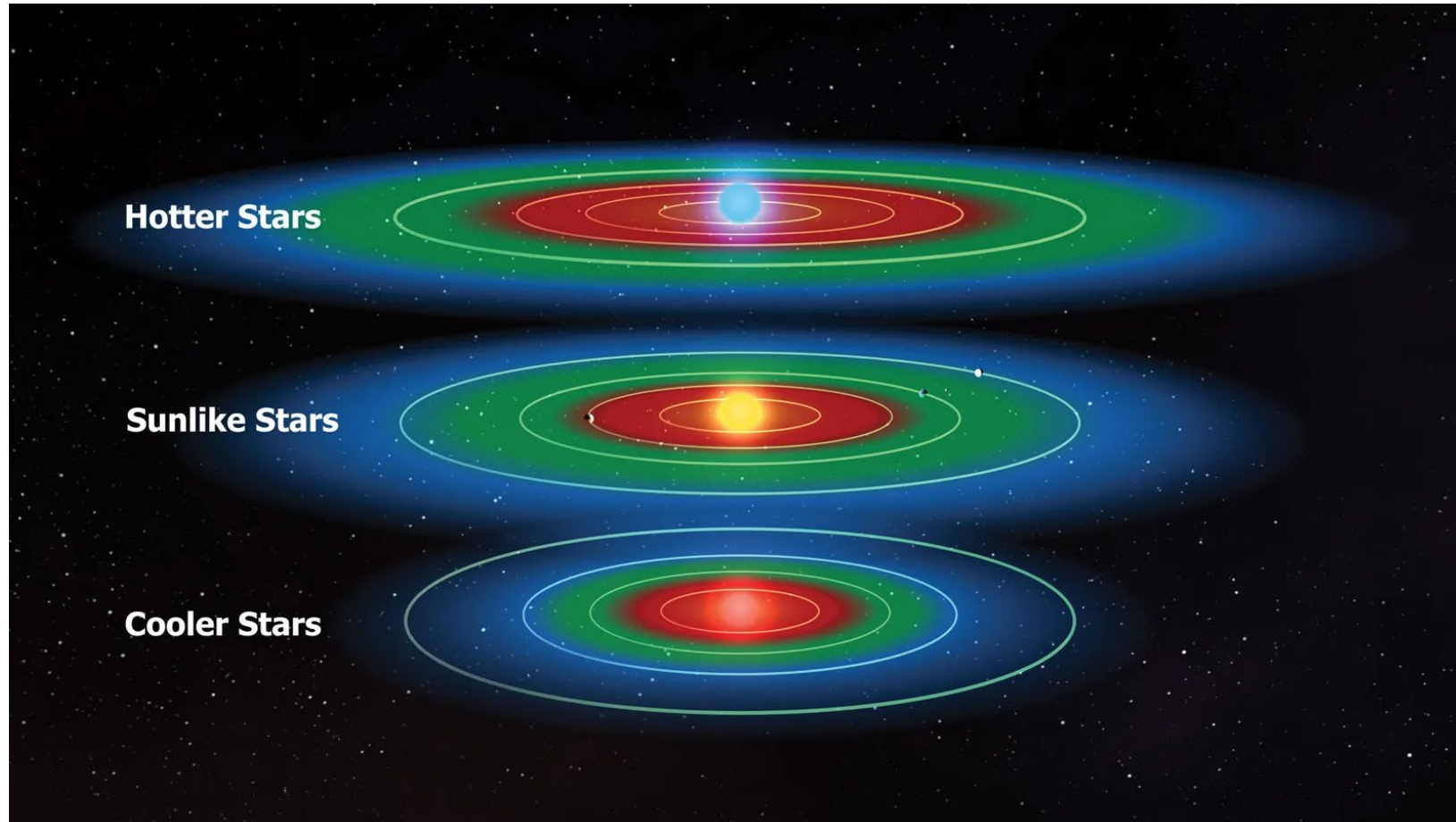


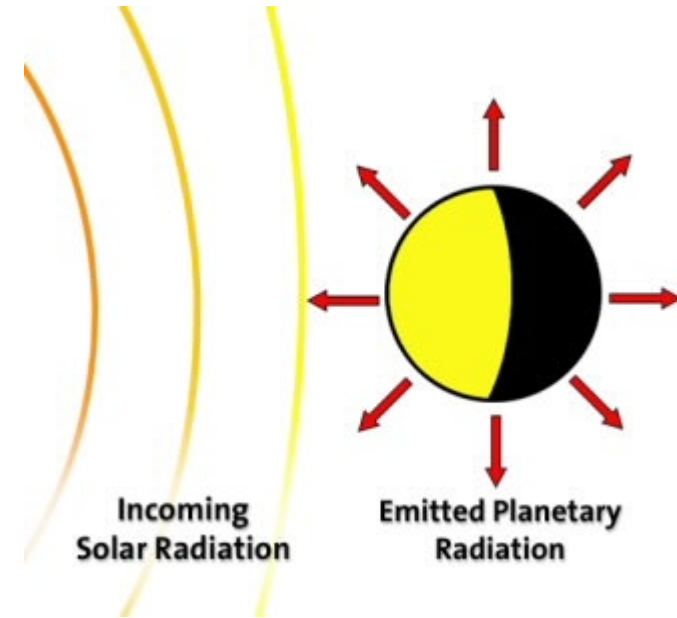
Orion: modrobel Rigel, rdeča Betelgeza

življenje zvezde

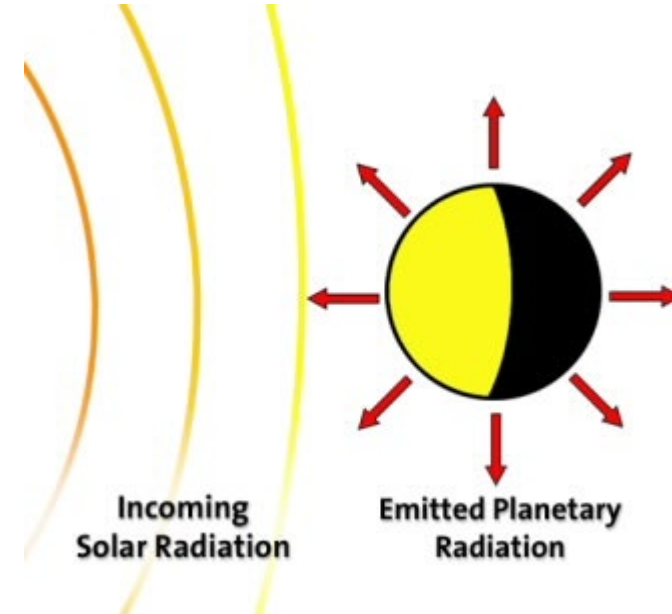


habitabilno območje zvezde



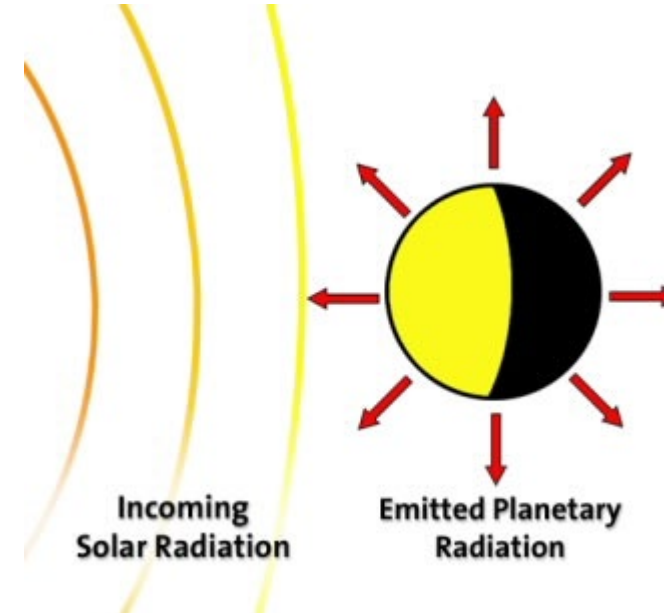


- $\frac{P}{4\pi r^2} \pi r_p^2 = \sigma T^4 4\pi r_p^2$



$$\bullet \frac{P}{4\pi r^2} \pi r_p^2 = \sigma T^4 4\pi r_p^2$$

$$\bullet r = \sqrt{\frac{P}{16\pi\sigma T^4}}$$

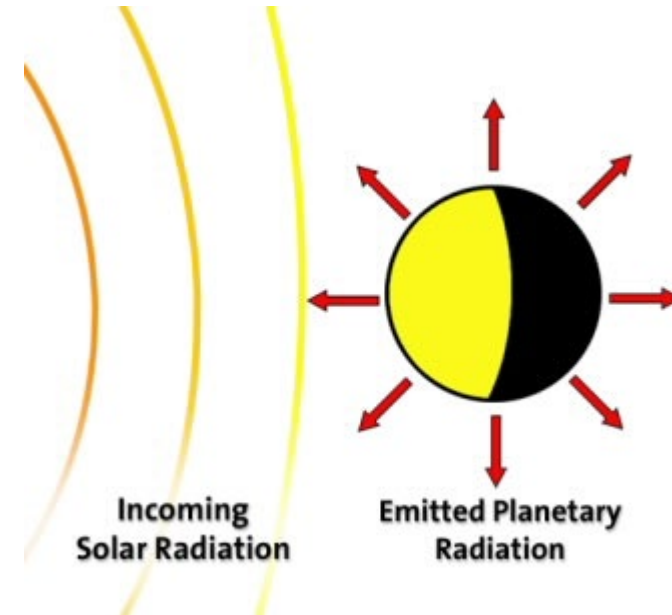


- $\frac{P}{4\pi r^2} \pi r_p^2 = \sigma T^4 4\pi r_p^2$

- $r = \sqrt{\frac{P}{16\pi\sigma T^4}}$

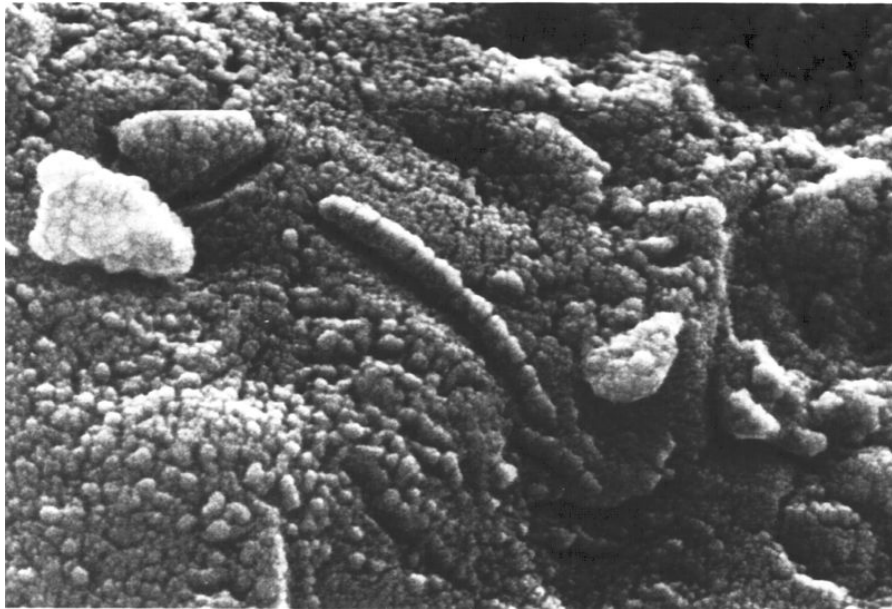
- $P = 4 \cdot 10^{26} \text{ W}, \sigma = 5,67 \cdot 10^{-8} \frac{\text{W}}{\text{m}^2 \text{K}^4}, 273 \text{ K} < T < 373 \text{ K}$

- $1,6 \cdot 10^{11} \text{ m} > r > 8,5 \cdot 10^{10} \text{ m}$

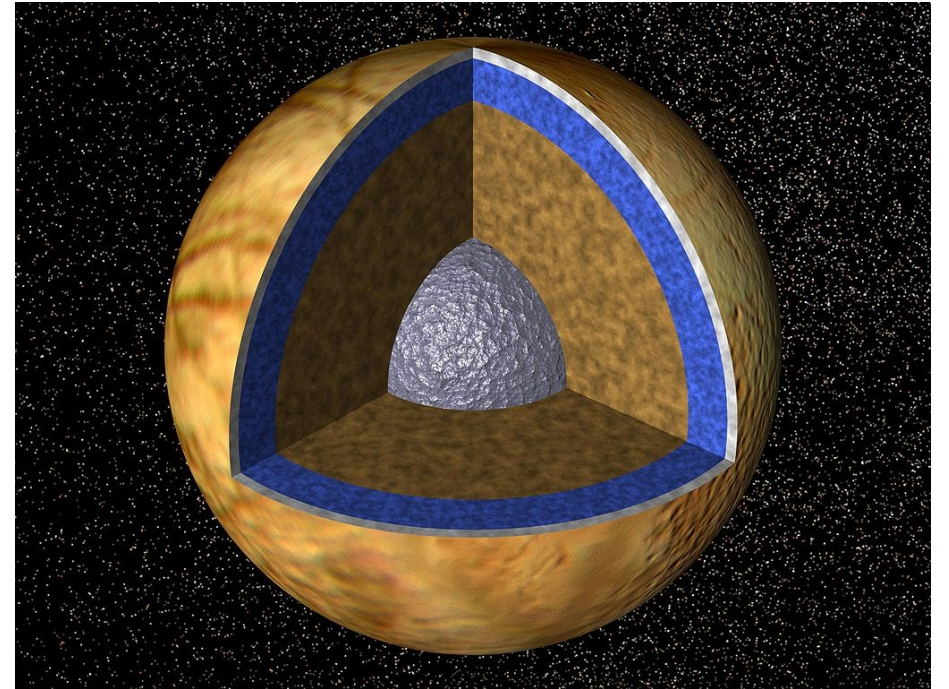


življenje v Osončju

- Merkur – ne, nima atmosfere,
- Venera – ne, prevroča,
- Mars – morda, mikroskopsko
- Jupiter, Saturn – ne, hladna, brez trdne površine
- Evropa, Jupitrova luna – možno, slani ocean, ni fotosinteze, plimsko segrevanje
- Titan, Saturnova luna – morda, gosta atmosfera



strukture na meteoritu ALH84001

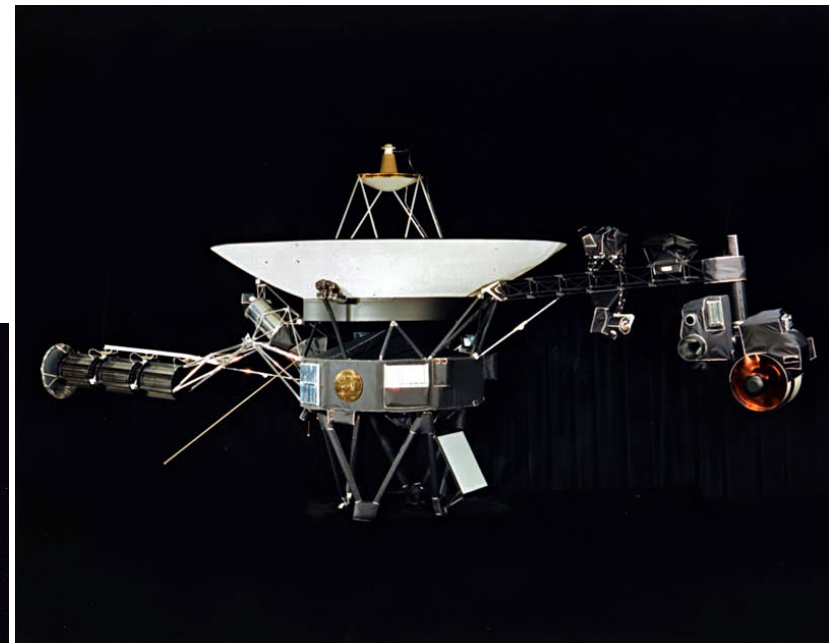


Evropa

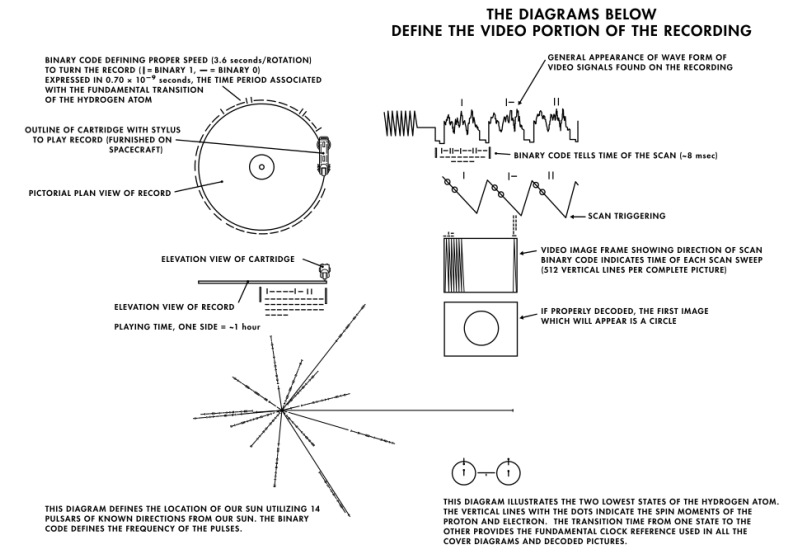
SETI



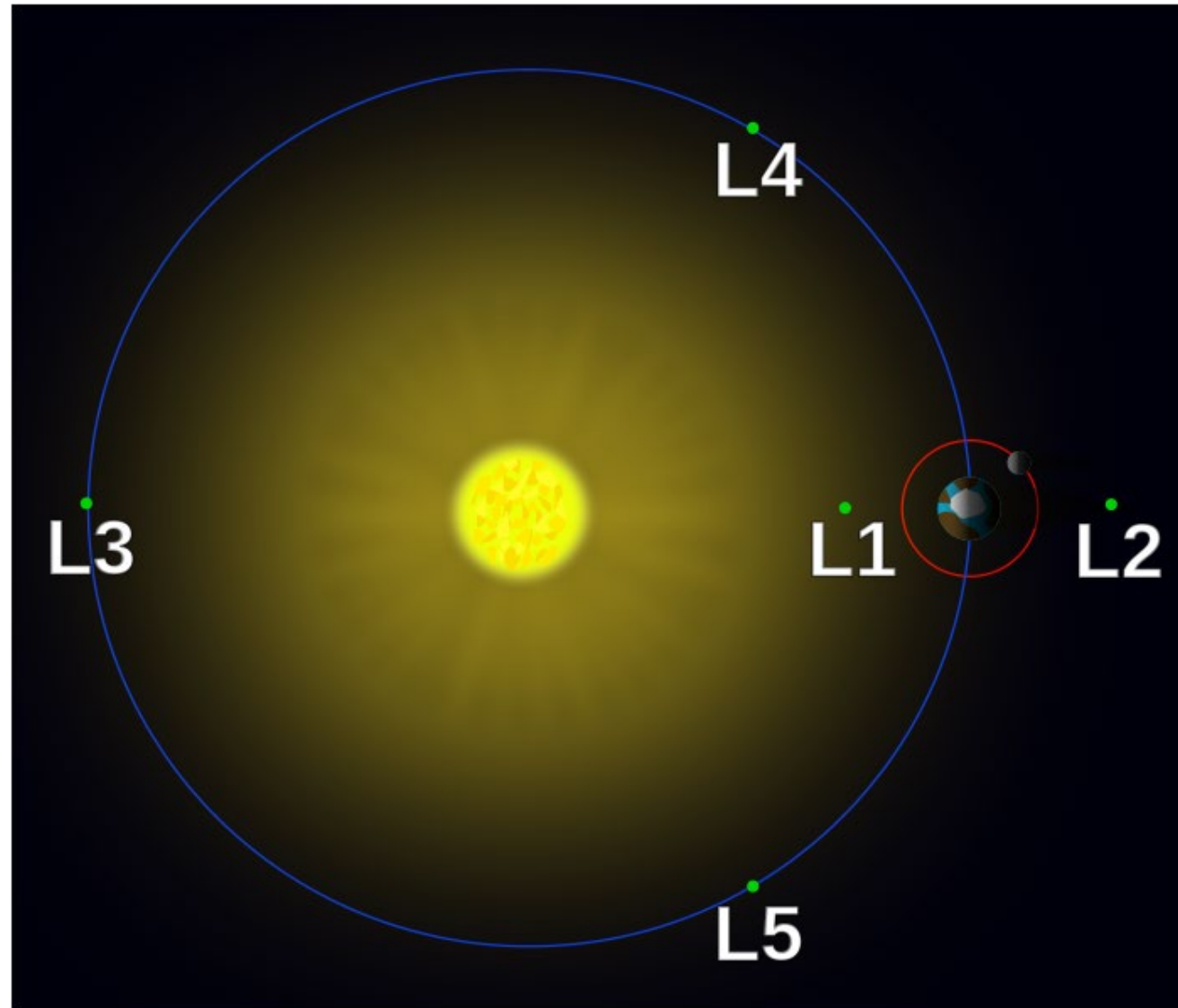
Voyager Golden Record



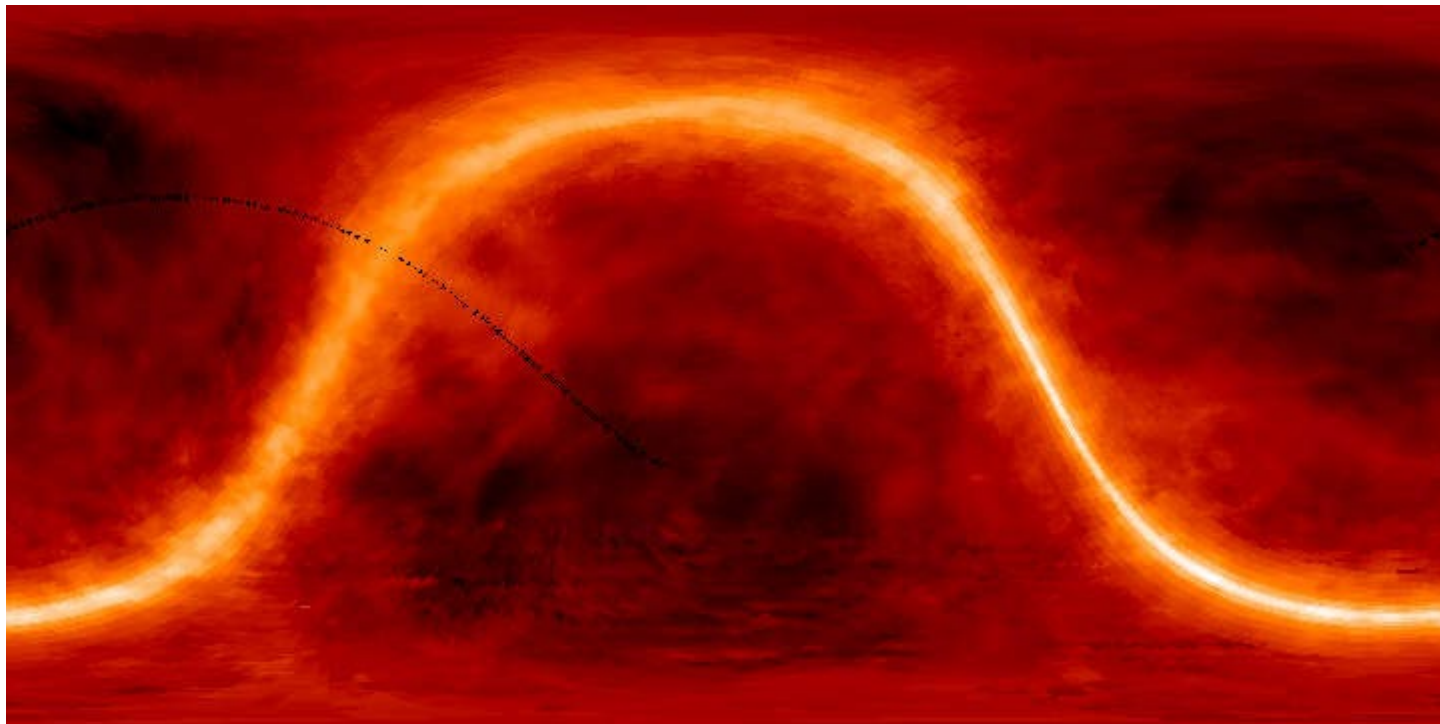
EXPLANATION OF RECORDING COVER DIAGRAM



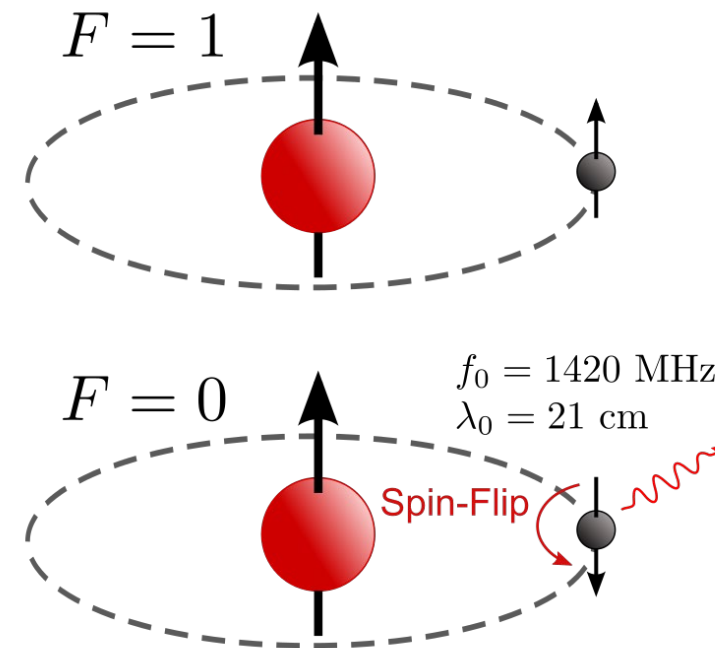
Lagrangeva točka L2



črta pri 21 cm



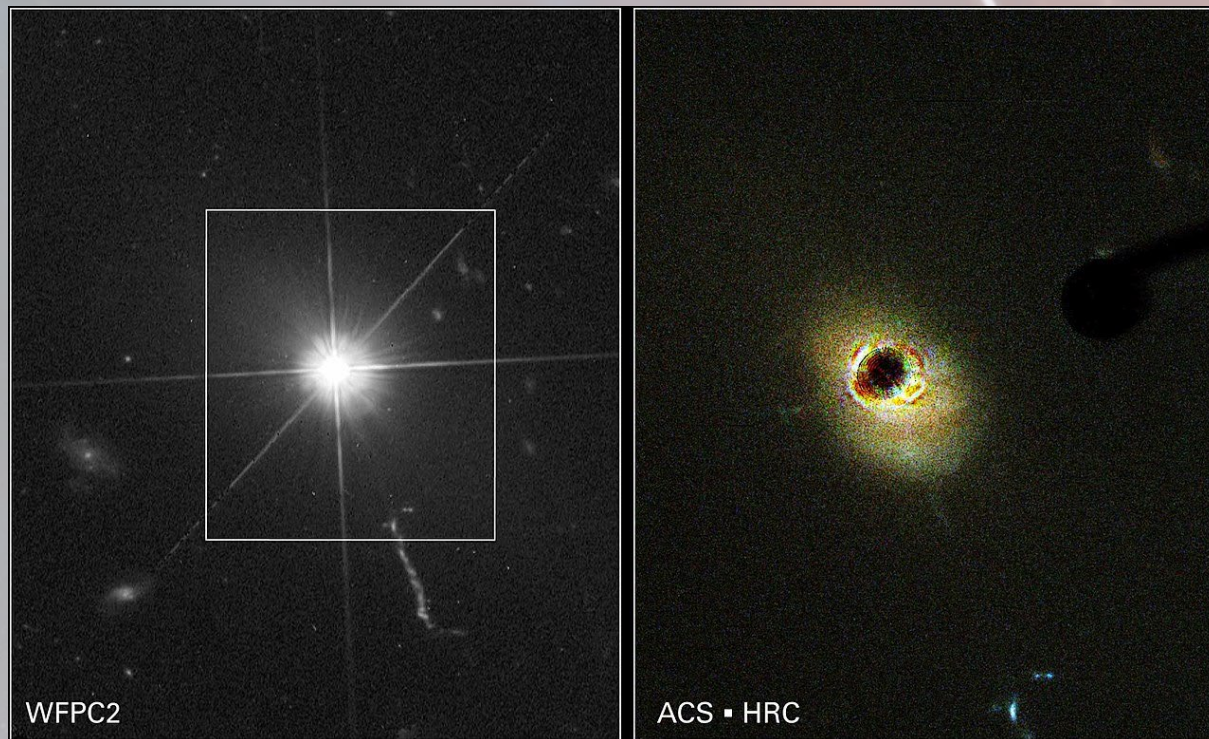
slika celotnega neba pri valovni dolžini 21 cm



hiperfina sklopitev

kvazar

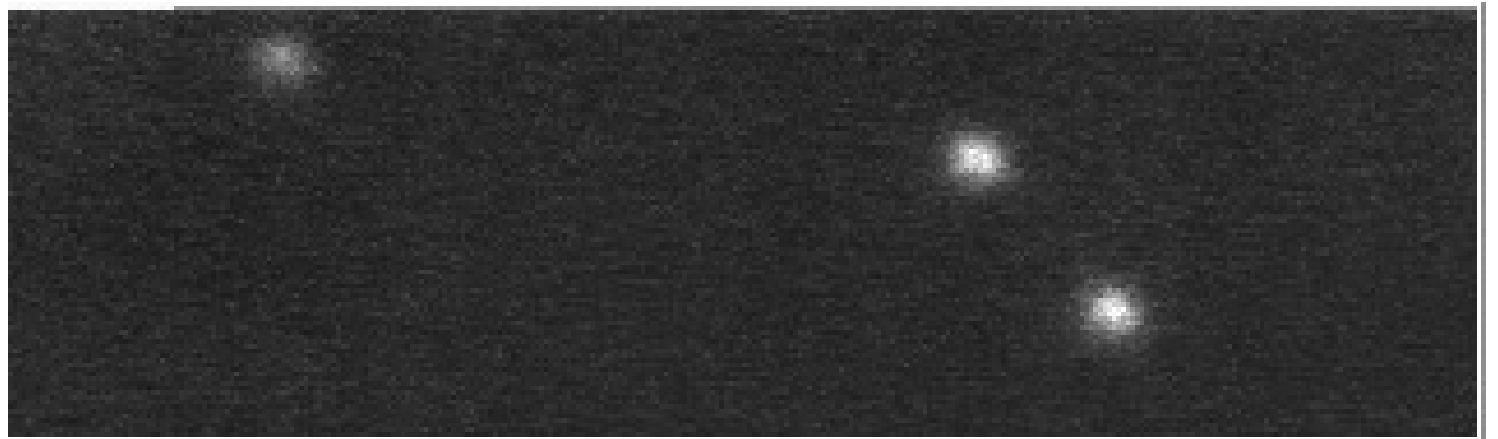
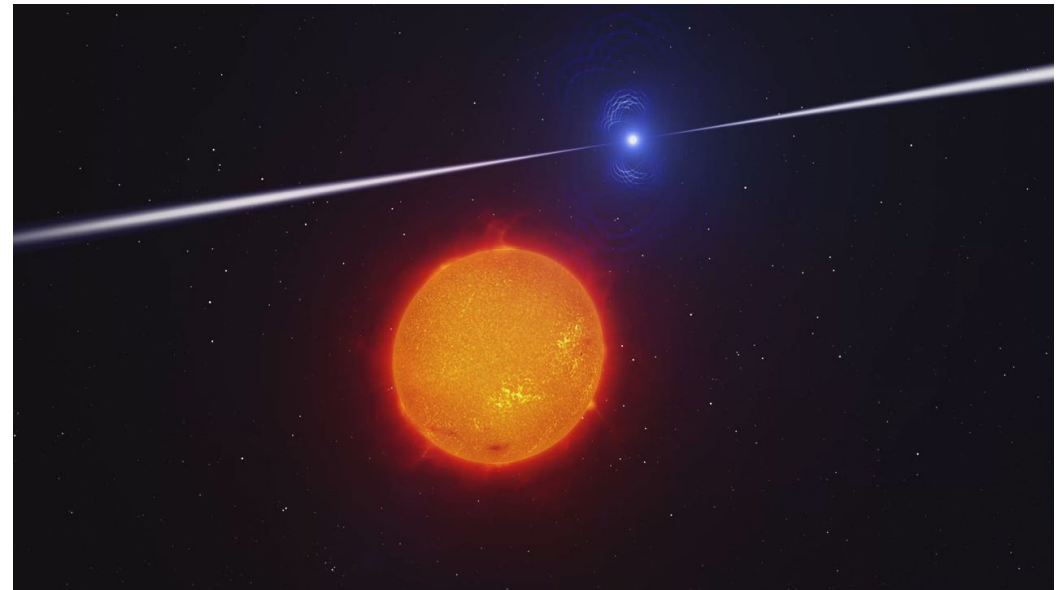
- zelo svetlo galaktično jedro



Hubble, kvazar 3C 273. Desno: koronograf z matično galaksijo

pulzar

Pulsa(ting) r(adio source), močno namagnetena, vrteča se nevtronska zvezda, ki oddaja curke elektromagnetnega valovanja iz magnetnih polov



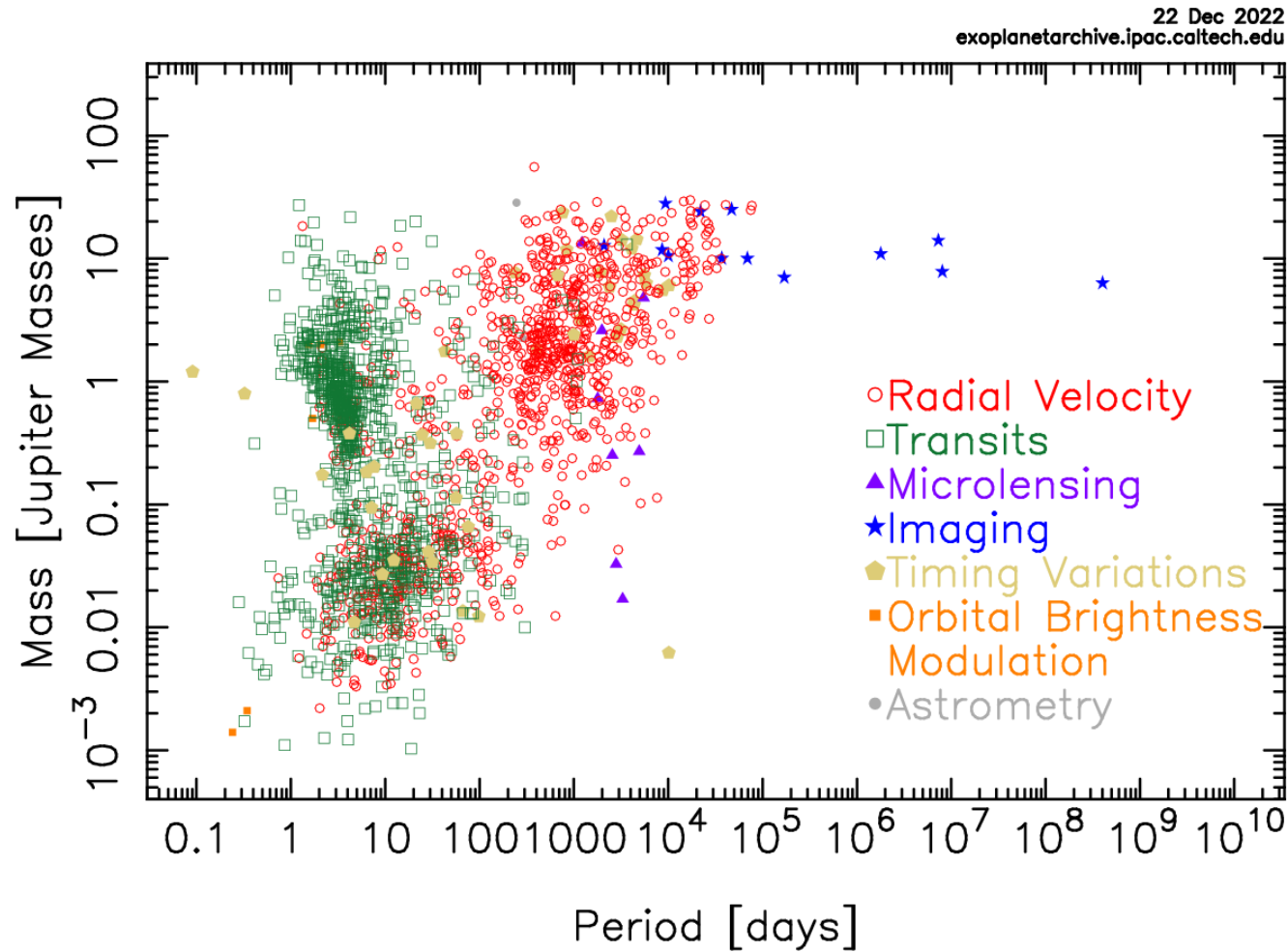
Crab Pulsar

N = ena ali milijon?

- $N = R \cdot f_s \cdot f_p \cdot E \cdot f_h \cdot f_l \cdot f_i \cdot f_c \cdot V$
- N – število civilizacij v Galaksiji, s katerimi bi se hipotetično lahko sporazumevalo.
- R – frekvenca nastajanja zvezd $\sim 2/\text{leto}$
- f_s – delež Soncu podobnih zvezd $\sim 0,1$
- f_p – delež teh zvezd z lastnimi planeti ~ 1
- E – povprečno število planetov, ki omogočajo življenje, na zvezdo.
- f_h – delež naseljivih planetov; $E \cdot f_h \sim 0,4$.
- f_l – delež planetov, kjer se življenje zares razvije ~ 1
- f_i – delež planetov, kjer se razvije inteligentno življenje $\sim 1\text{mio}/4,6\text{mrd}(?)$.
- f_c – delež inteligentnih civilizacij, ki so razvila sredstva za medzvezdno komuniciranje ~ 0.1
- V – doba komuniciranja civilizacije $\sim 100-10^9$

eksoplaneti

Mass – Period Distribution



Extent of Human Radio Broadcasts



Thanks to Nick Ringer for the artist's conception of the Milky Way.
Taken from http://commons.wikimedia.org/wiki/File:Milky_Way_Galaxy.jpg