Esopianeti

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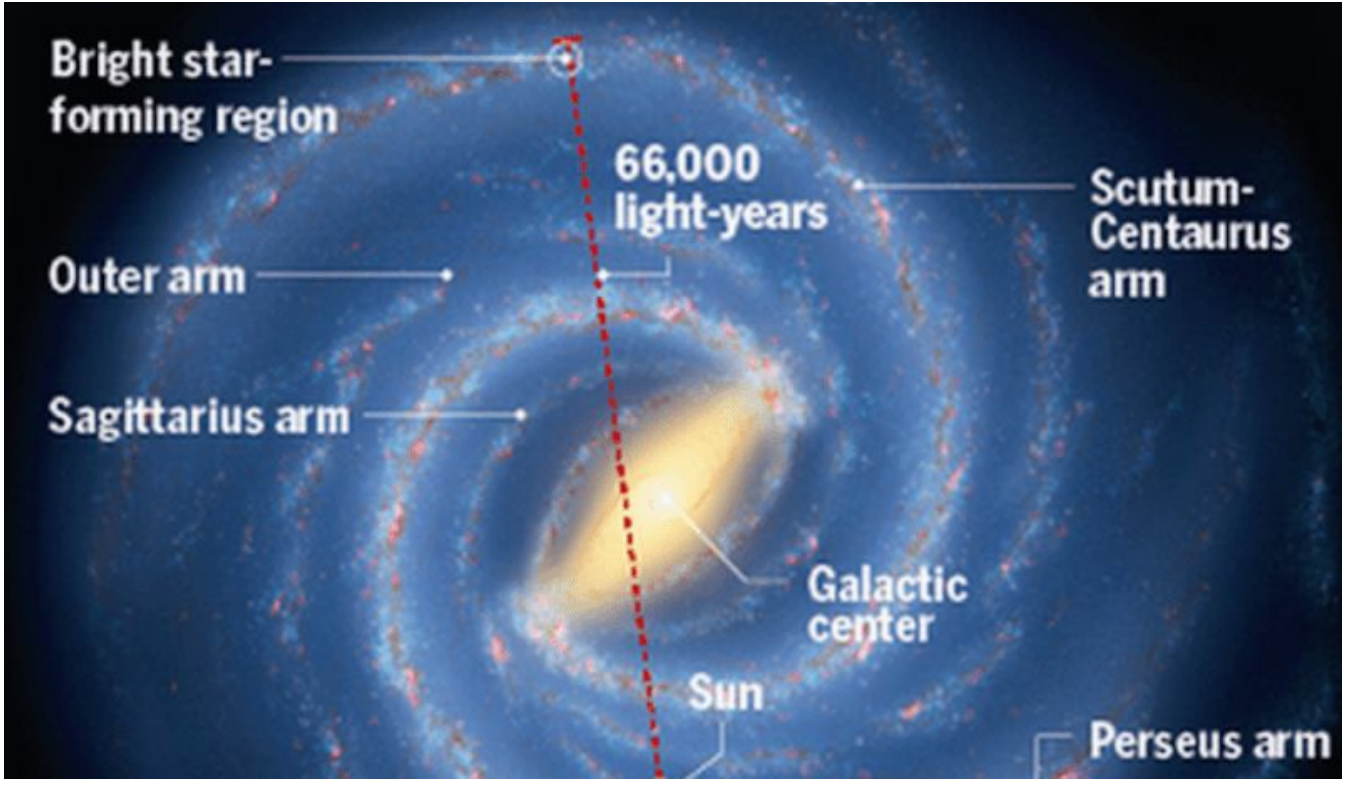
Contenuti

- Che cosa sono gli esopianeti, e dove si trovano?
- Perche’ sono importanti?
- La prima scoperta
- Metodi di ricerca
- Lo zoo degli esopianeti
- Ricerche future

Che cosa sono gli esopianeti, e dove si trovano?

La Via Lattea: 400 miliardi di stelle

Un anno luce: un anno a 300000 km/s, Un Parsec: 3.2 anni luce, La Via Lattea misura piu' di 70000 anni luce

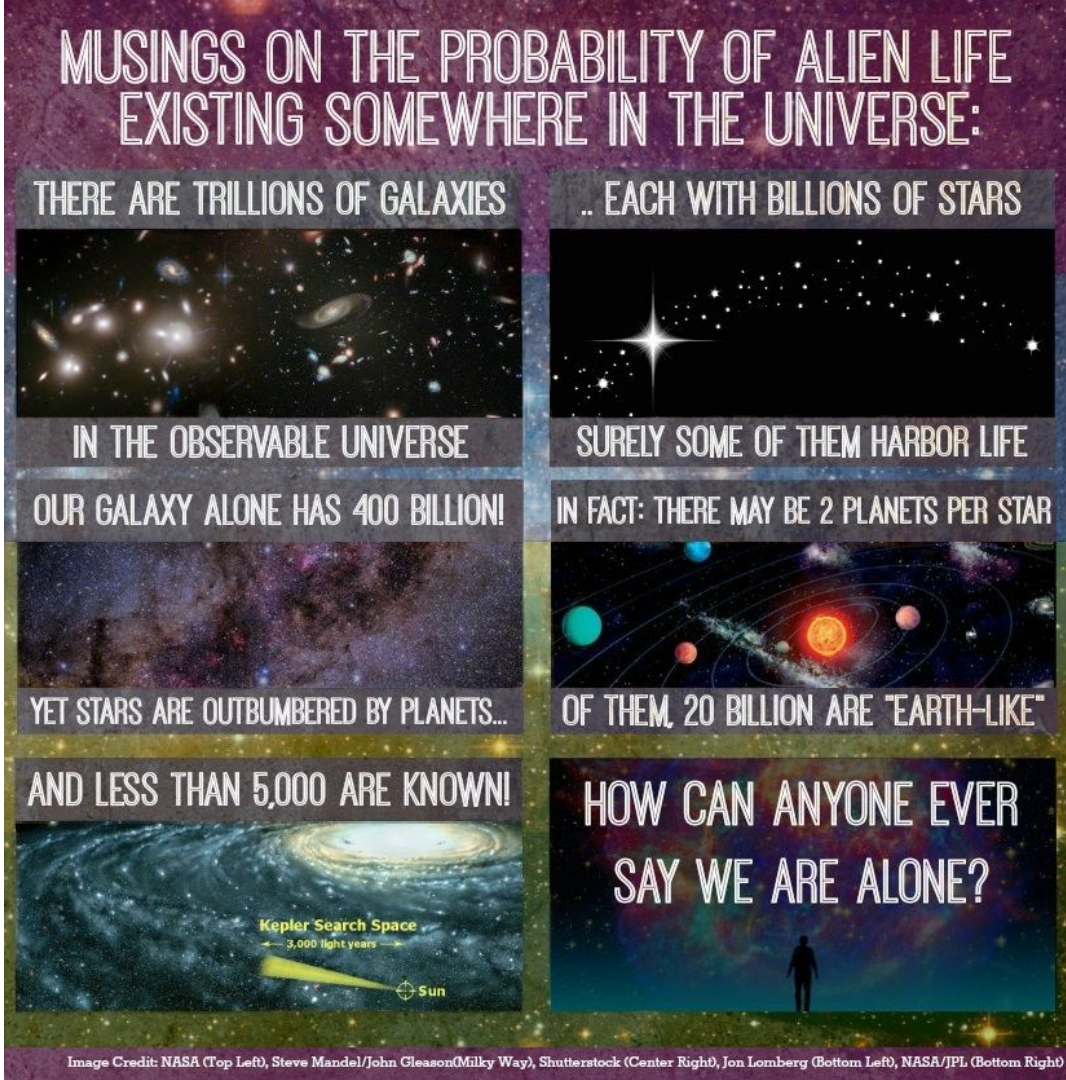


Esopianeti: pianeti orbitanti intorno alle stelle nell'Universo

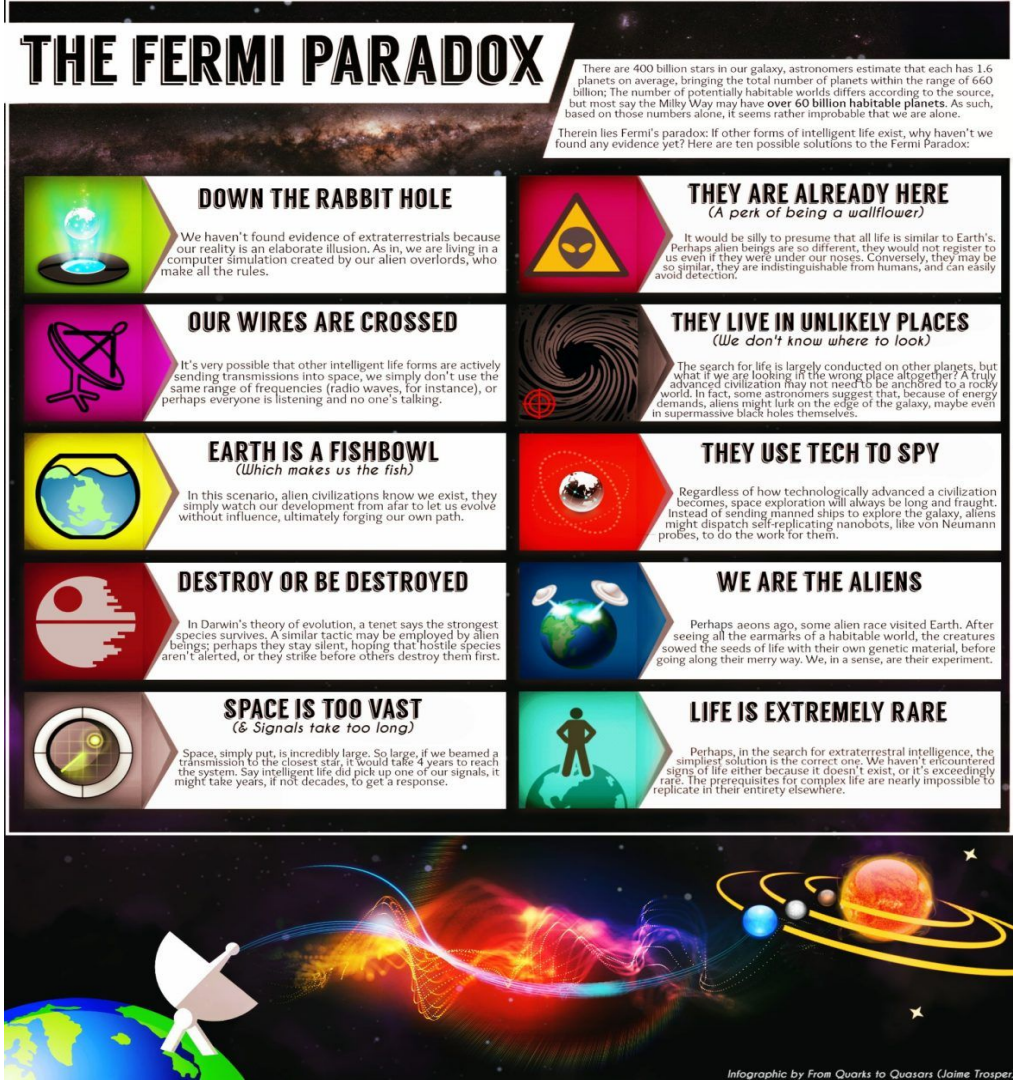
Perche’ sono importanti?

Siamo soli?

Paradosso di Fermi



Possibili soluzioni al paradosso di Fermi



Equazione di Drake

$$N = R_* \cdot f_P \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

N = number of civilizations with which humans could communicate

R_* = mean rate of star formation

f_P = fraction of stars that have planets

n_e = mean number of planets that could support life per star with planets

f_l = fraction of life-supporting planets that develop life

f_i = fraction of planets with life where life develops intelligence

f_c = fraction of intelligent civilizations that develop communication

L = mean length of time that civilizations can communicate

Equazione di Drake

$$N = R_* \cdot f_P \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

Sconosciuto	N = number of civilizations with which humans could communicate
Misurato	R_* = mean rate of star formation
Misurato	f_P = fraction of stars that have planets
Misura in atto	n_e = mean number of planets that could support life per star with planets
Sconosciuto	f_l = fraction of life-supporting planets that develop life
Sconosciuto	f_i = fraction of planets with life where life develops intelligence
Sconosciuto	f_c = fraction of intelligent civilizations that develop communication
Sconosciuto	L = mean length of time that civilizations can communicate

Astrobiologia: il mistero della formazione della vita nell'Universo

Molecole trovate nello spazio.

2 atomi	3 atomi	4 atomi	5 atomi	6 atomi	7 atomi	8 atomi	9 atomi
H_2	C_3	c-C3H	C_5	C_5H	C_6H	CH_3C_3N	CH_3C_4H
AlF	C_2H	l-C_3H	C_4H	l-H_2C_4	CH_2CHCN	$HCOOCH_3$	CH_3CH_2CN
AlCl	C_2O	C_3N	C_4Si	C_2H_4	CH_3C_2H	CH_3COOH?	$(CH_3)_2O$
C_2	C_2S	C_3O	l-C_3H_2	CH_3CN	HC_5N	C_7H	CH_3CH_2OH
CH	CH_2	C_3S	c-C_3H_2	CH_3NC	$HCOCH_3$	H_2C_6	HC_7N
CH+	HCN	C_2H_2	CH_2CN	CH_3OH	NH_2CH_3	CH_2OHCHO	C_8H
CN	HCO	CH_2D^+?	CH_4	CH_3SH	c-C_2H_4O		
CO	HCO+	HCCN	HC_3N	$HCONH_2$	CH_2CHOH		
CO+	HCS+	HCNH+	HC_3NC	HC_3NH^+			
CP	HOC+	HNCO	HCOOH	HC_2CHO			
CSi	H_2O	HNCS	H_2CHN	NH2CHO			
HCl	H_2S	HOCO+	H_2C_2O	C_5N			
KCl	HNC	H_2CO	H_2NCN				
NH	HNO	H_2CN	HNC_3				
NO	MgCN	H_2CS	SiH_4				
NS	MgNC	H_3O^+	H_2COH^+				
NaCl	N_2H^+	NH_3					
OH	N_2O	SiC_3					
PN	NaCN	CH_3					
SO	OCS						
SO+	SO_2						
SiN	c-SiC_2						
SiO	CO_2						
SiS	NH_2						
CS	H_3^+						
HF	SiCN						
SH	AlNC						
FeO?	H_2D^+						

10 atomi	11 atomi	12 o più atomi
CH_3C_5N?	HC_9N $HC_{11}N$	C_6H_6?
$(CH_3)_2CO$		PAH
NH_2CH_2COOH?		C_{60}+?

Acido cianidrico

Formammide

Acido acetico

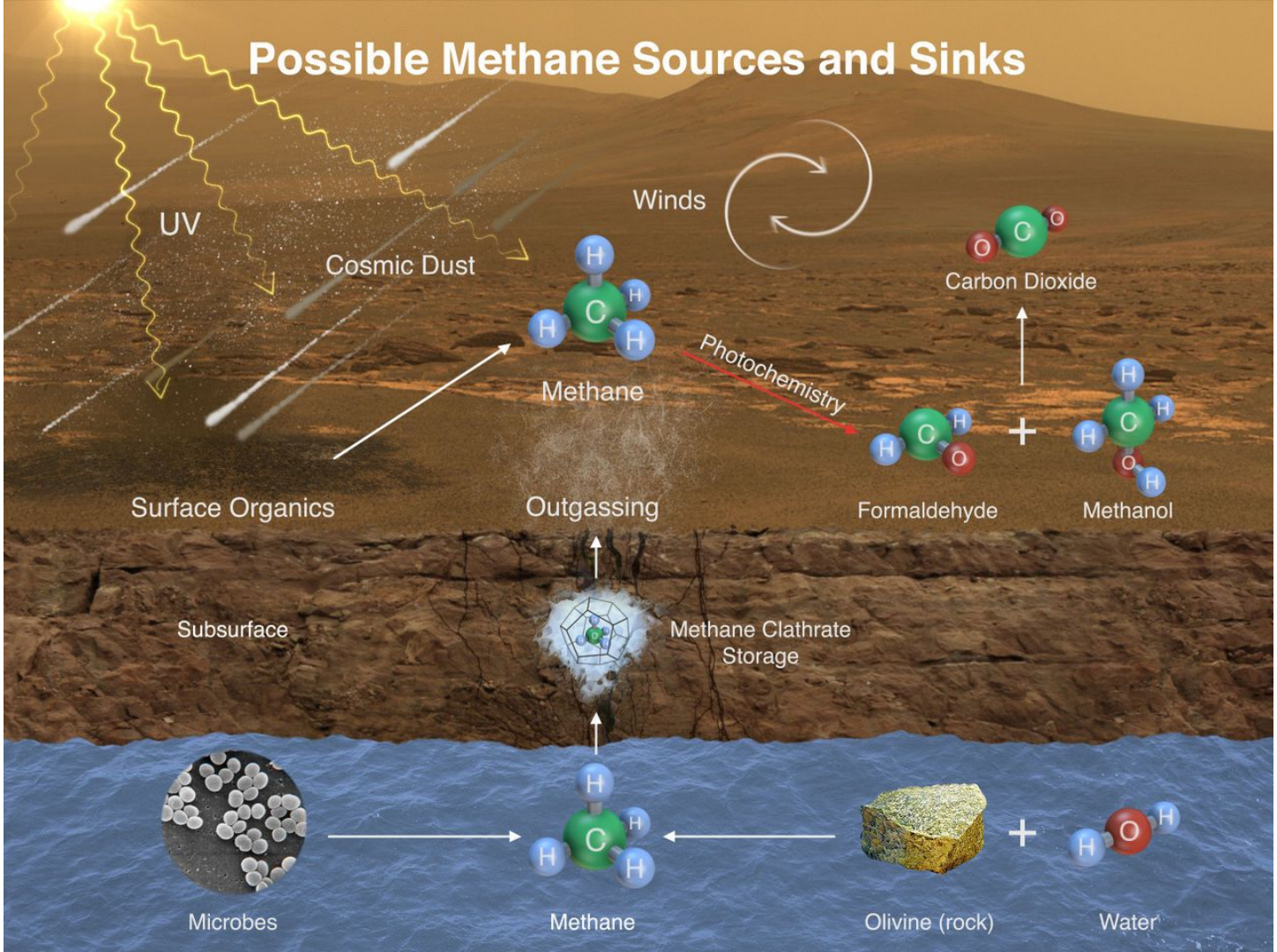
Glicolaldeide

Acido formico

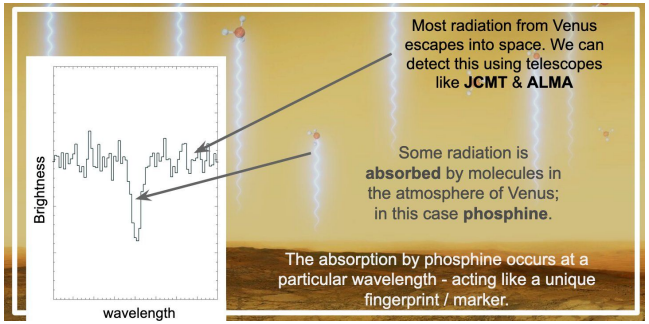
Glicina

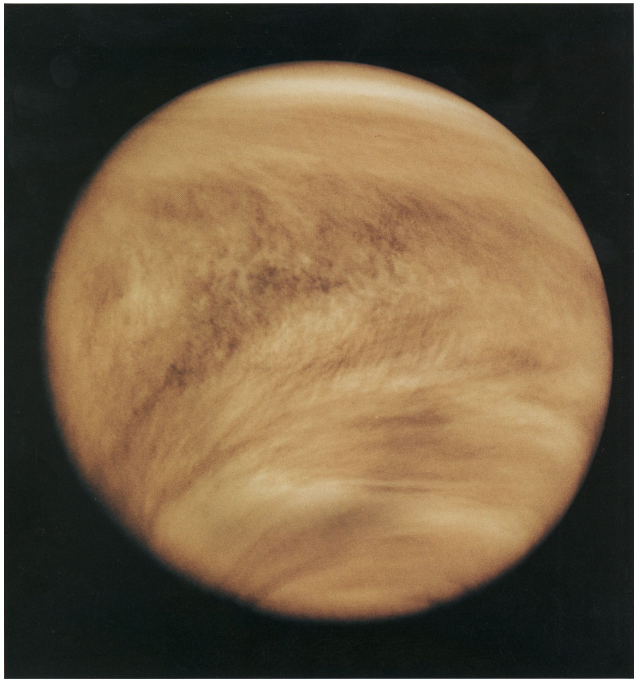
Idrocarburi Policiclici Aromatici

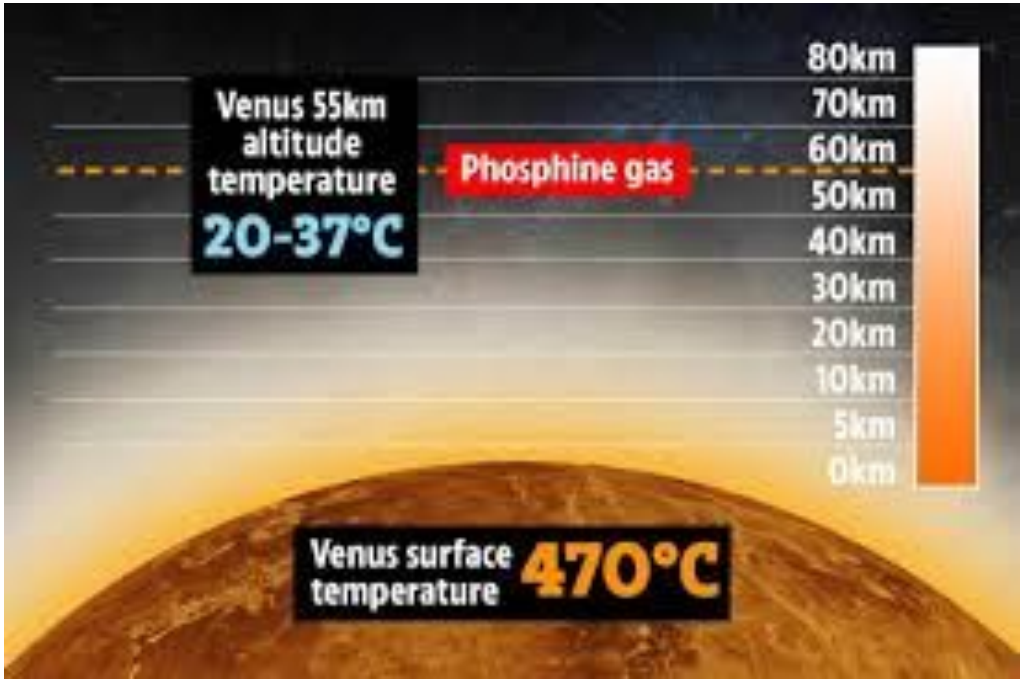
Fullereni


Possible Methane Sources and Sinks
UV
Cosmic Dust
Winds
Carbon Dioxide
Methane
Photochemistry
Surface Organics
Outgassing
Formaldehyde
Methanol
Subsurface
Methane Clathrate
Storage
Microbes
Methane
Olivine (rock)
Water

Vita su Venere?







Symbols explain the record's use

1. This overhead illustration of the record shows the correct placement of the stylus. Binary arithmetic surrounding the record explains that it should be played at 3.6 seconds per rotation.

2. A side-view of record and stylus has binary arithmetic below it to show that the record has about an hour of play time.

3. This diagram and the three below explain the images on the record. The wavelengths illustrate how pictures are constructed of analogue video signals, with binary arithmetic showing that each scan lasts eight milliseconds.

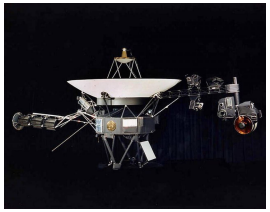
4. Picture lines one, two and three show that they are drawn vertically with a staggered interlace.

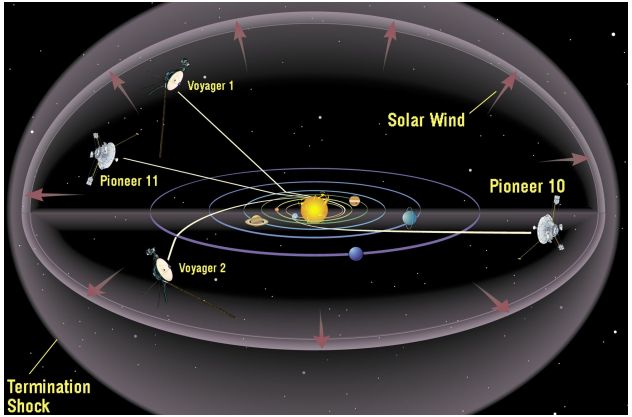
5. This is an image frame showing that each scan is vertical and each image contains 512 lines.

6. If the pictures are rendered correctly, the first image on the record should match this image.

7. This pulsar map shows the location of our Sun and the direction of 14 of its pulsars. Binary code along each pulsar gives the frequency.

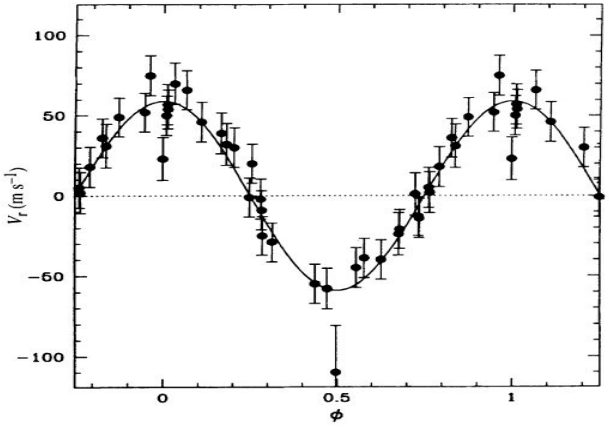
8. This illustration shows the two lowest states of the hydrogen atom. The vertical lines and dots show the spin moments of each atom's proton and electron. The connecting line and '1' show that the transition from one state to another is to be used as the timescale for all pictures on the cover as well as on the record.

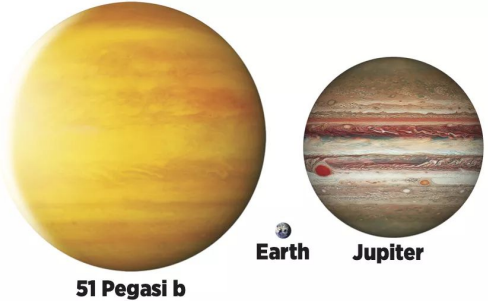




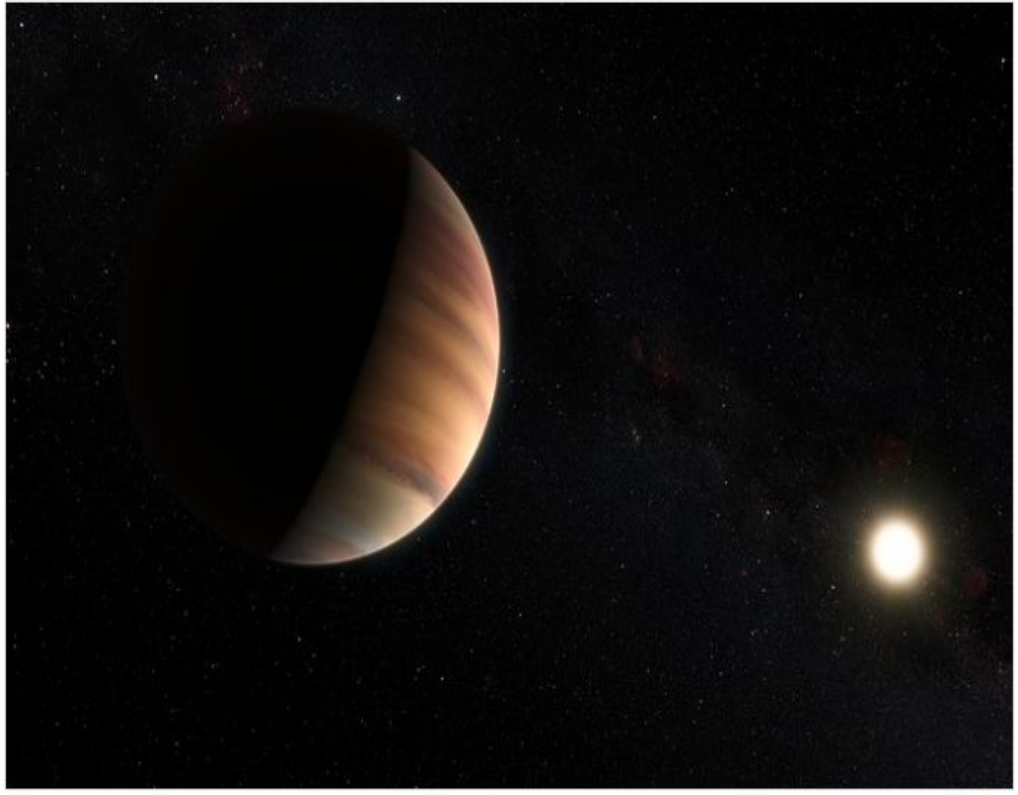
Il Primo Esopianeta

Il primo Esopianeta





Artist's impression of the exoplanet 51 Pegasi b



This artist's view shows the hot Jupiter exoplanet 51 Pegasi b, sometimes referred to as Bellerophon, which orbits a star about 50 light-years from Earth in the northern constellation of Pegasus (The Winged Horse). This was the first exoplanet around a normal star to be found in 1995. Twenty years later this object was also the first exoplanet to be be directly detected spectroscopically in visible light.

Credit: ESO/M. Kornmesser/Nick Risinger (skysurvey.org)

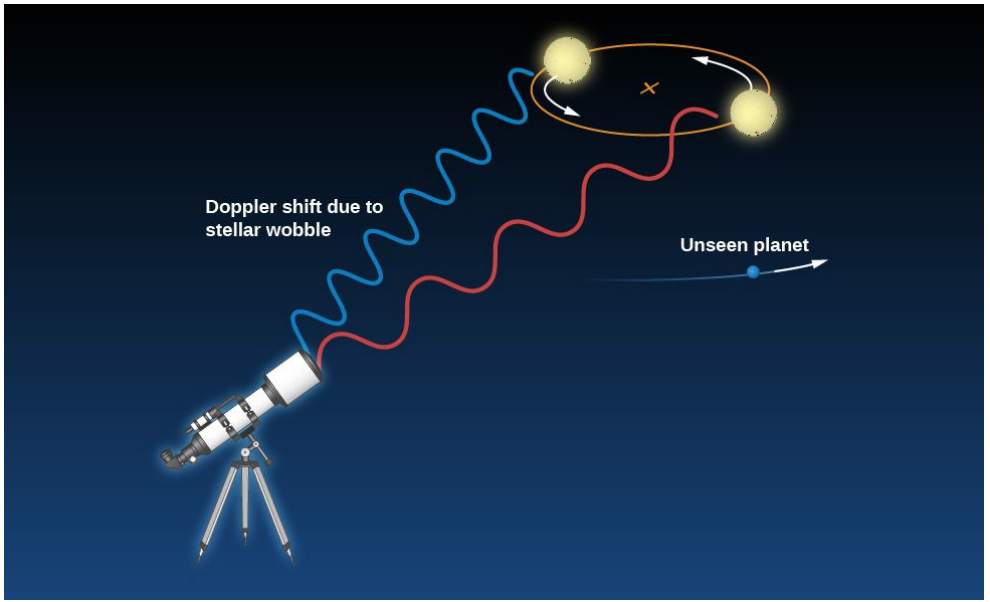
Metodi di Ricerca

Stelle Erranti

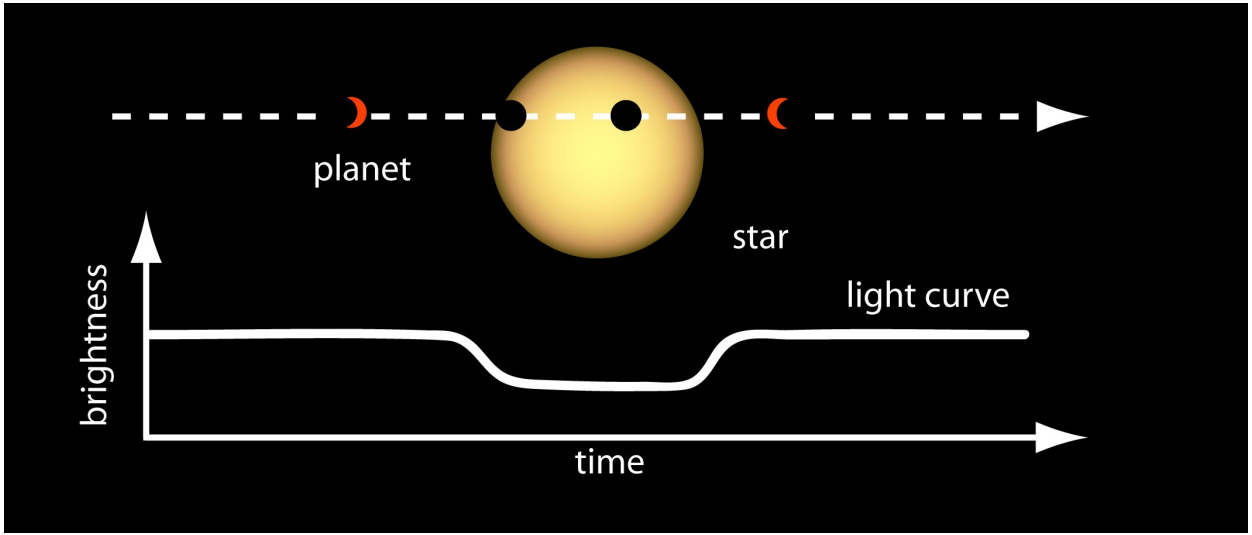
WOBBLING STARS HINT

AT EXOPLANET

PRESENCE



Eclissi Parziale della Luce Stellare



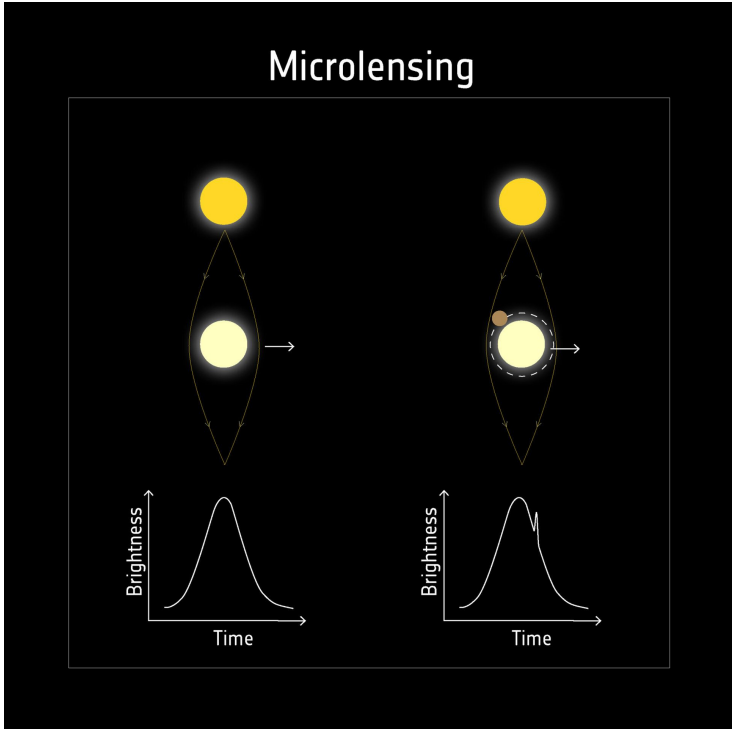
TRANSITING PLANET CAUSES DIP IN STELLAR LIGHT

Effetto Lente Gravitazionale

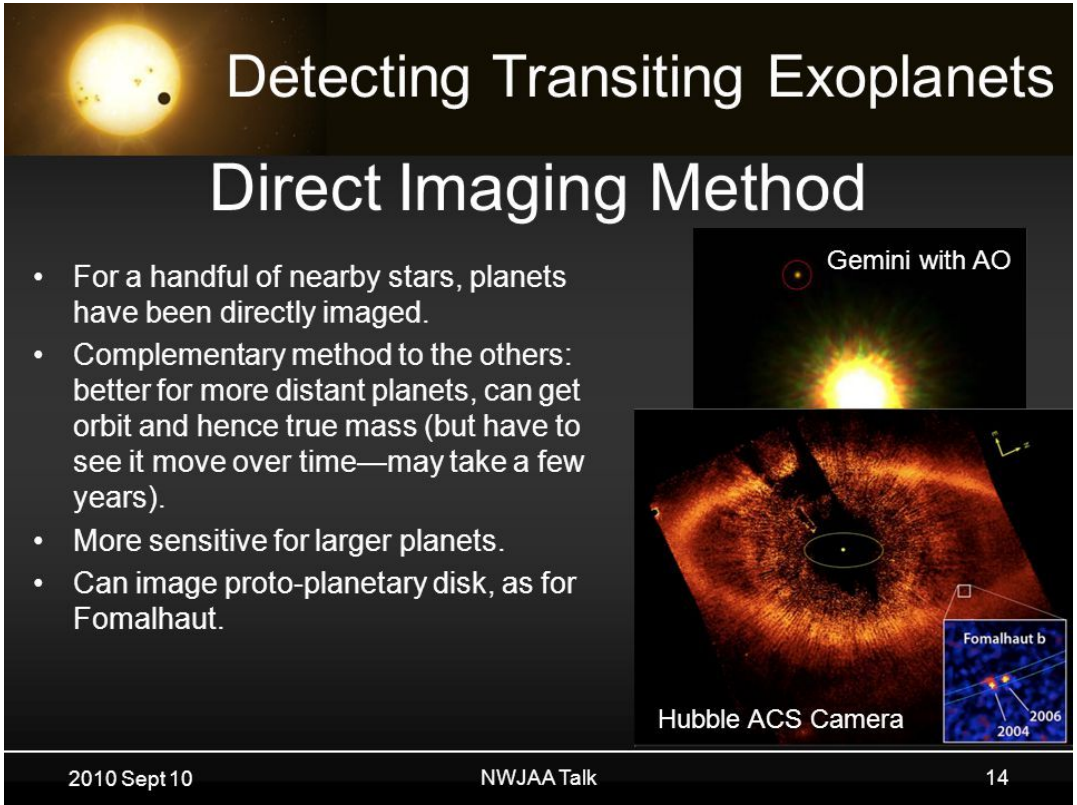
GRAVITATIONAL

MICROLENSING – CHANCE ALIGNMENT

REVEALS PLANET



Osservazione Diretta



Lo Zoo degli Esopianeti

Lo Zoo Esoplanetario

EXOPLANET GJ 1214B

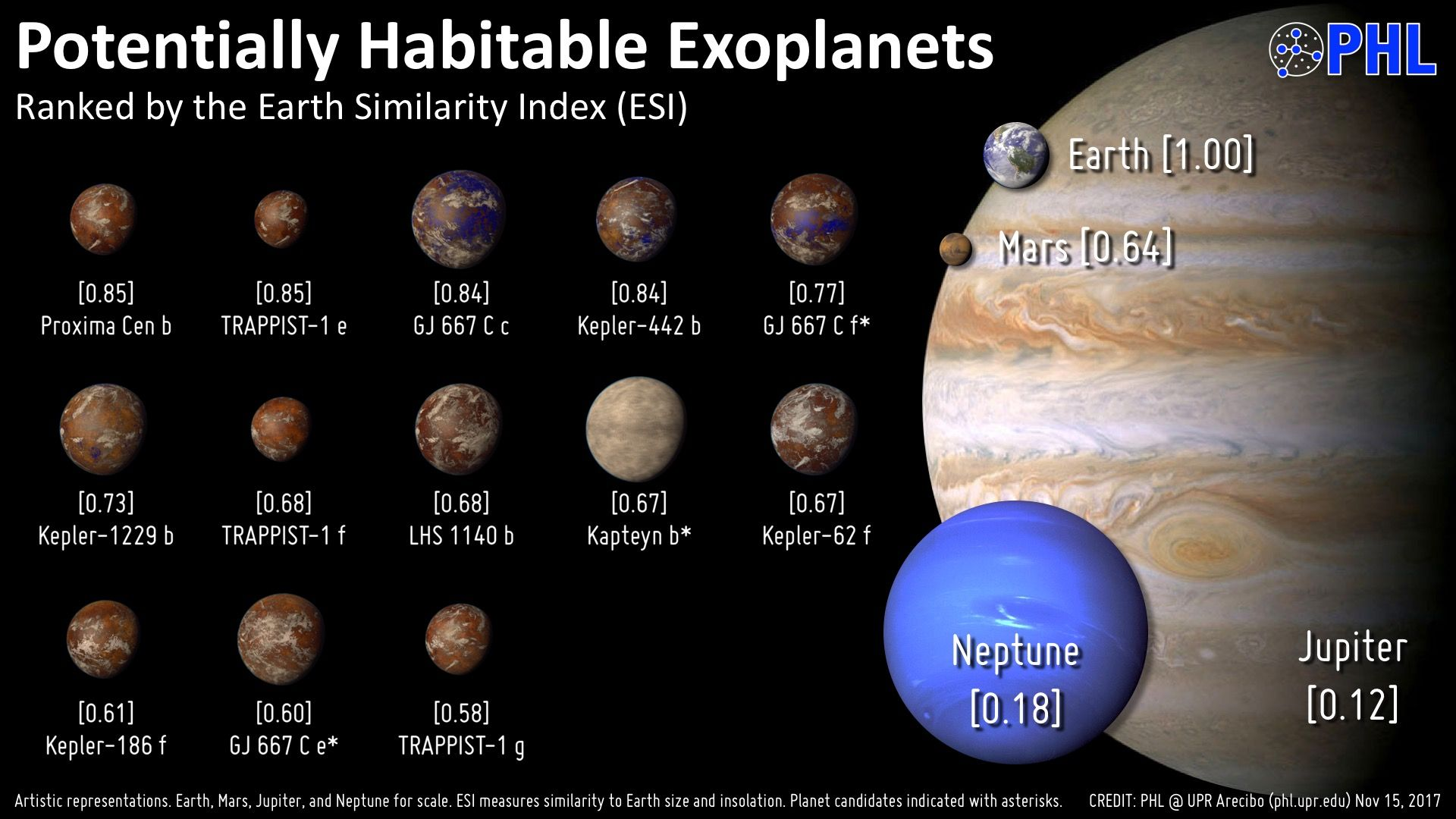
FIRST EVAPORATING PLANET

TRAPPIST-1 PLANETS

http://exoplanet.eu/catalog/

Potentially Habitable Exoplanets

Ranked by the Earth Similarity Index (ESI)



Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. ESI measures similarity to Earth size and insolation. Planet candidates indicated with asterisks.

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Nov 15, 2017

Ricerche Future

Ground-based observatories

First discoveries of exoplanets in the 1990s opened up the field of exoplanet research. New innovations and discoveries continue to this day

Launch

1990 — **Hubble** (NASA, esa)

Probing the composition of exoplanet atmospheres

2003 — **Spitzer** (NASA)

Studying exoplanet signatures in infrared light

2006 — **Corot** (cnes, esa)

Pioneering stellar seismology and exoplanet hunting mission

2009 — **Kepler/K2** (NASA)

A targeted search for terrestrial and larger planets in or near the habitable zone of a wide variety of stars

2013 — **Gaia** (esa)

Revealing exoplanets through its all-sky survey of the position, brightness and motion of over one billion stars

2018 — **Tess** (NASA)

First all-sky transit survey satellite

2019 — **Cheops** (esa)

First step characterisation of known Earth-to-Neptune size exoplanets

Webb (NASA, esa, CSA)

Detailed characterisation of exoplanet atmospheres through transit studies and direct imaging

Plato (esa)

Studying terrestrial planets in orbits up to the habitable zone of Sun-like stars, and characterising these stars

Ariel (esa)

Performing a chemical census of a large and diverse sample of exoplanets by analysing their atmospheres

Dedicated exoplanet missions

Exoplanet-sensitive missions

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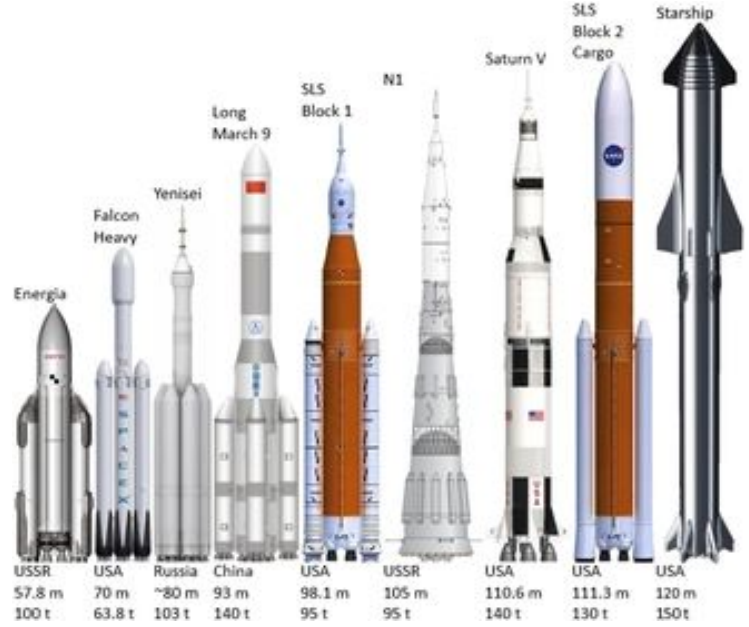
- Li raggiungeremo mai?


Interstellar challenges
Time
– Wait 50 principle: If a mission will take more than 50 years maybe it should not be started, as future developments could enable faster travel and a future ship might be able to overtake and older mission making it obsolete and useless.
– If time is long for astronauts, how can we send them to another star?
• Time Dilation
• Suspended animation
• Embryo colonization
• Generation ship
• Extended lifespan
• Mind uploading
• Communications
– Obviously x2 speed of light, so 8 years to send a message and receive an answer from Alpha Centauri, the closest star

Ma…come Fermi…il dato e', negli ultimi 120 anni…persone dalla Terra a Marte….



2019 1970 2021

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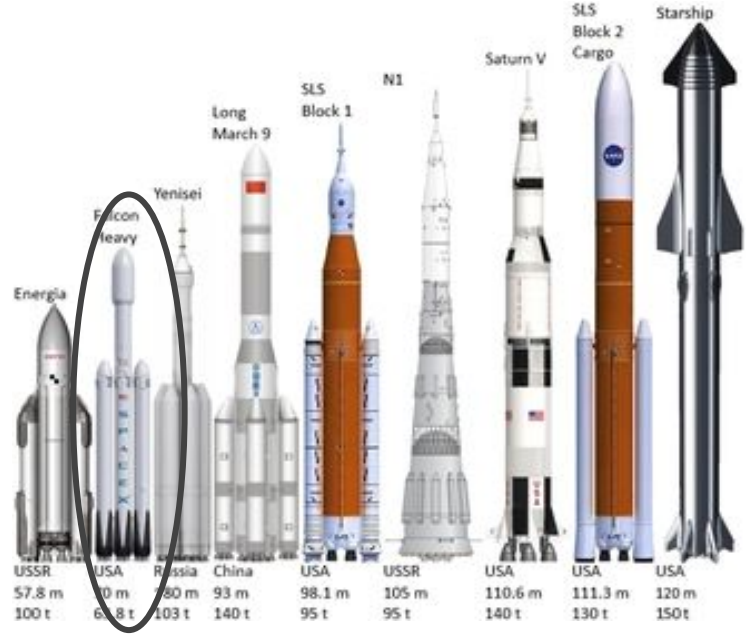

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