

Da Marte a Kerbin passando per Brera

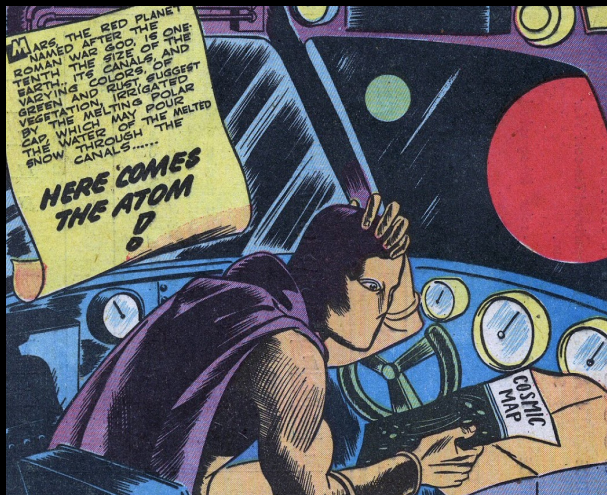
Gianluigi Filippelli, Stefano Sandrelli

Osservatorio Astronomico di Brera, Milano, 01/04/2019

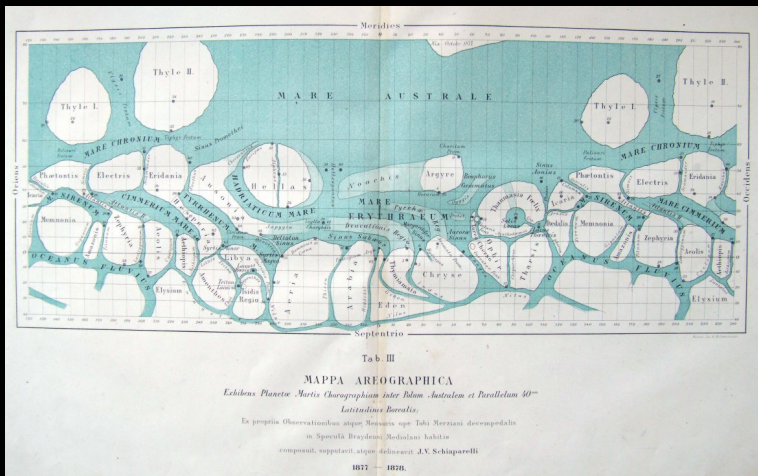
All Star Comics n.13 (1941)



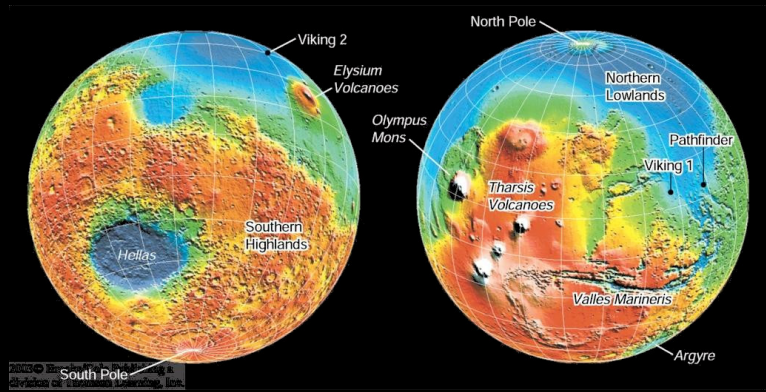
All Star Comics n.13 (1941)



La prima mappa di Marte



Topografia marziana



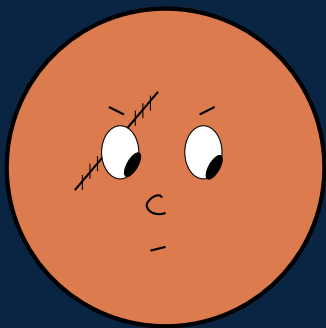
PRIME © 2000-2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100

Fatterelli marziani: distanza dal sole

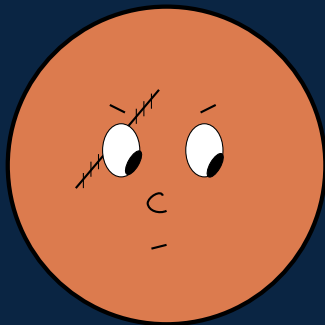
Distanza media tra il Sole
e le orbite di Terra e Marte



Fatterelli marziani: caratteristiche fisiche



Fatterelli marziani: caratteristiche fisiche



Marte è il 4.o pianeta dal Sole

Possiede due lune:

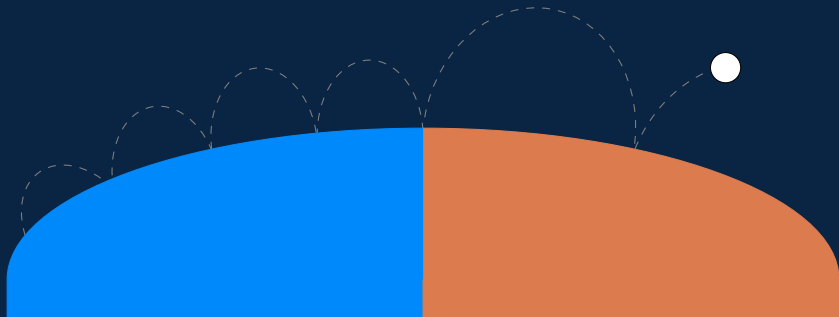
Phobos, con un diametro di
22.2 chilometri

e Deimos, con un diametro di
12.6 chilometri

Fatterelli marziani: gravità e atmosfera

Gravità

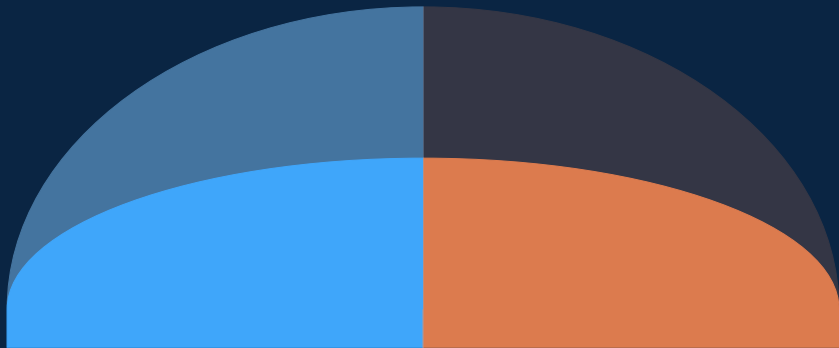
Un astronauta su Marte sperimenterebbe una gravità del 62.5% inferiore rispetto alla Terra



Fatterelli marziani: gravità e atmosfera

Atmosfera

L'atmosfera su Marte, ricca di CO_2 (96%) è circa 100 volte meno densa di quella sulla Terra



Il nostro vicino Marte

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L'acqua su Marte

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L'equazione del razzo

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In viaggio per Marte

○○○○○○○

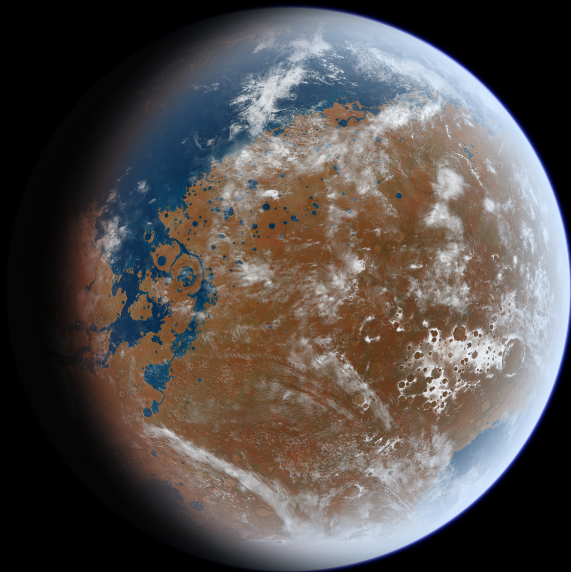
In viaggio su Kerbin

○

Fine

○

Marte ieri



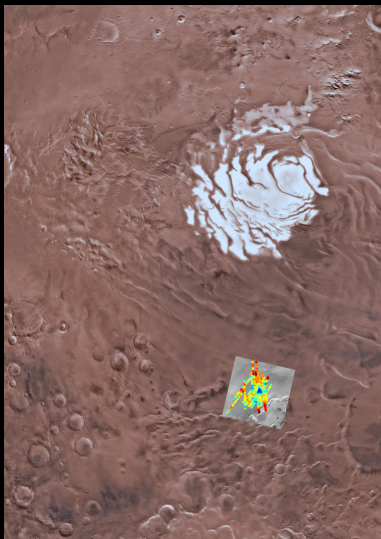
Brindisi

25 luglio 2018

Roberto Orosei
INAF

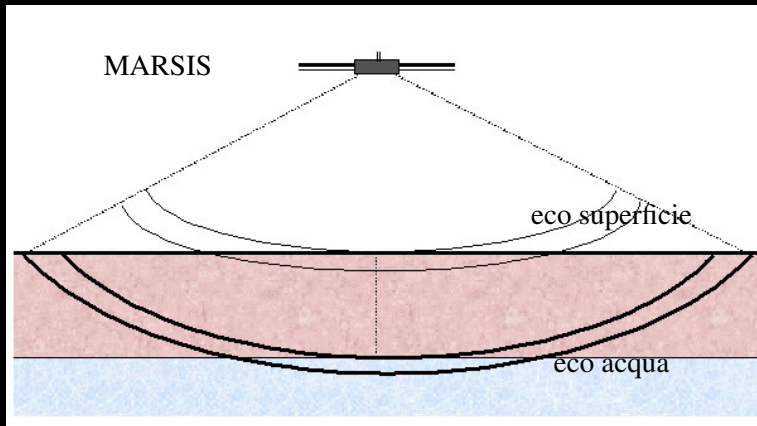


Un lago salato



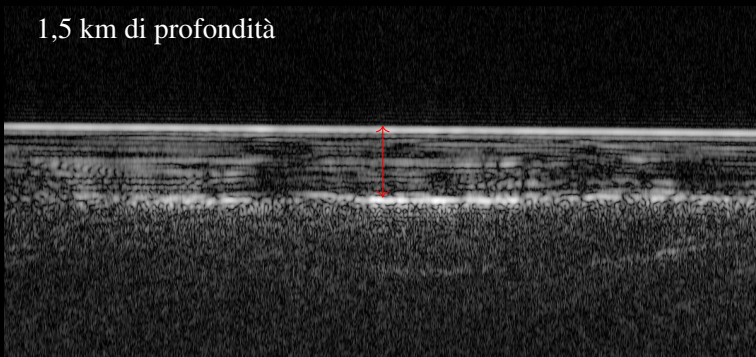
Profondità: 1500 m
Estensione: 20 km
Spessore: almeno 1m
Temperatura: tra $-10^{\circ}C$ e $-20^{\circ}C$

Marsis: Mars Advanced Radar for Subsurface and Ionosphere Sounding

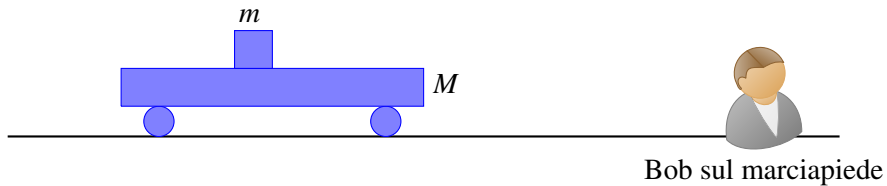


Una foto col radar

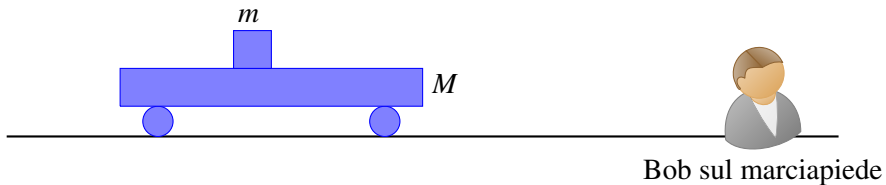
1,5 km di profondità



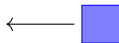
Muovere un carrellino



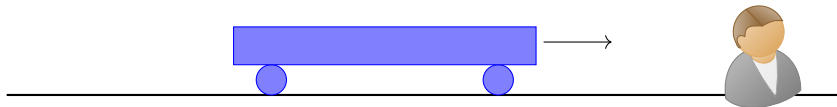
Muovere un carrellino



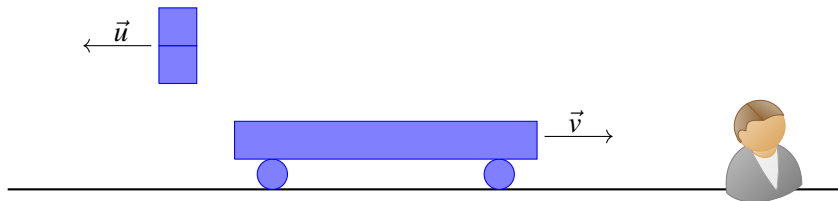
\vec{u} = velocità relativa tra m e M



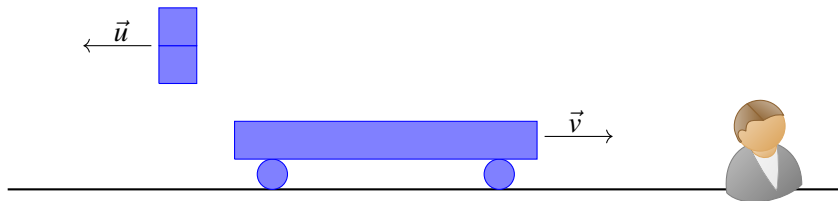
\vec{v} = velocità di M rispetto a Bob



Aumentiamo i blocchetti

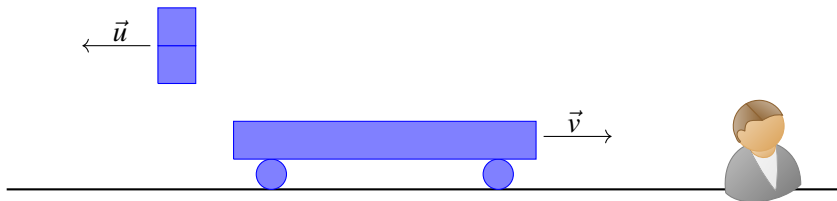


Aumentiamo i blocchetti



$$\vec{v}_{2b} = \frac{2m\vec{u}}{M+2m}$$

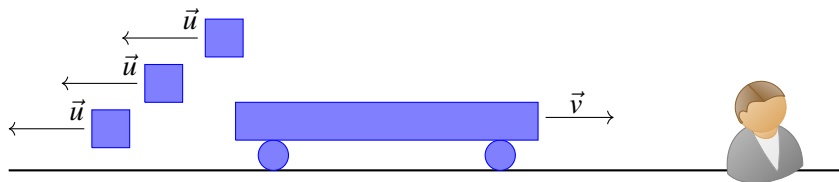
Aumentiamo i blocchetti



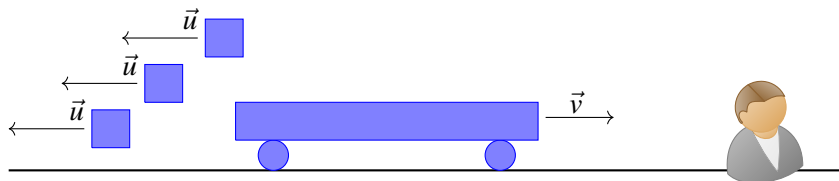
$$\vec{v}_{2b} = \frac{2m\vec{u}}{M+2m}$$

$$\vec{v}_{Nb} = \frac{Nm\vec{u}}{M+Nm}$$

Aumentiamo i blocchetti

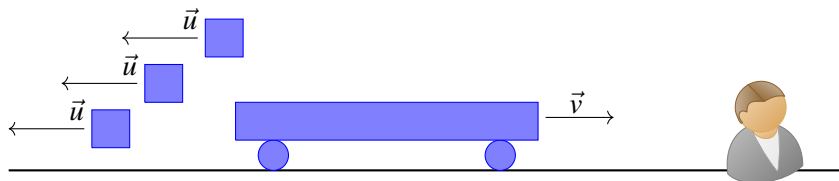


Aumentiamo i blocchetti



$$\vec{v}_3 = \frac{m\vec{u}}{M+3m} + \frac{m\vec{u}}{M+2m} + \frac{m\vec{u}}{M+m}$$

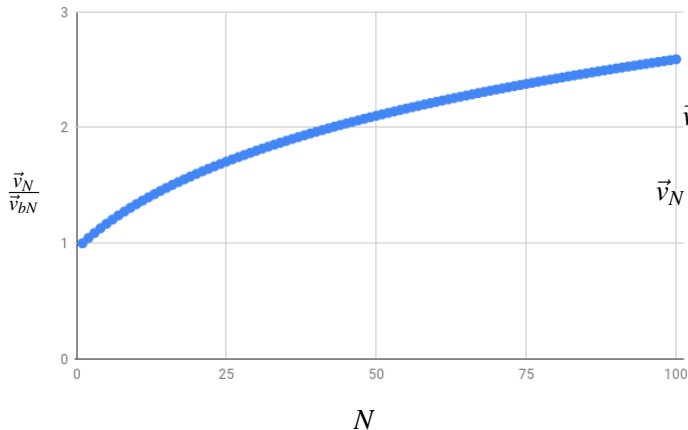
Aumentiamo i blocchetti



$$\vec{v}_3 = \frac{m\vec{u}}{M+3m} + \frac{m\vec{u}}{M+2m} + \frac{m\vec{u}}{M+m}$$

$$\vec{v}_N = \sum_{i=1}^N \frac{m\vec{u}}{M+im}$$

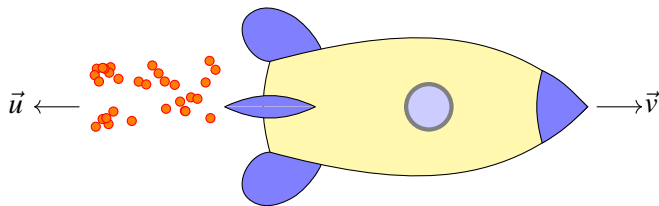
Confrontiamo i due metodi



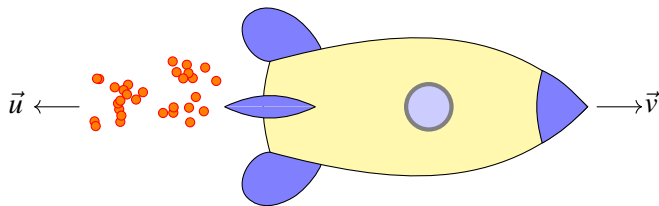
$$\vec{v}_{Nb} = \frac{Nm\vec{u}}{M+Nm}$$

$$\vec{v}_N = \sum_{i=1}^N \frac{m\vec{u}}{M+im}$$

L'equazione del razzo

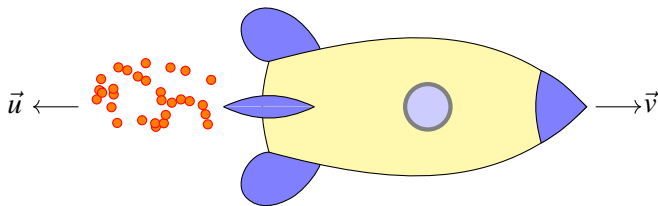


L'equazione del razzo



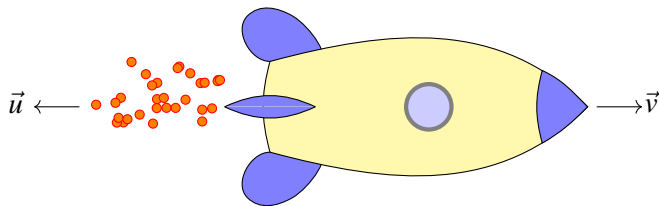
$$F = \frac{\Delta(mv)}{\Delta t}$$

L'equazione del razzo



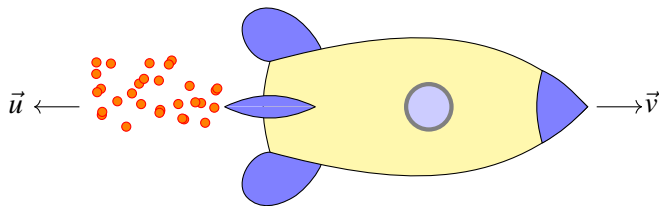
$$m \frac{\Delta \vec{v}}{\Delta t}$$

L'equazione del razzo



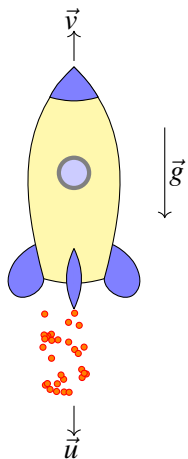
$$m \frac{\Delta \vec{v}}{\Delta t} = \vec{F}_{\text{ext}}$$

L'equazione del razzo



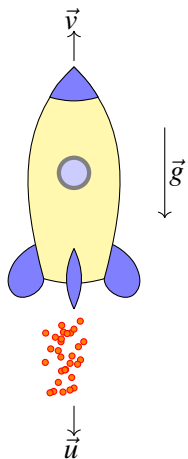
$$m \frac{\Delta \vec{v}}{\Delta t} = \vec{F}_{\text{ext}} + \vec{u} \frac{\Delta m}{\Delta t}$$

L'equazione del razzo



$$m \frac{\Delta v}{\Delta t} = -mg - u \frac{\Delta m}{\Delta t}$$

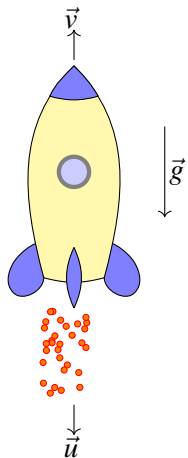
L'equazione del razzo



$$m \frac{\Delta v}{\Delta t} = -mg - u \frac{\Delta m}{\Delta t}$$

$$v = -u \ln \frac{m_i}{m_f} - gt$$

L'equazione del razzo

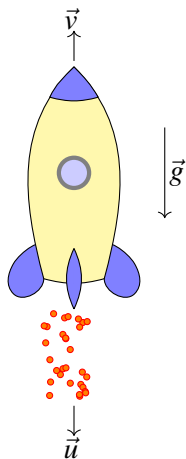


$$m \frac{\Delta v}{\Delta t} = -mg - u \frac{\Delta m}{\Delta t}$$

$$v = -u \ln \frac{m_i}{m_f} - gt$$

Konstantin Ciolkovskij

L'equazione del razzo



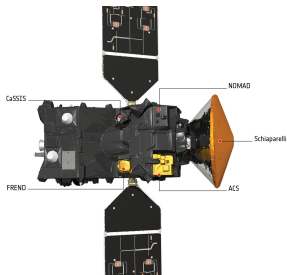
$$m \frac{\Delta v}{\Delta t} = -mg - u \frac{\Delta m}{\Delta t}$$

$$v = -u \ln \frac{m_i}{m_f} - gt$$

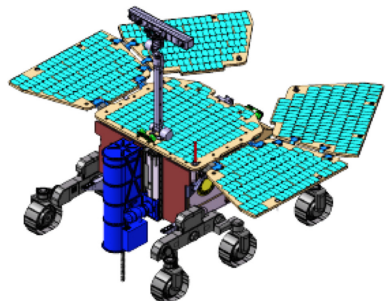
Konstantin Ciolkovskij

Per il principio di conservazione
della quantità di moto,
è possibile accelerare un corpo in una data direzione,
espellendo massa nella direzione opposta.

ExoMars 2016



Journey to Mars



Schiaparelli's descent to Mars

ExoMars 2016



Schiaparelli

Dimostratore tecnologico per atterraggio

Trace Gas Orbiter - TGO

Atmosfera, ricerca di gas rari - metano

Ghiaccio di acqua superficiale e subsuperficiale

Identificazione del luogo di atterraggio

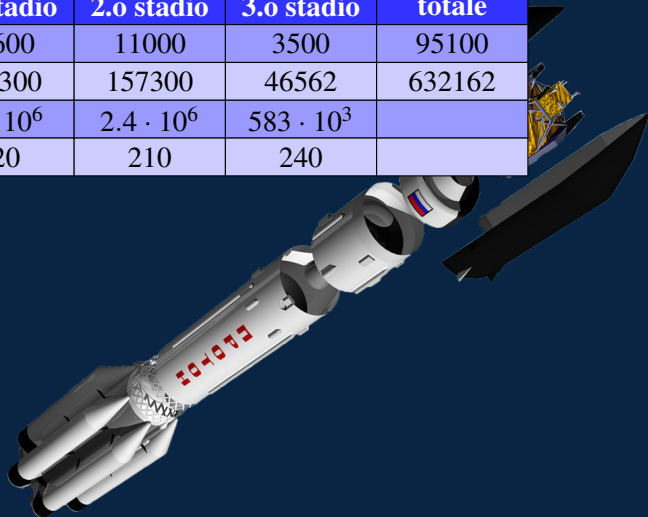
di *Pasteur*

Agenzie: ESA / Roscosmos

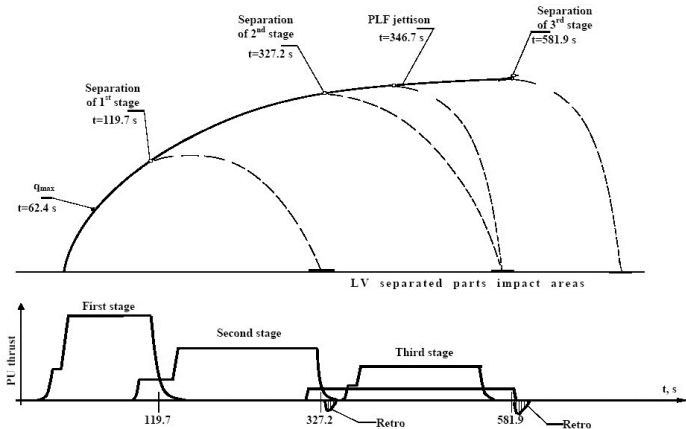
Forte contributo INAF e ASI

Gli stadi del razzo di ExoMARS

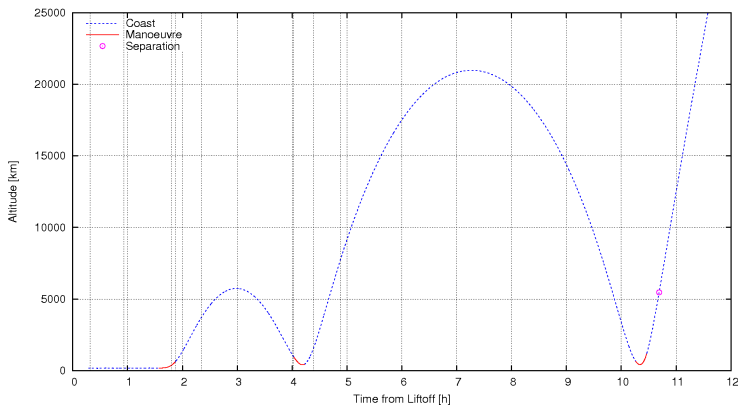
	1.o stadio	2.o stadio	3.o stadio	totale
massa (kg)	30600	11000	3500	95100
carburante (kg)	428300	157300	46562	632162
spinta (N)	$10 \cdot 10^6$	$2.4 \cdot 10^6$	$583 \cdot 10^3$	
tempo (s)	120	210	240	



Lo stacco degli stadi



Accensione dei motori



La discesa di Schiaparelli

Schiaparelli enters atmosphere
 Time: 0 sec
 Altitude: 121 km
 Speed: 21 000 km/h

Heatshield protection during atmospheric deceleration
 Time of maximum heating: 1 m 12 sec
 Altitude: 45 km
 Speed: 19 000 km/h

Parachute deploys
 Time: 3 m 21 sec
 Altitude: 11 km
 Speed: 1700 km/h

Front shield separates, radar turns on
 Time: 4 m 1 sec
 Altitude: 7 km
 Speed: 320 km/h

Parachute jettisoned with rear cover
 Time: 5 m 22 sec
 Altitude: 1.2 km
 Speed: 240 km/h

Thruster ignition
 Time: 5 m 23 sec
 Altitude: 1.1 km
 Speed: 250 km/h

Thrusters off; freefall
 Time: 5 min 52 sec
 Altitude: 2 m
 Speed: 4 km/h

Touchdown
 Time: 5 min 53 sec
 Altitude: 0 m
 Speed: 10 km/h

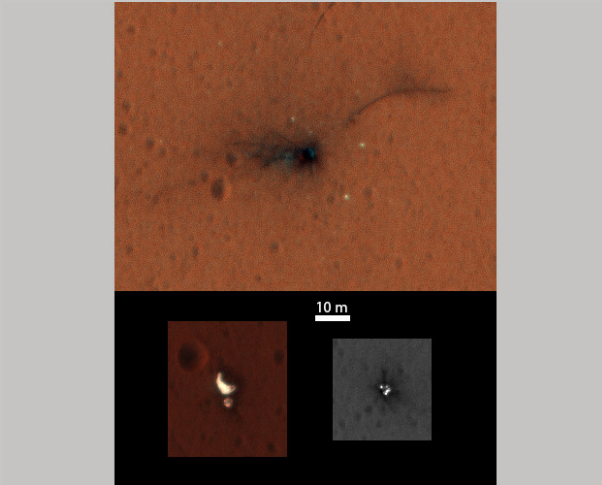
www.esa.int

Credits: ESA/ATG mediafile

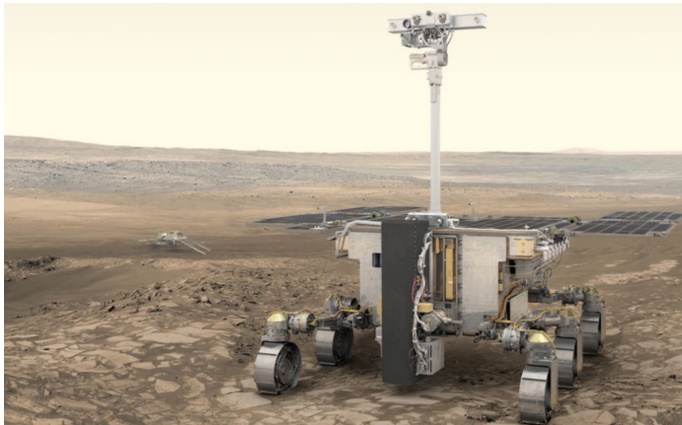
European Space Agency

esa

La fine di Schiaparelli



ExoMars 2020



Verso Kerbin



Verso Kerbin



Verso Kerbin



Verso Kerbin



Il nostro vicino Marte
○○○○○○○○○○

L'acqua su Marte
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L'equazione del razzo
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In viaggio per Marte
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In viaggio su Kerbin
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Fine
○

Verso Kerbin



