VITA EXTRATERRESTRE

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Che cos’è la vita?

Aristotele

Francesco Redi

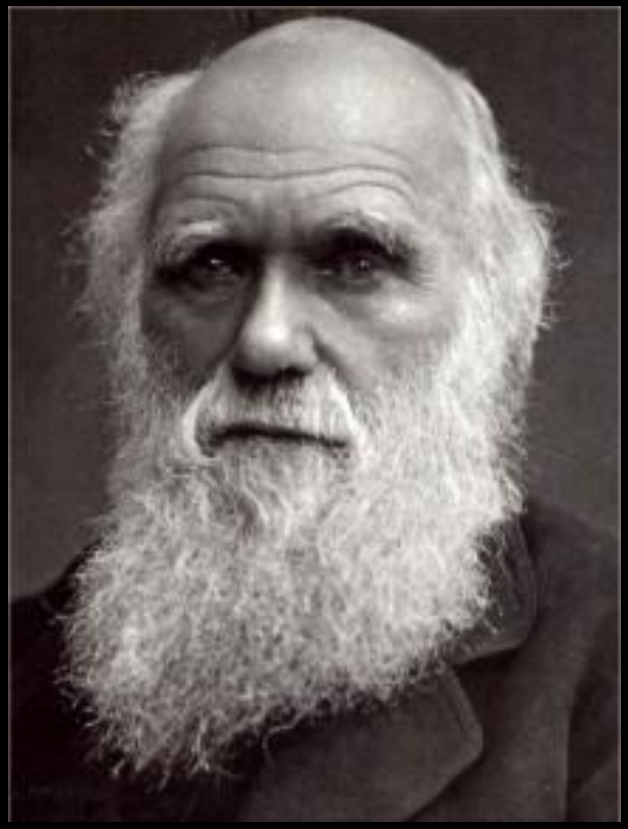
Generazione spontanea

Confutazione *Generazio aequivoca*

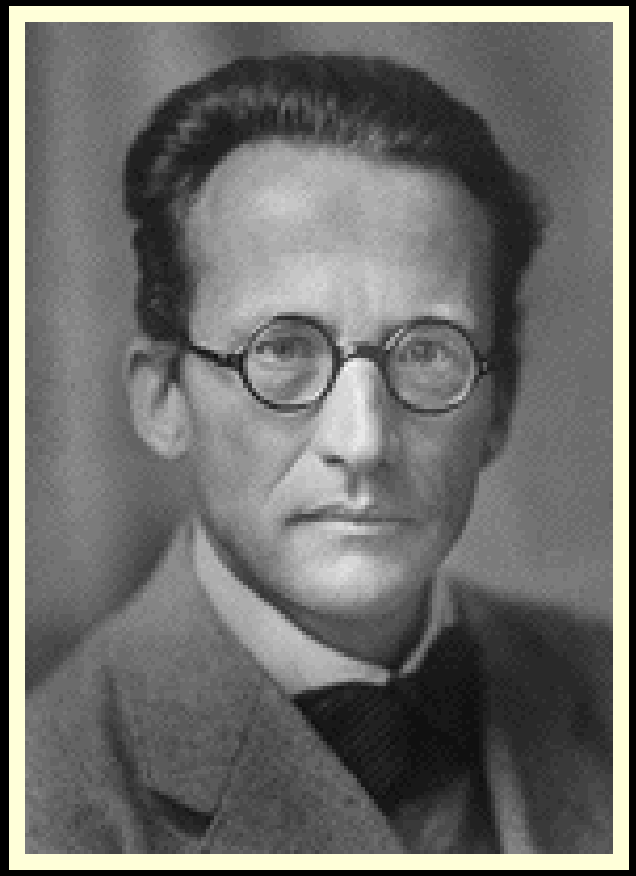
300 a.c.

1668

Charles Darwin



Erwin Schrödinger



L’origine della specie

Che cos’è la vita?

1859

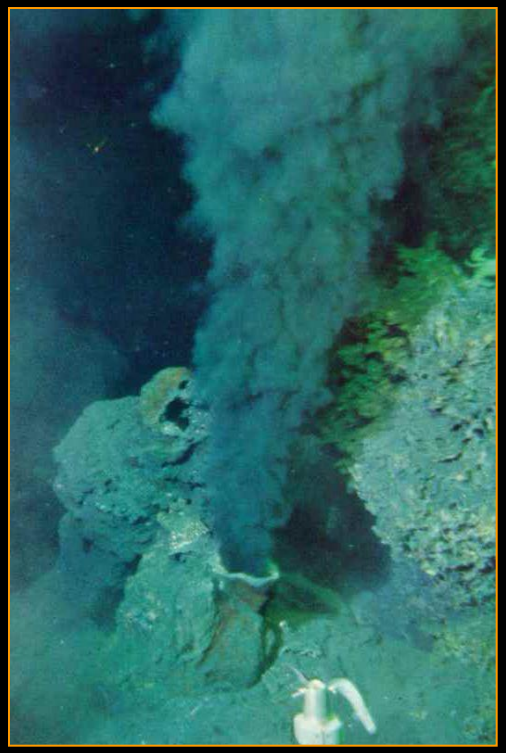
1944

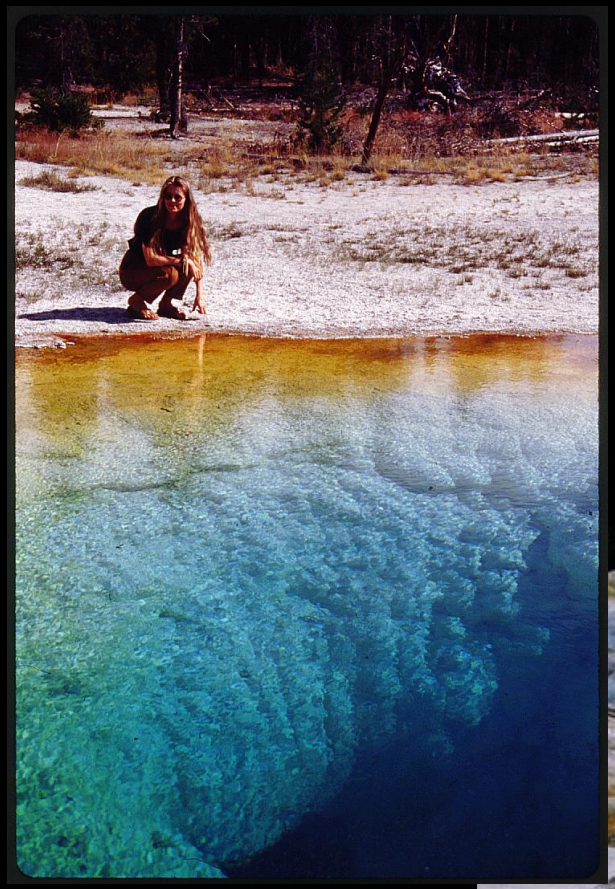
NON ESITE UNA DEFINIZIONE UNIVERSALE DELLA VITA

Definizione di Vita per la NASA

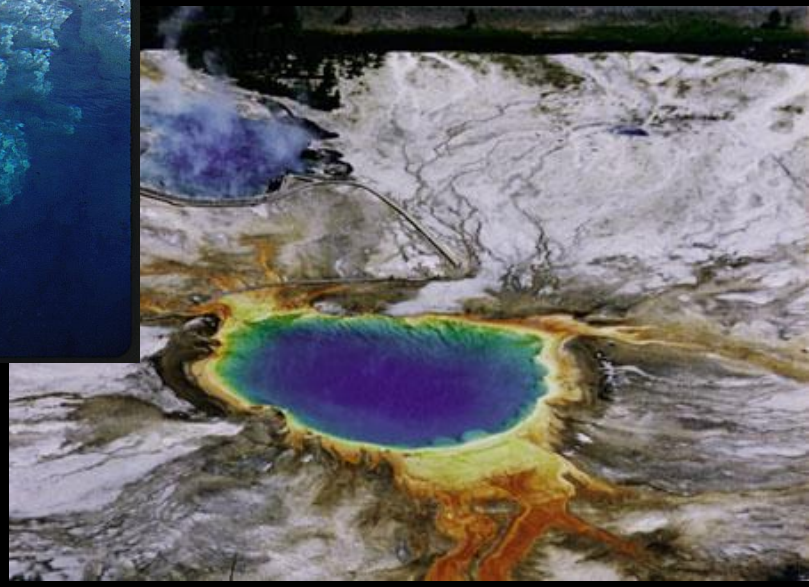
"Life is a system able to self-maintain, self-replicate, and capable of undergoing Darwinian evolution"

La vita è resistente



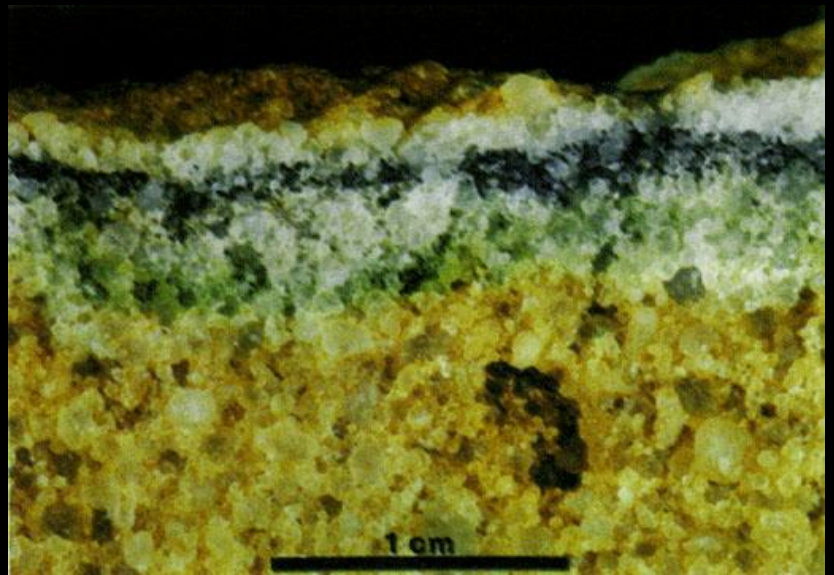


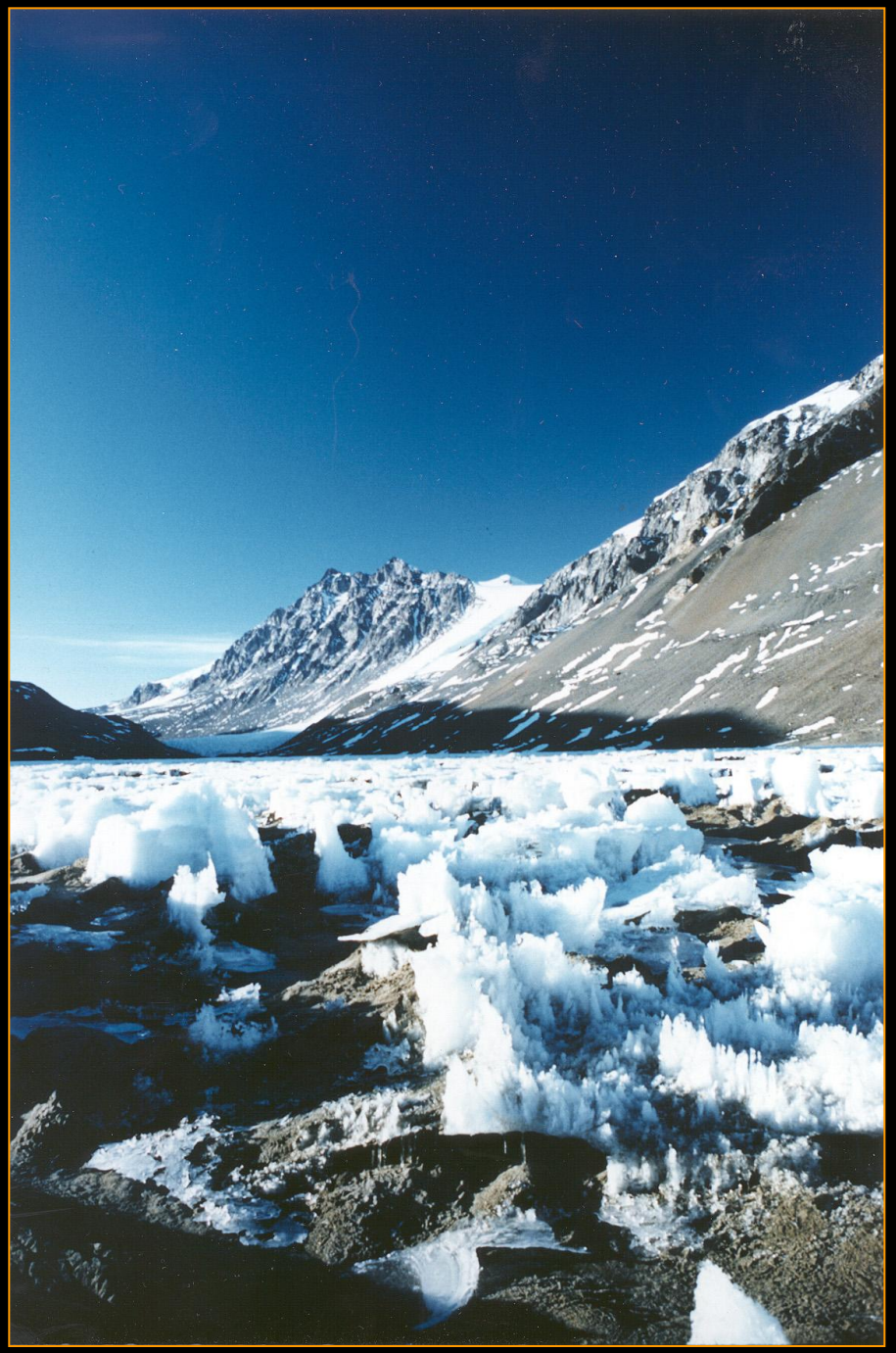
Microbial life (extremophiles) can make a living near undersea volcanic vents, in deep underground aquifers, within rocks, or in hot (~120 C!) acid lakes



La vita è ovunque

- Existence of life in these environments implies that life needs only water, a source of energy, and common chemical compounds



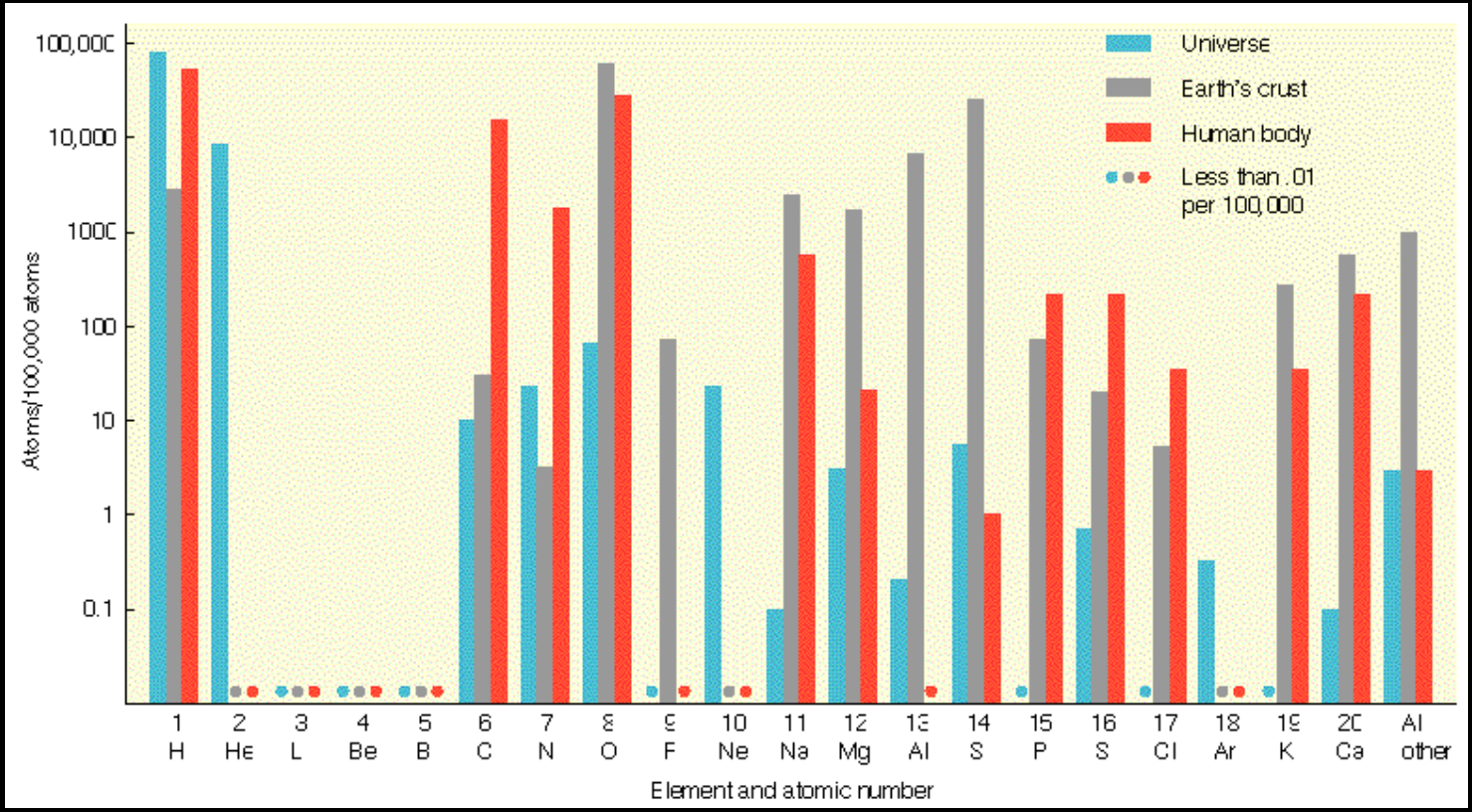


La vita è antica

Resti di 3.5 miliardi anni di comunità batteriche

Australian *stromatolites*

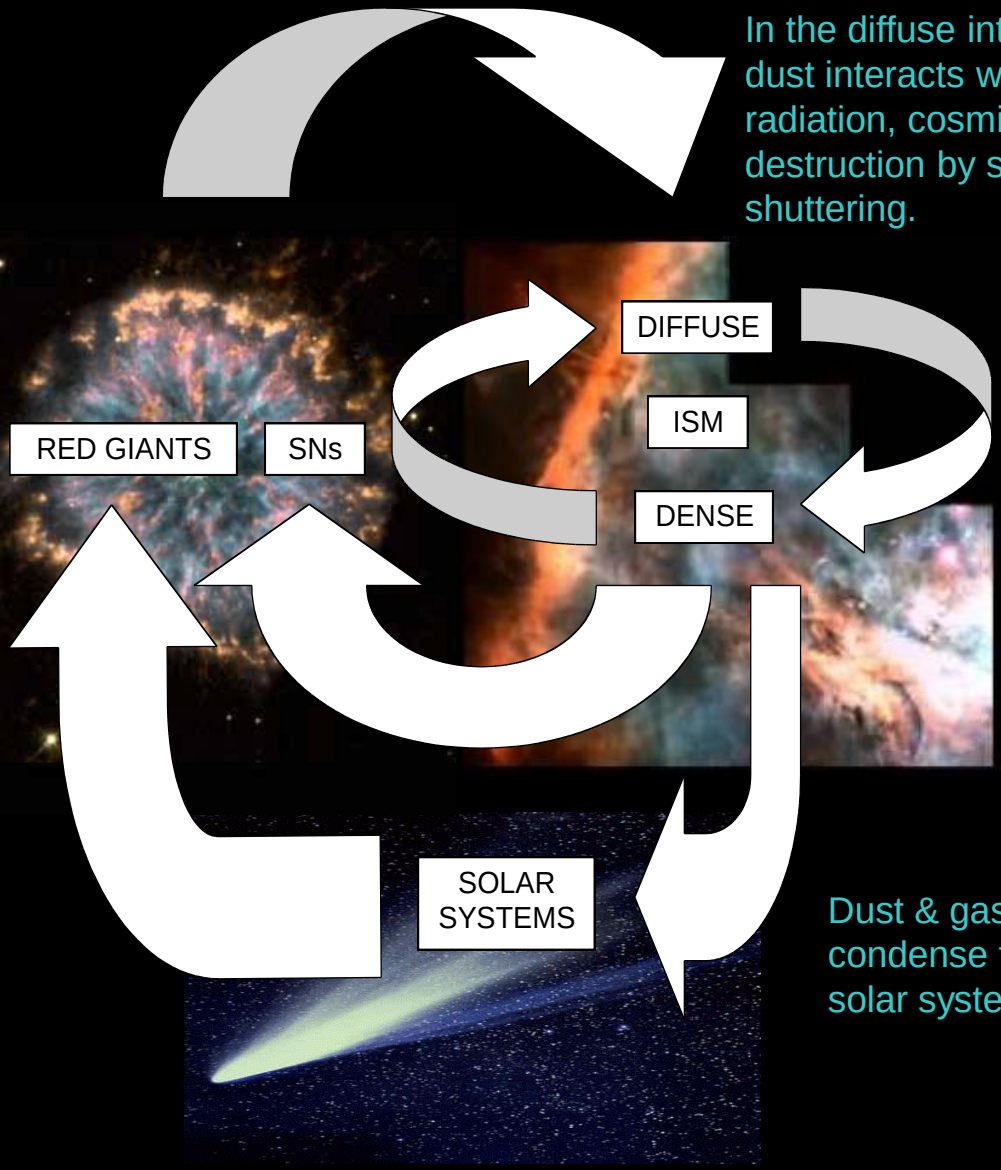
Composizione chimica dell'Universo, della crosta terrestre e dell'uomo



Amounts are expressed as number of atoms of each element per 100,000 atoms
(Courtesy Addiso-Wesley Pub. Comp.)

Il Ciclo infinito

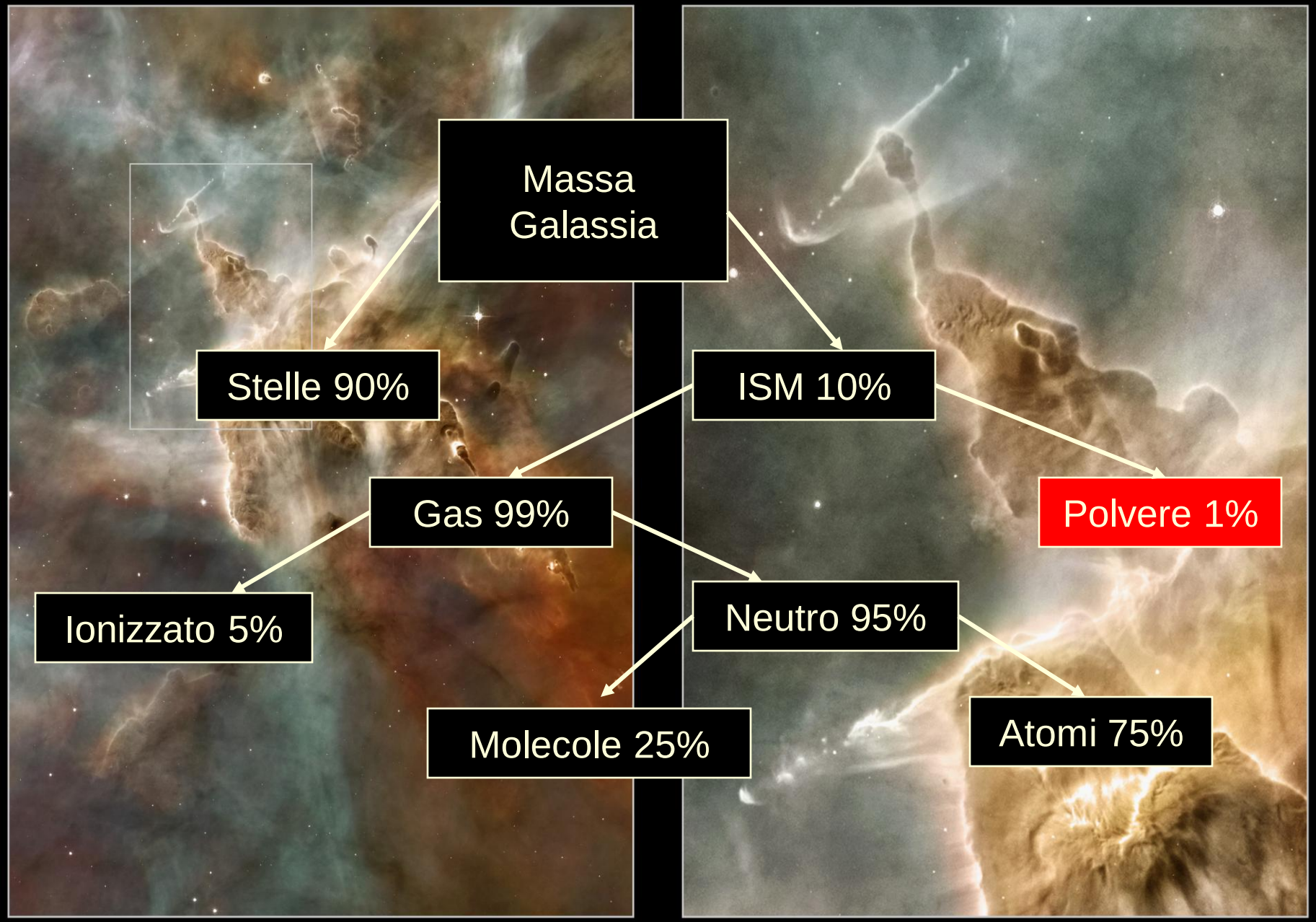
In the diffuse interstellar medium dust interacts with hot gas, UV radiation, cosmic rays, undergo destruction by sputtering and shuttering.



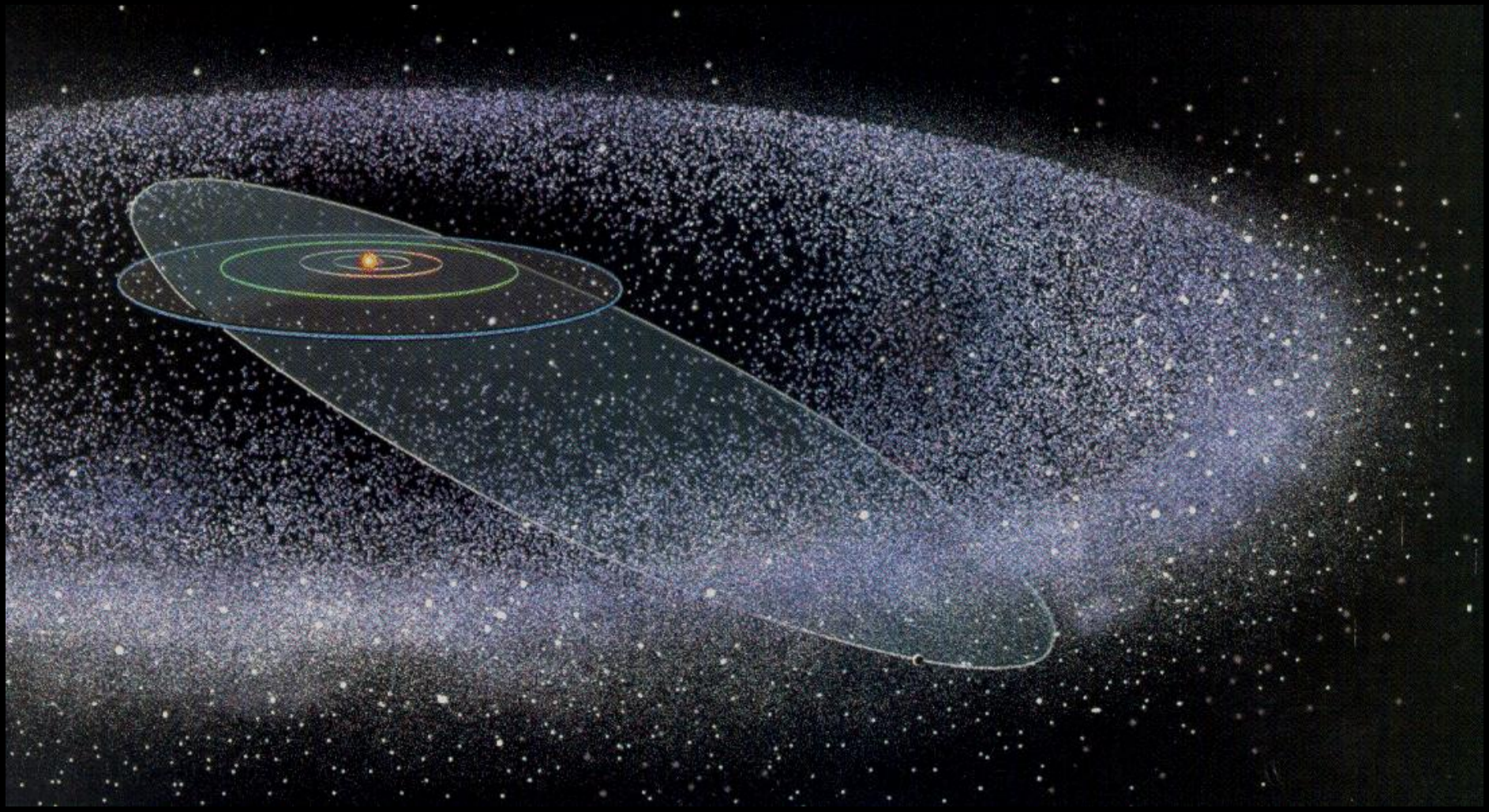
Dust condense in cool atmosphere of evolved stars

In dense interstellar medium dust growths through ice accretion and coagulation and undergo chemical evolution.

Dust & gas condense forming solar system objects


Starforming Region in the Carina Nebula
HST•ACS/WFC
Massa Galassia
Stelle 90%
ISM 10%
Gas 99%
Polvere 1%
Ionizzato 5%
Neutro 95%
Molecole 25%
Atomi 75%


David Hardy



Materia in viaggio nello spazio

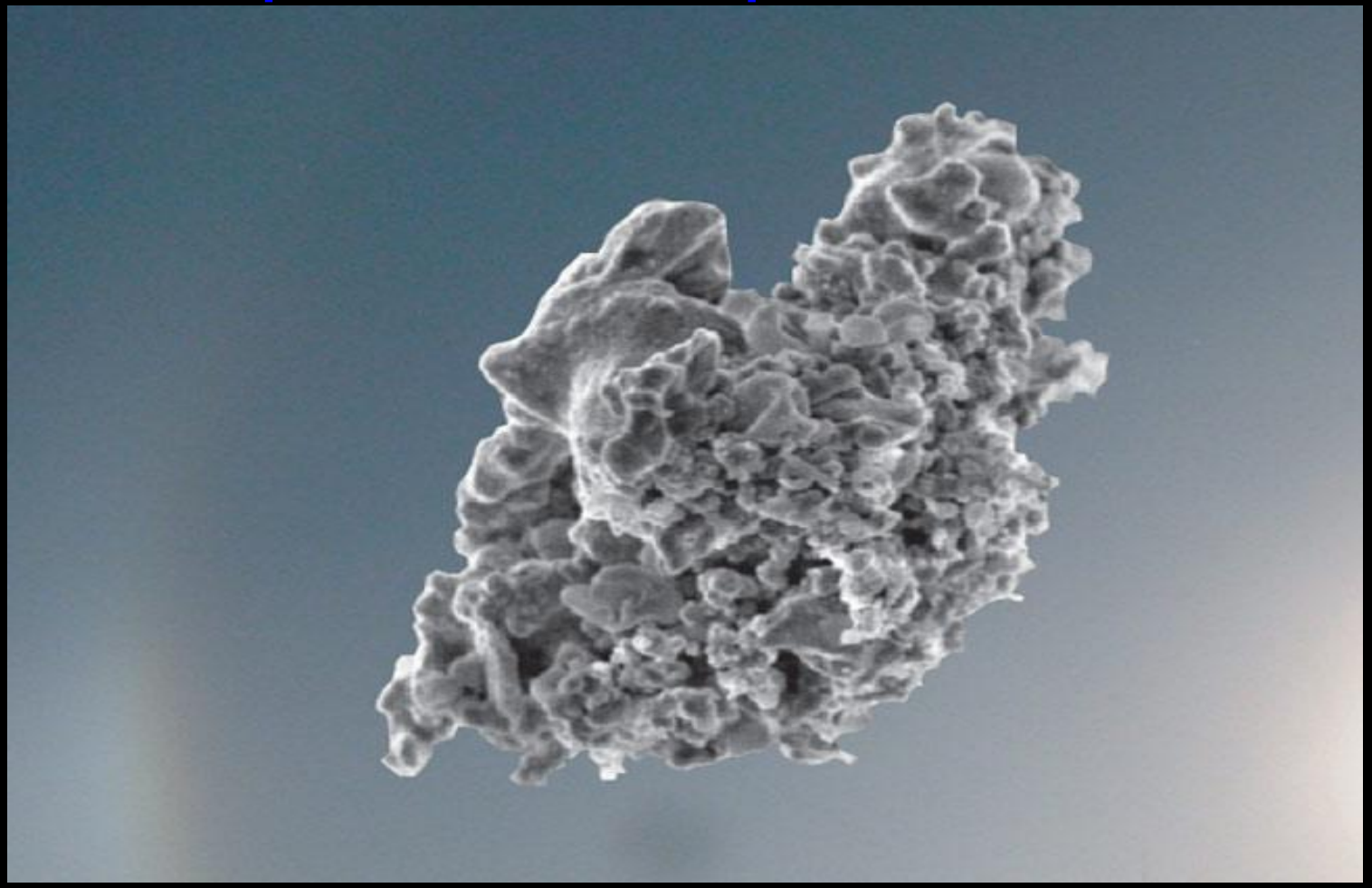
Molecole cometarie

Molecule	*[X]/[H_2O]*
H_2O	100
HDO	0.06
CO	23
CO_2	20
CH_4	0.6
C_2H_2	0.2
CH_3OH	2.4
H_2CO	1.1
HCOOH	0.08
NH_3	0.7
HCN	0.25
DCN	0.25
HNCO	0.10
HNC	0.25
CH_3CN	0.02
HC_3N	0.02
NH_2CHO	0.015
H_2S	1.5
OCS	0.4
SO	0.3
CS	0.2
SO_2	0.2
H_2CS	0.02
NS	0.02
H_2O_2	<0.03
CH_2CO	<0.032
C_2H_5OH	<0.05
HC_5N	<0.032
Glycine I	<0.5

Source: Bockelee-Morvan and Crovisier (2002).

La Cometa Hartley-2

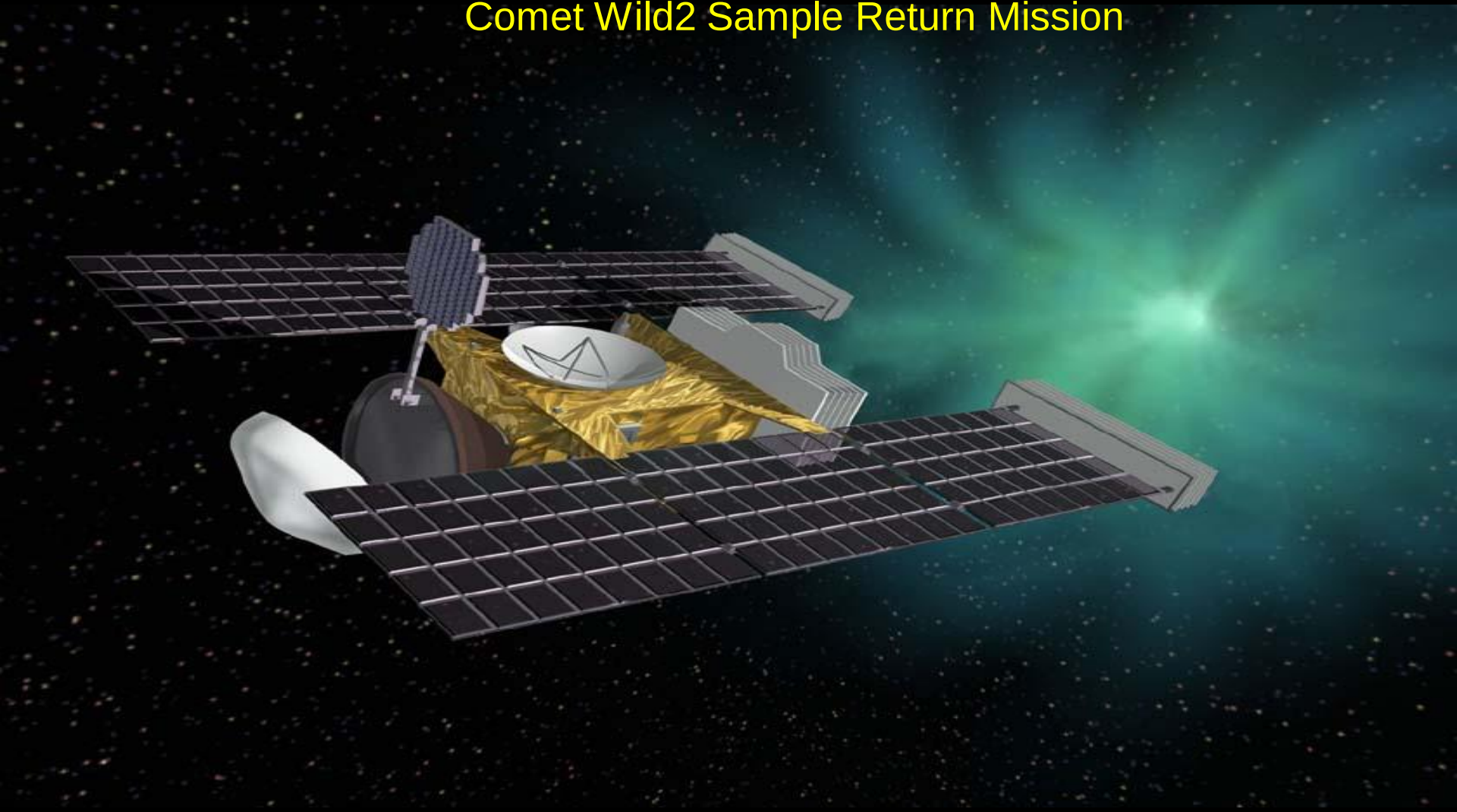
La polvere Interplanetaria.

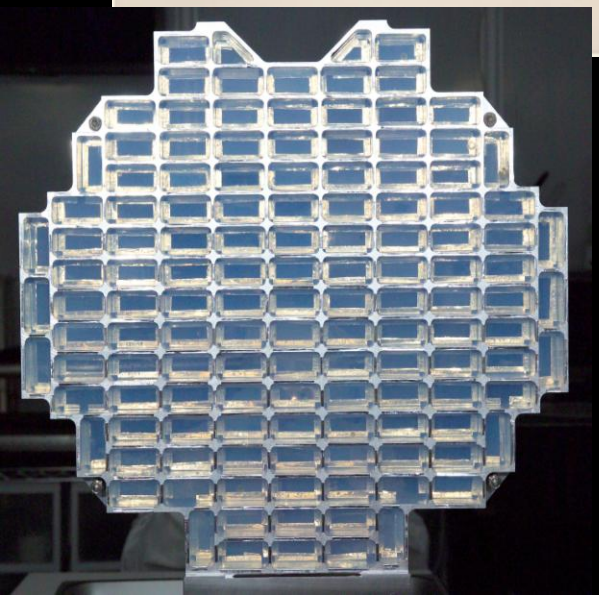


Circa 30,000 tonnellate di polvere interplanetaria sono raccolte dalla Terra ogni anno!

NASA STARDUST MISSION

Comet Wild2 Sample Return Mission





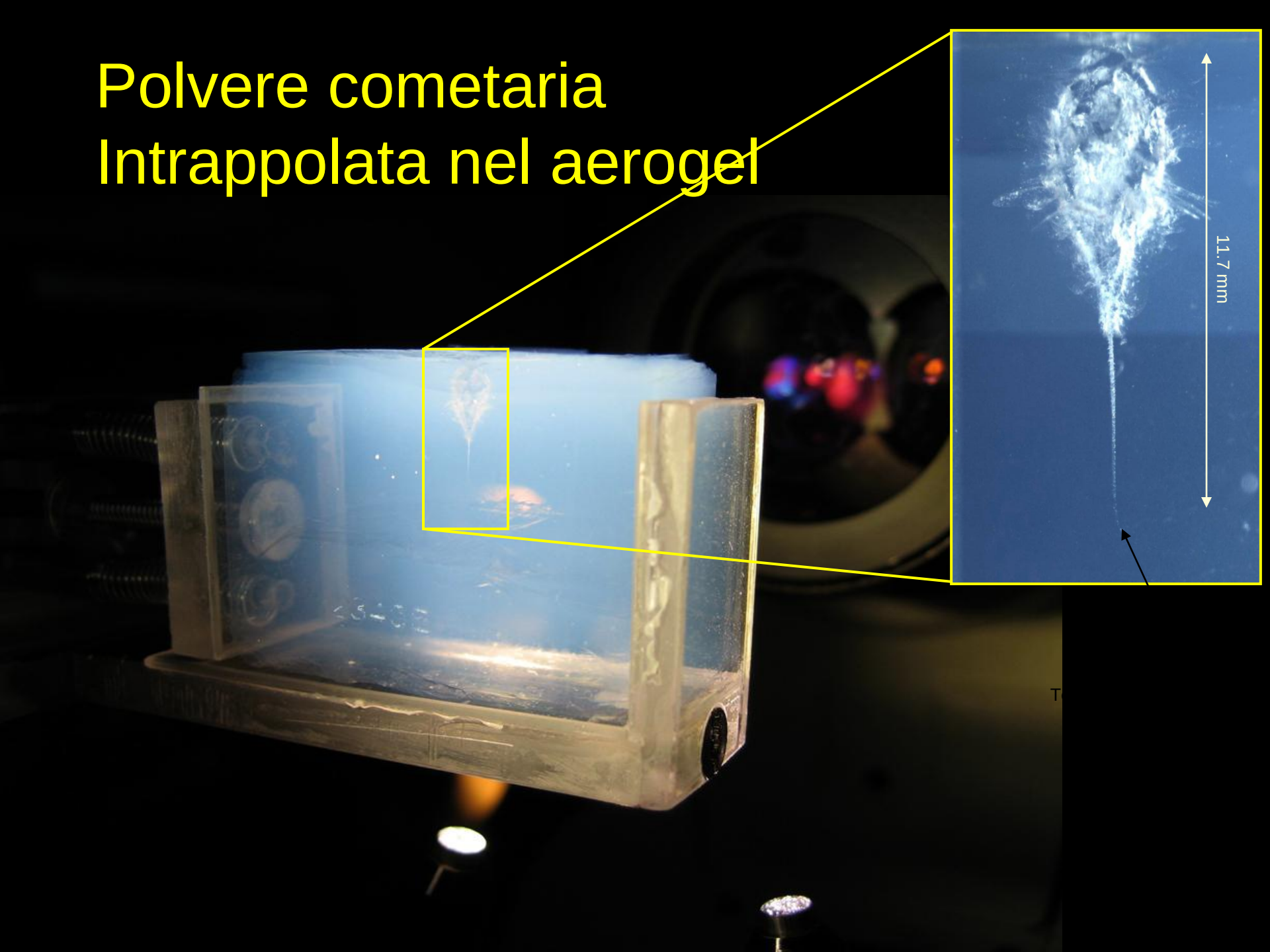
Super-Fantastico Aerogel

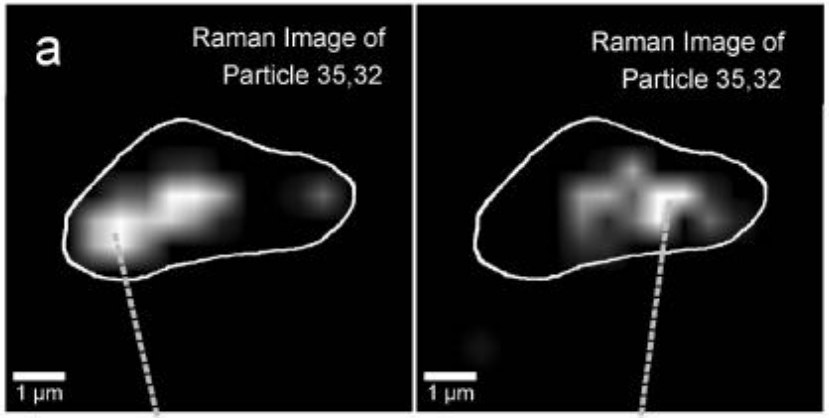
SiO_2 - PURE QUARTZ FOAM

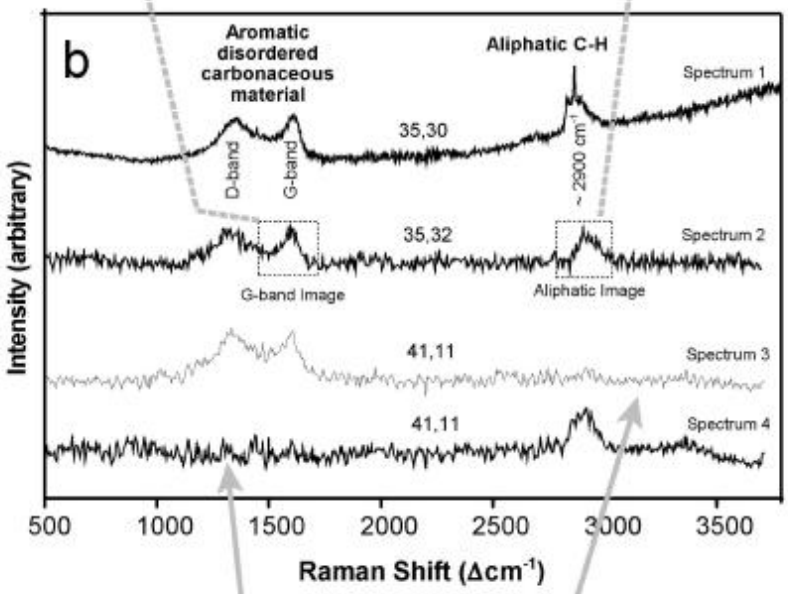
1. The lowest density solid, <1.5 mg/ml
2. The widest density range, $>7x10^2$
3. The smallest pore size, ~ 50nm
4. The highest porosity, >99.9%
5. The lowest thermal conductivity, <16mW/mK
6. The lowest sound speed, <70 m/s
7. The lowest dielectric constant, <1.003
8. The lowest refractive index, <1.0003
9. Lowest loss tangents, $<10^{-4}$
11. The widest compressive modules, $> 7 \times 10^6$
12. Highest acoustic impedance, 10^6 kg/m^{2}s
13. Highest refractive index range, 116%
14. The lowest Young's modules $<10^6$ N/m^2

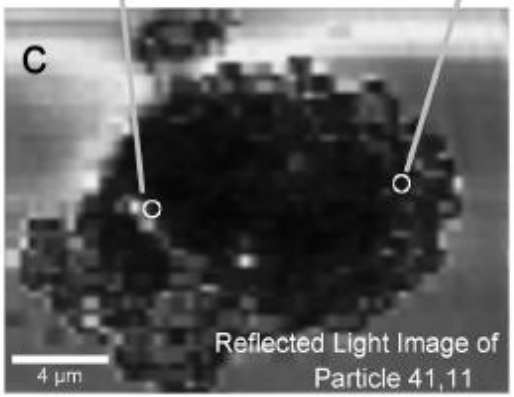

La cometa è atterrata!

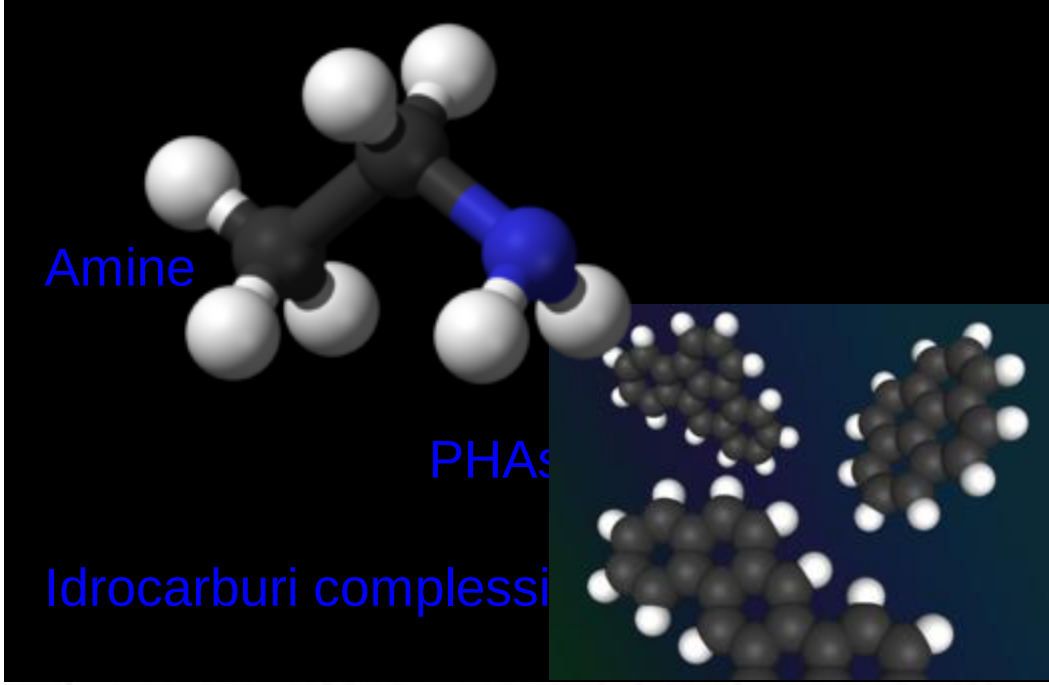
Polvere cometaria
Intrappolata nel aerogel

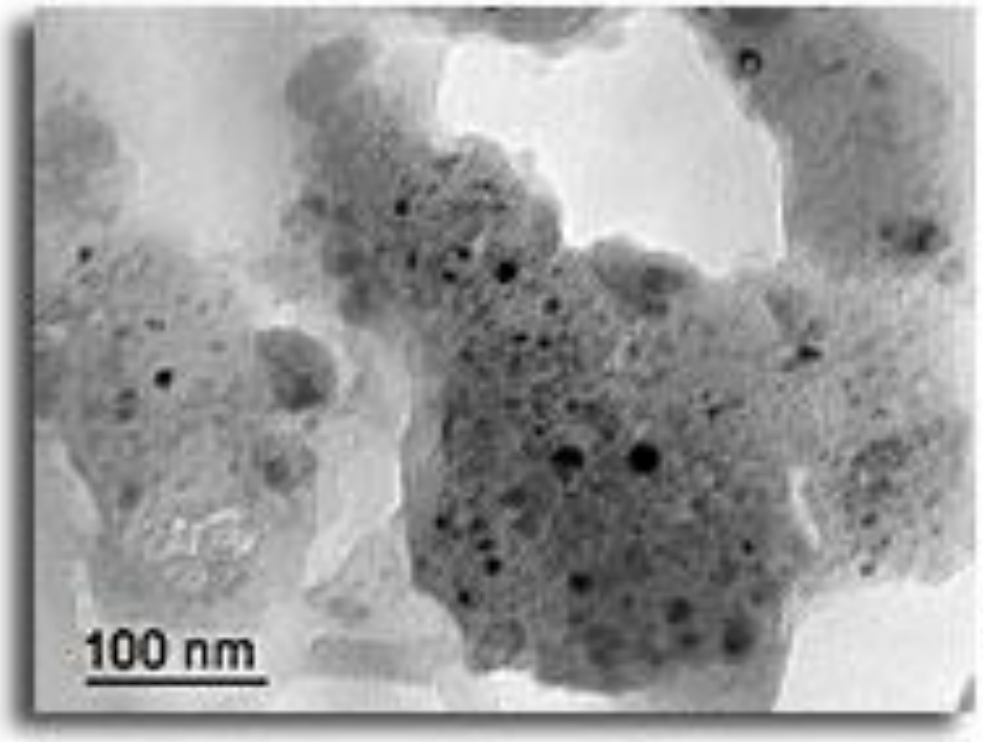



a
Raman Image of Particle 35,32
1 µm
Raman Image of Particle 35,32
1 µm

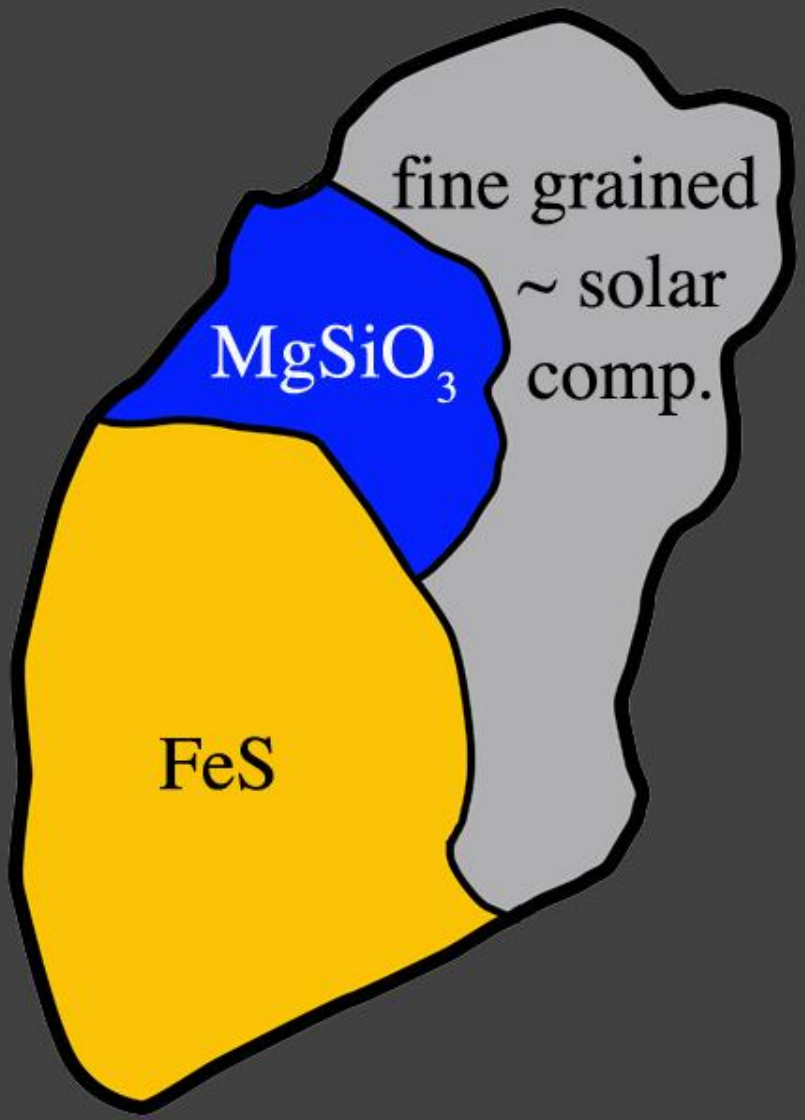

b
Aromatic disordered carbonaceous material
Aliphatic C-H
Spectrum 1
35,30
D-band
G-band
~ 2900 cm-1
Spectrum 2
35,32
G-band Image
Aliphatic Image
Spectrum 3
41,11
Spectrum 4
41,11
Intensity (arbitrary)
500
1000
1500
2000
2500
3000
3500
Raman Shift (Δcm-1)

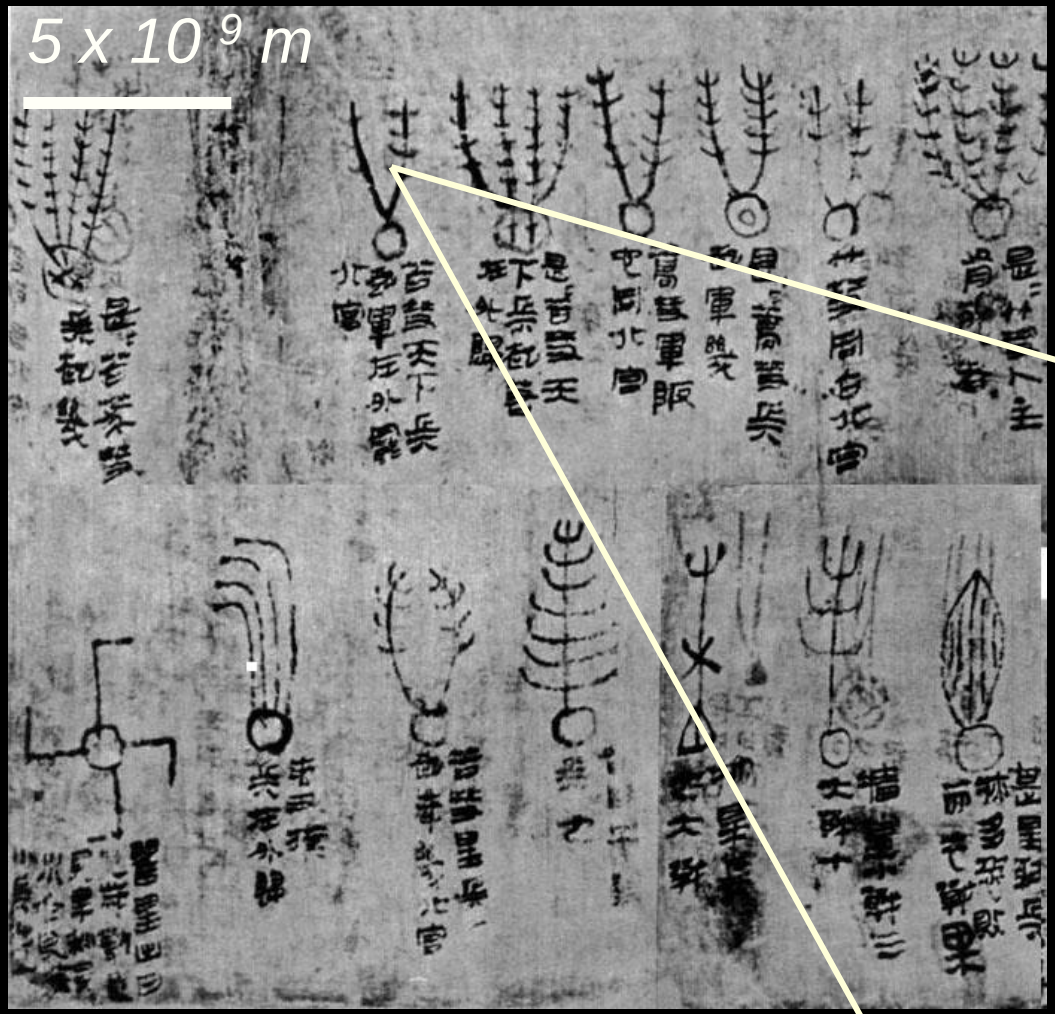

c
4 µm
Reflected Light Image of Particle 41,11


Amine
PHAs
Idrocarburi complessi


100 nm

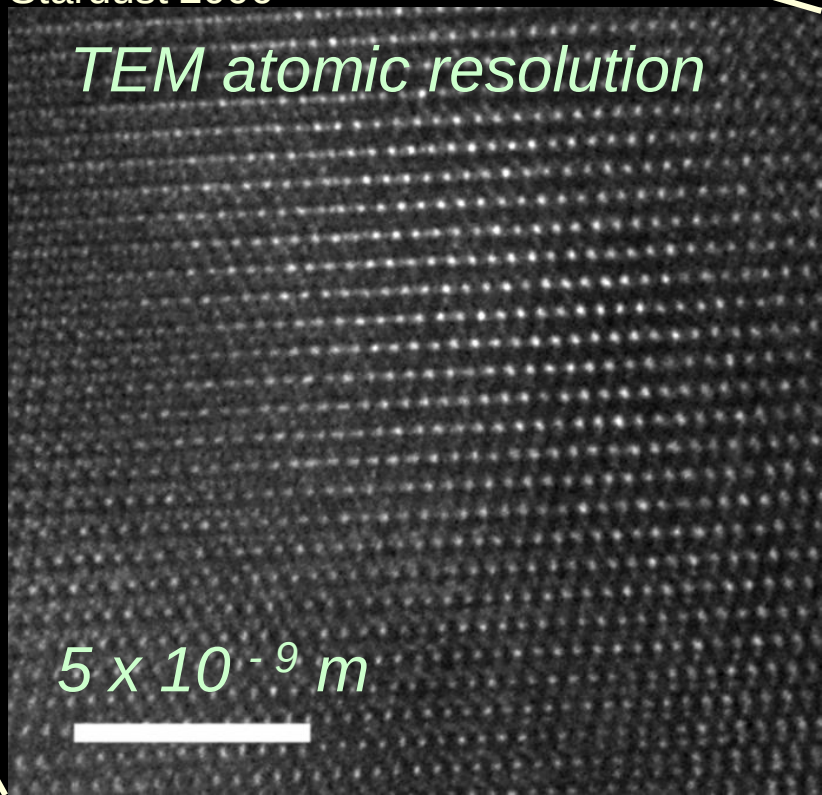

T57
Febo

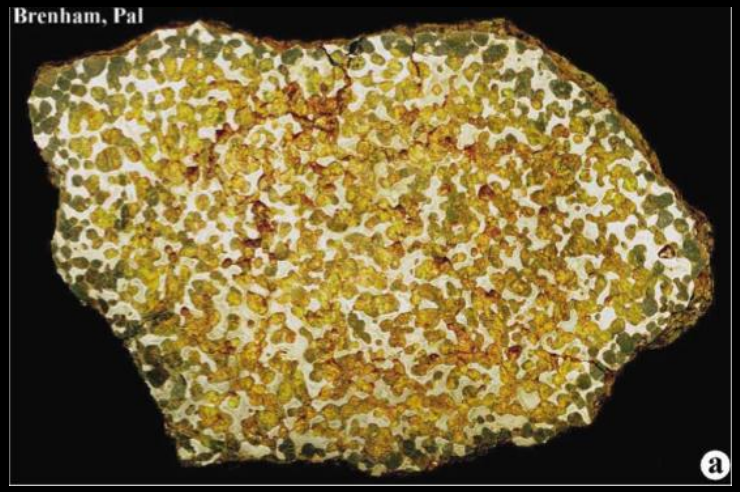

fine grained
~ solar
comp.
MgSiO3
FeS

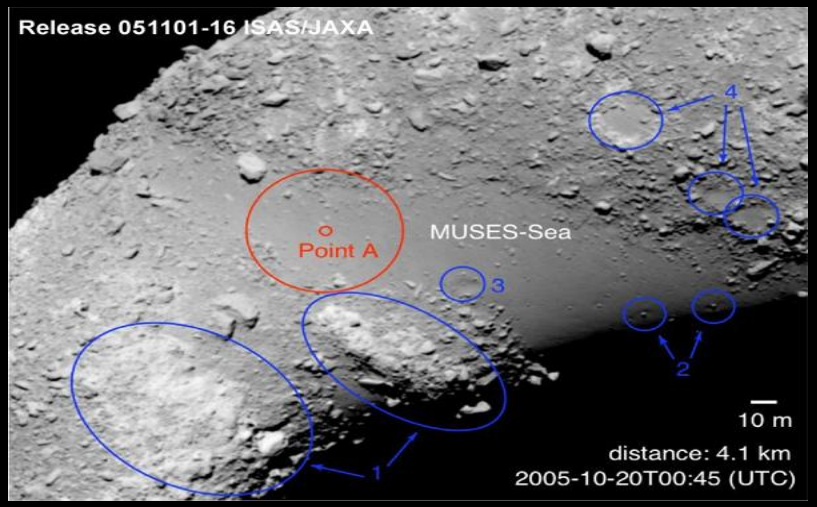


Chinese Comet 168 BC

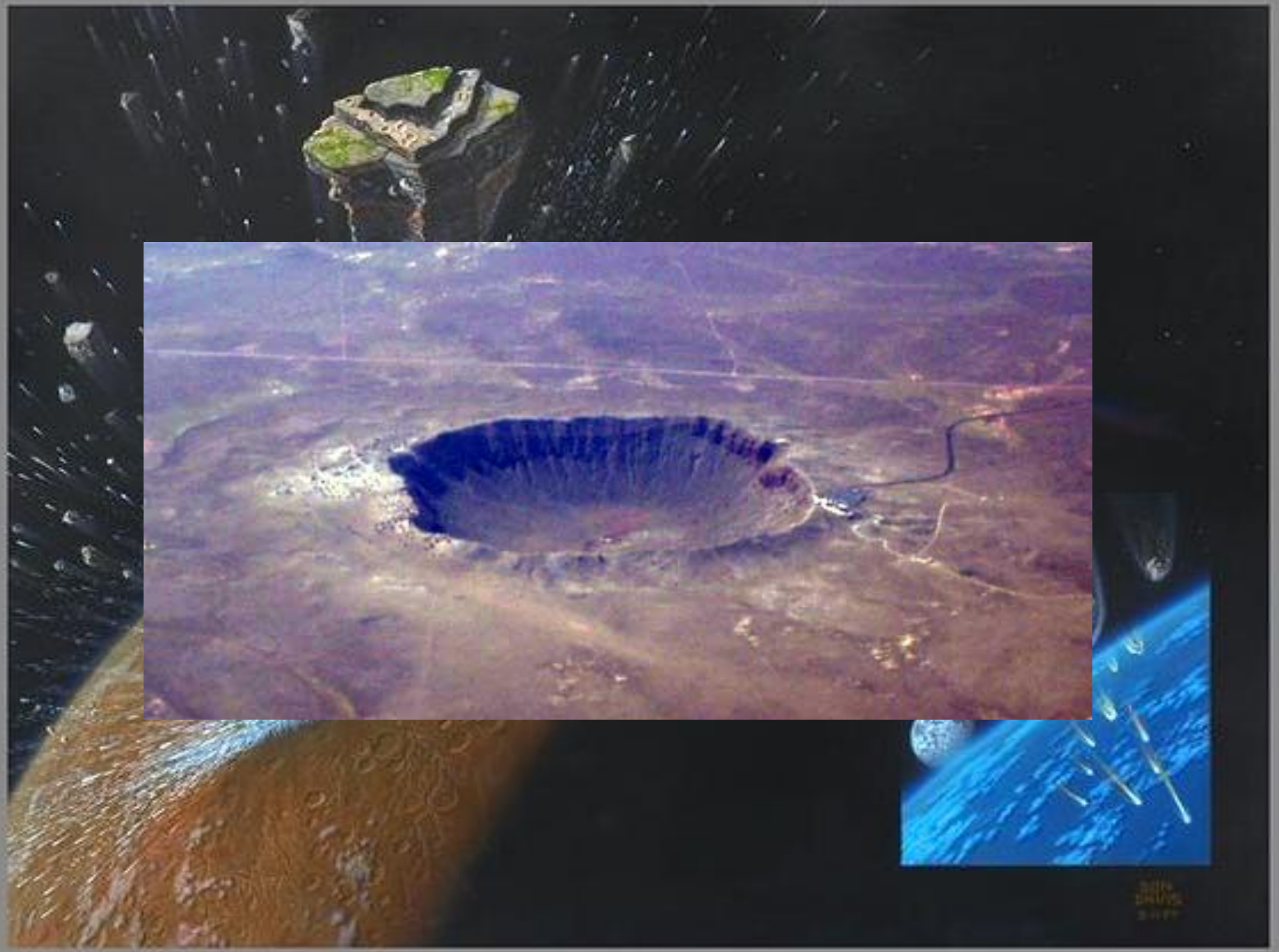
Stardust 2006







ASTEROIDI & METEORITI



Si pensa che le meteoriti condriti carbonacee ed ordinarie possano aver contribuito alla formazione della Terra

Meteorite di Murchison

Condrite carbonacea (4.6 10^9 anni)

Analisi chimica:

Aminoacidi

Acidi carbossilici

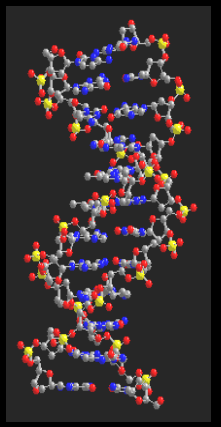
Idrocarburi

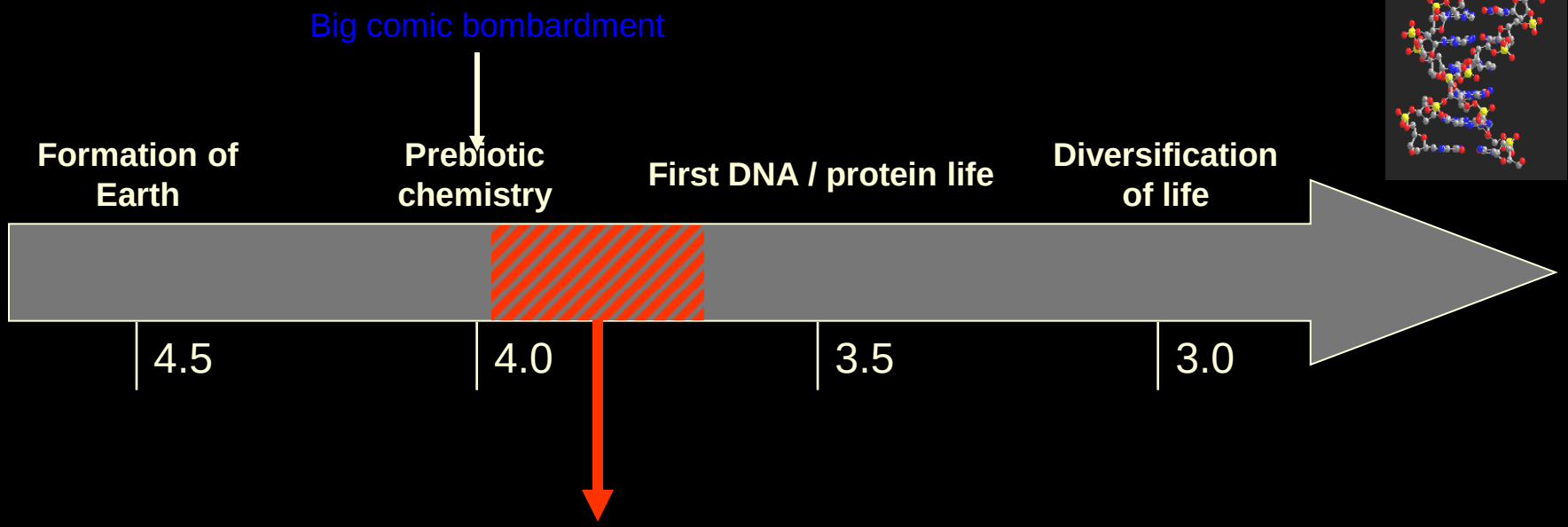
Basi nucleotidiche

Composti organici del Fosforo e Zolfo

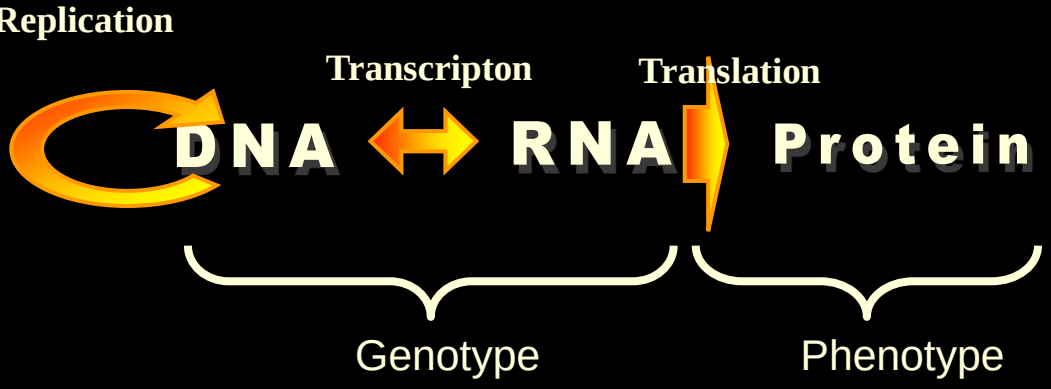
Zuccheri

Evoluzione molecolare

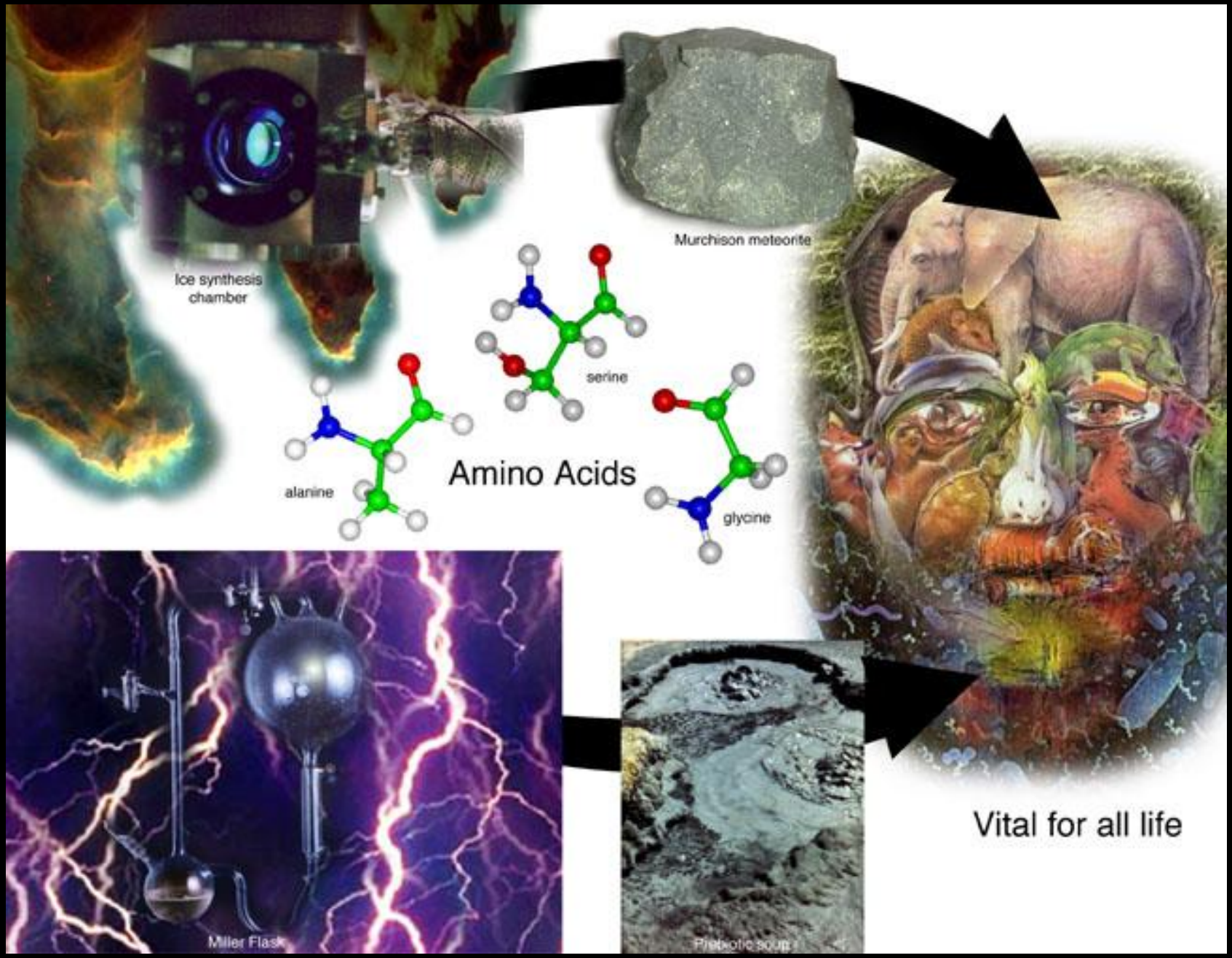




La comparsa di un polimero simile agli acidi nucleici ed in grado di evolvere segna l'inizio della vita



Una nascita comune avvenuta ~4 miliardi di anni fa?


Ice synthesis chamber
Murchison meteorite
serine
alanine
Amino Acids
glycine
Miller Flask
Vital for all life

Come è nata la vita?

Esiste vita nell'Universo?

Qual è il futuro della vita sulla Terra o altrove?

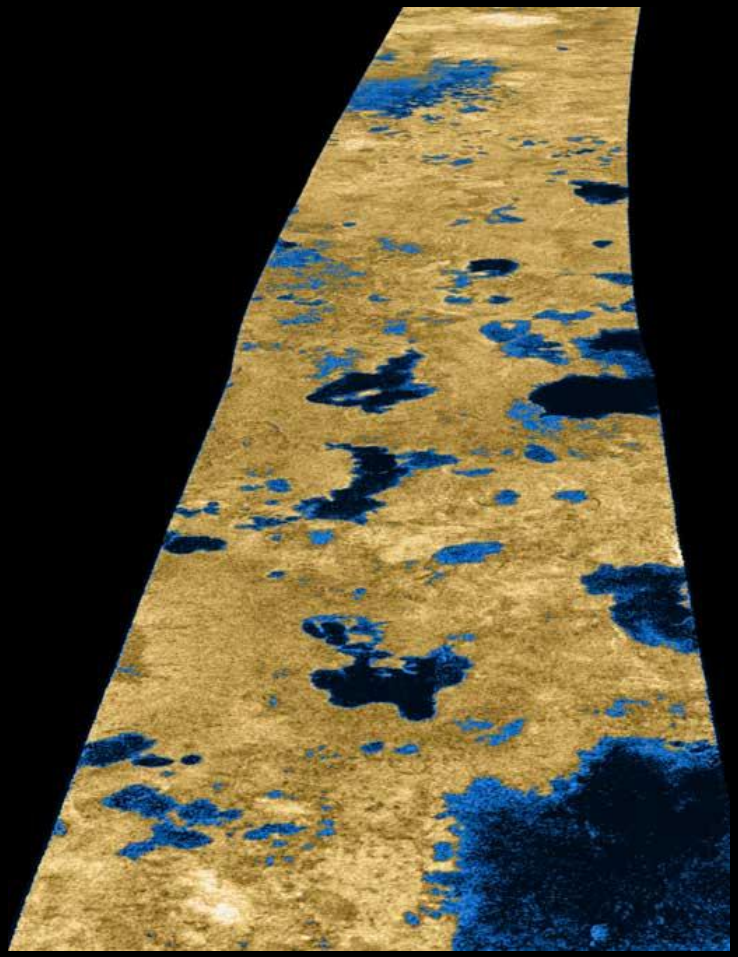
Quattro Mondi

- Quattro mondi con atmosfera
- Quattro mondi con cicli attivi nell’interno, nell’atmosfera e in superficie

Laghi su Titano senz'acqua

La temperatura di Titano è 94 K, troppo fredda per avere acqua liquida, ma non per avere etano e metano liquidi.

L'etano ed il metano hanno lo stesso ruolo dell'acqua sulla Terra.

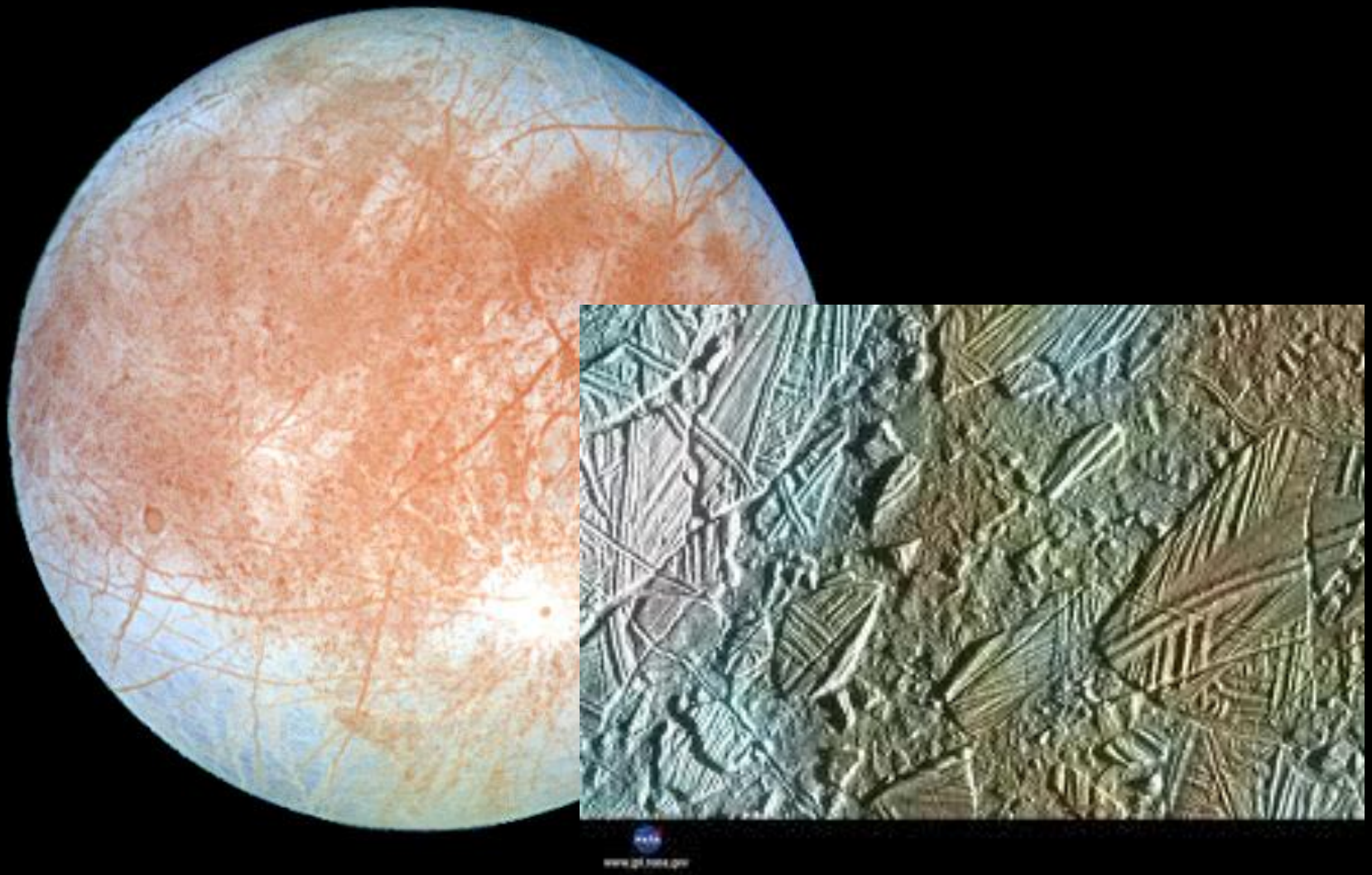


False color Cassini image showing the amount of radar signal reflected from a region of Titan's northern hemisphere. Dark regions are likely lakes.

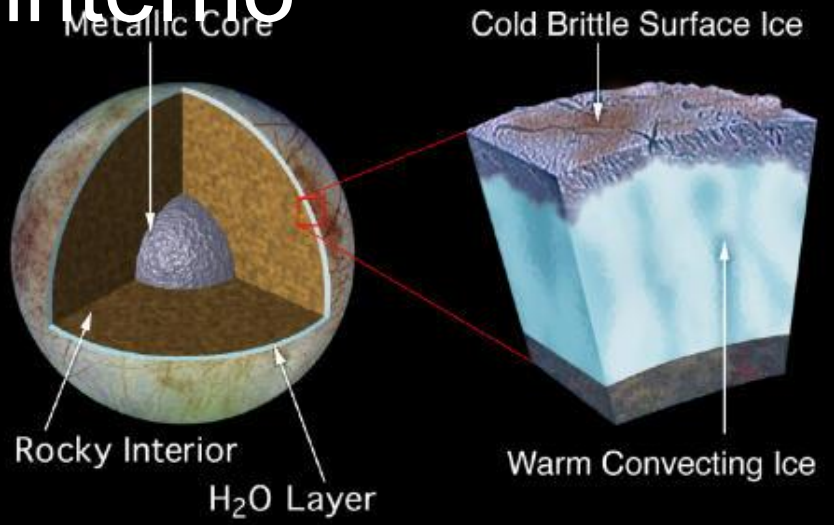
"The stay of the Cassini-Huygens mission on the surface of Titan was unfortunately brief; but this moon of Saturn is the locale that is arguably likely to support exotic life."

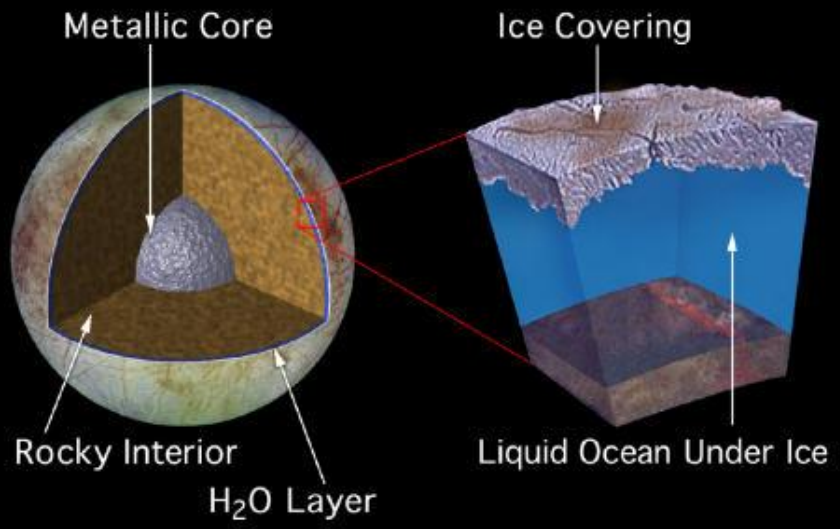
Limits of Organic Life, National Research Council. 2007

Ghiaccio su Europa

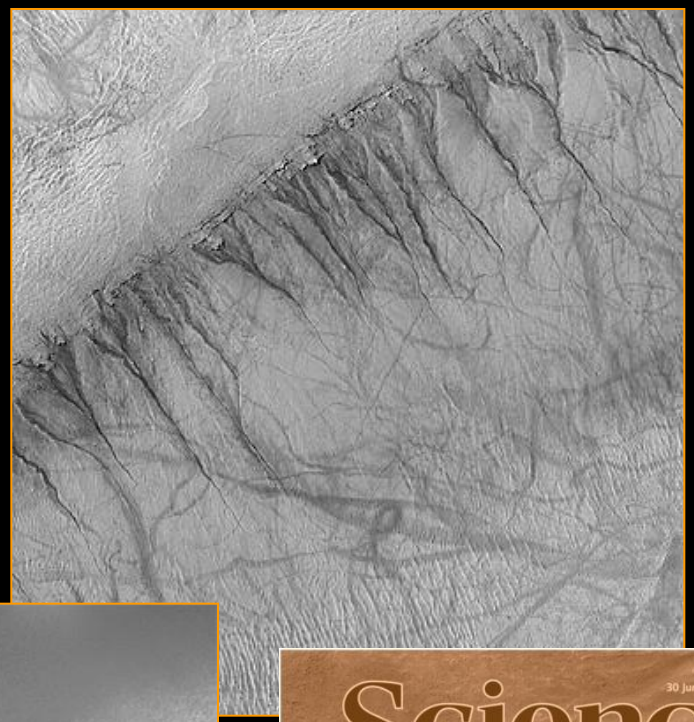


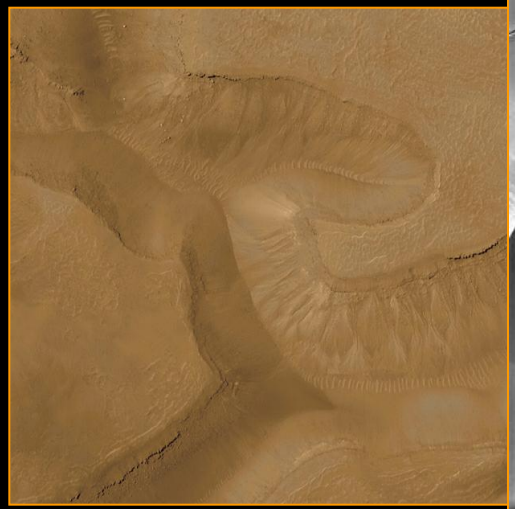
…e un oceano all'interno

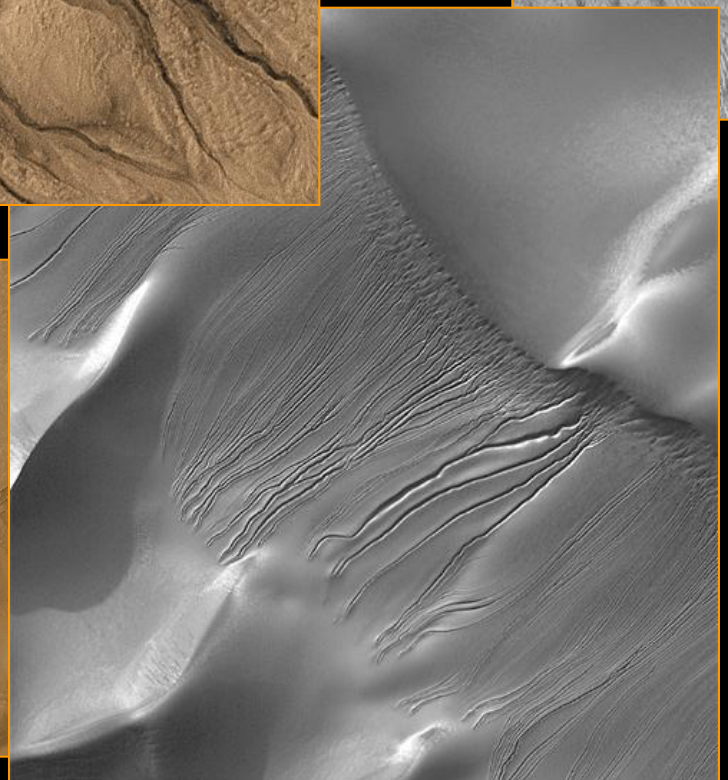




Marte





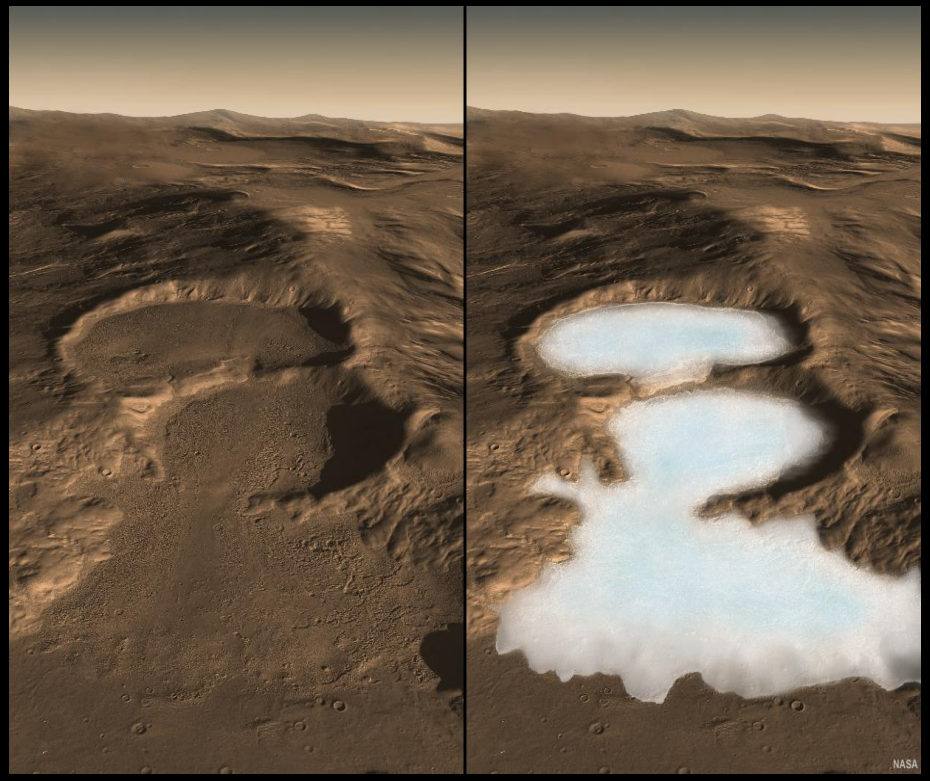



30 June 2000
Science
Vol. 288 No. 5475
Pages 2273-2412 $8
American Association for the Advancement of Science

Ghiacciai nascosti su Marte

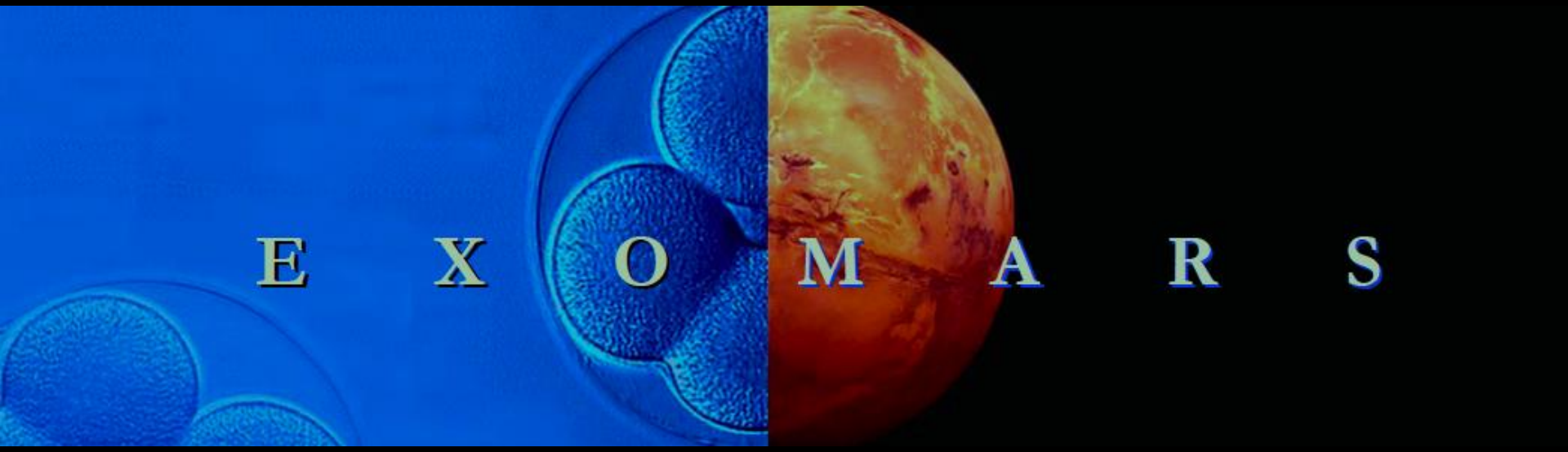
Misure Radar condotte dai satelliti hanno mostrato che esistono su marte ghiacciai ricoperti da sedimenti rocciosi.

Lo strato di polveri protegge il ghiaccio dalla sublimazione nella tenue atmosfera marziana



(Left) Perspective image of craters in the southern hemisphere of Mars, created using NASA Mars Reconnaissance Orbiter images; (Right) Artist conception of ice underlying a surface layer, based on radar observations.

esa



The Aurora Programme

ESA's new programme to prepare for the human exploration of the Solar system.

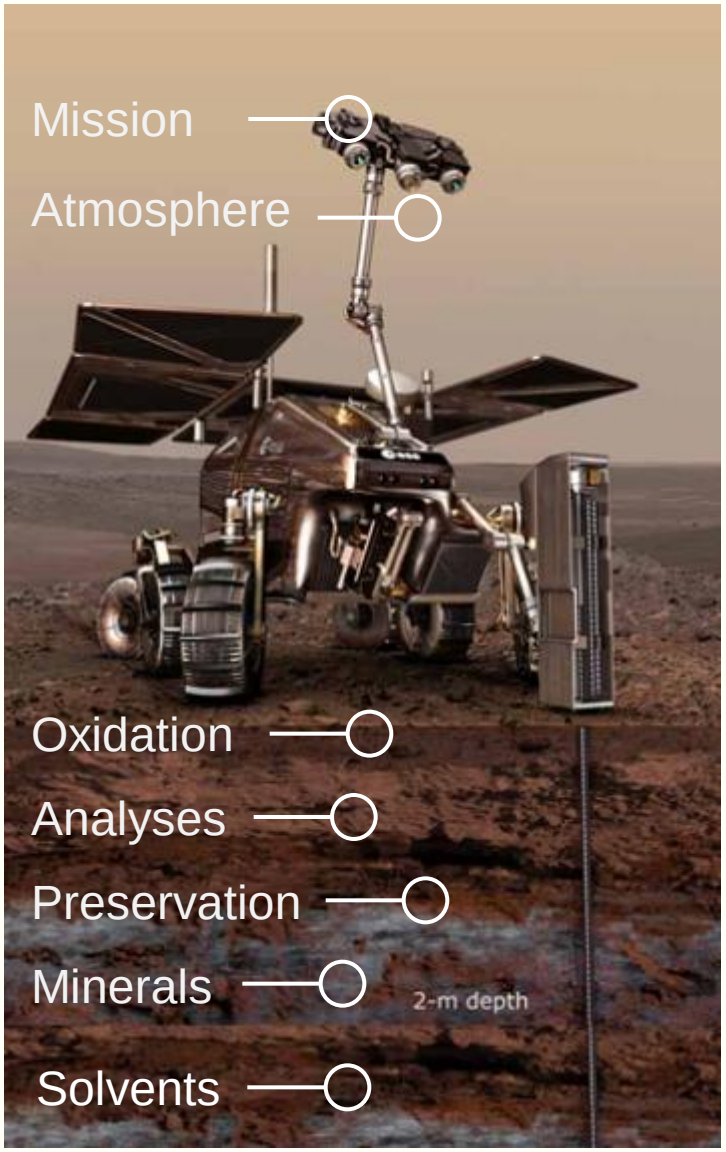
Characteristics:

- Defines a long-term space exploration strategy for Europe;
- Focuses on exploration infrastructure and technology development;
- Robotic missions in preparation of future human ones;
- Synergy between scientific and technological objectives;
- Provides a framework for cooperation with other space agencies.

La missione ExoMars – Lancio 2018

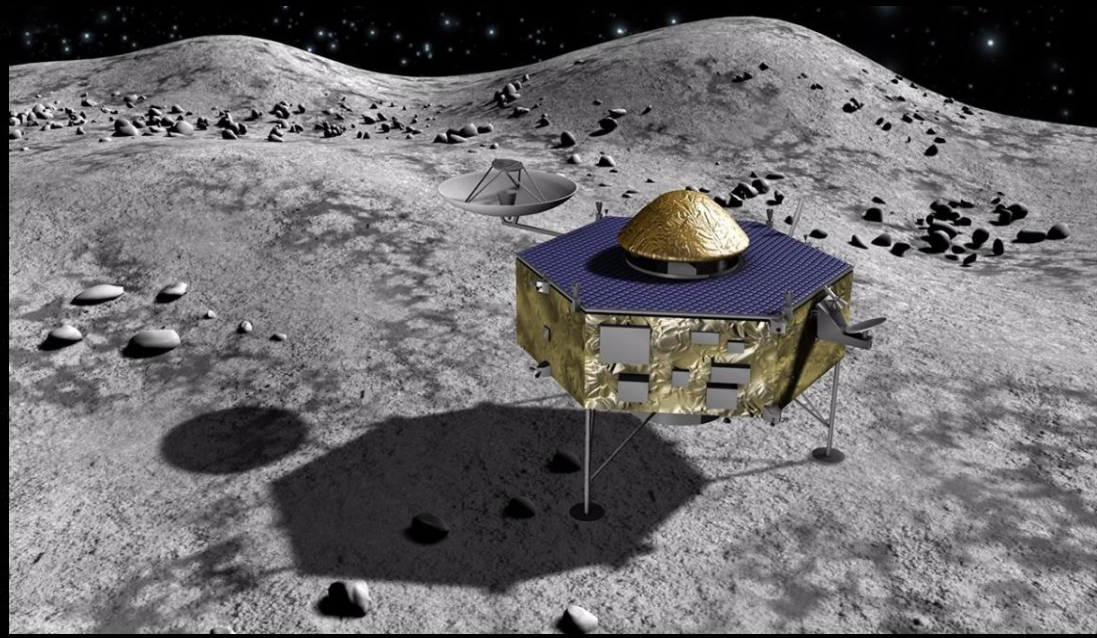
Life Marker Chip

- Mission
- Atmosphere
- Oxidation
- Analyses
- Preservation
- Minerals



Marco Polo-R

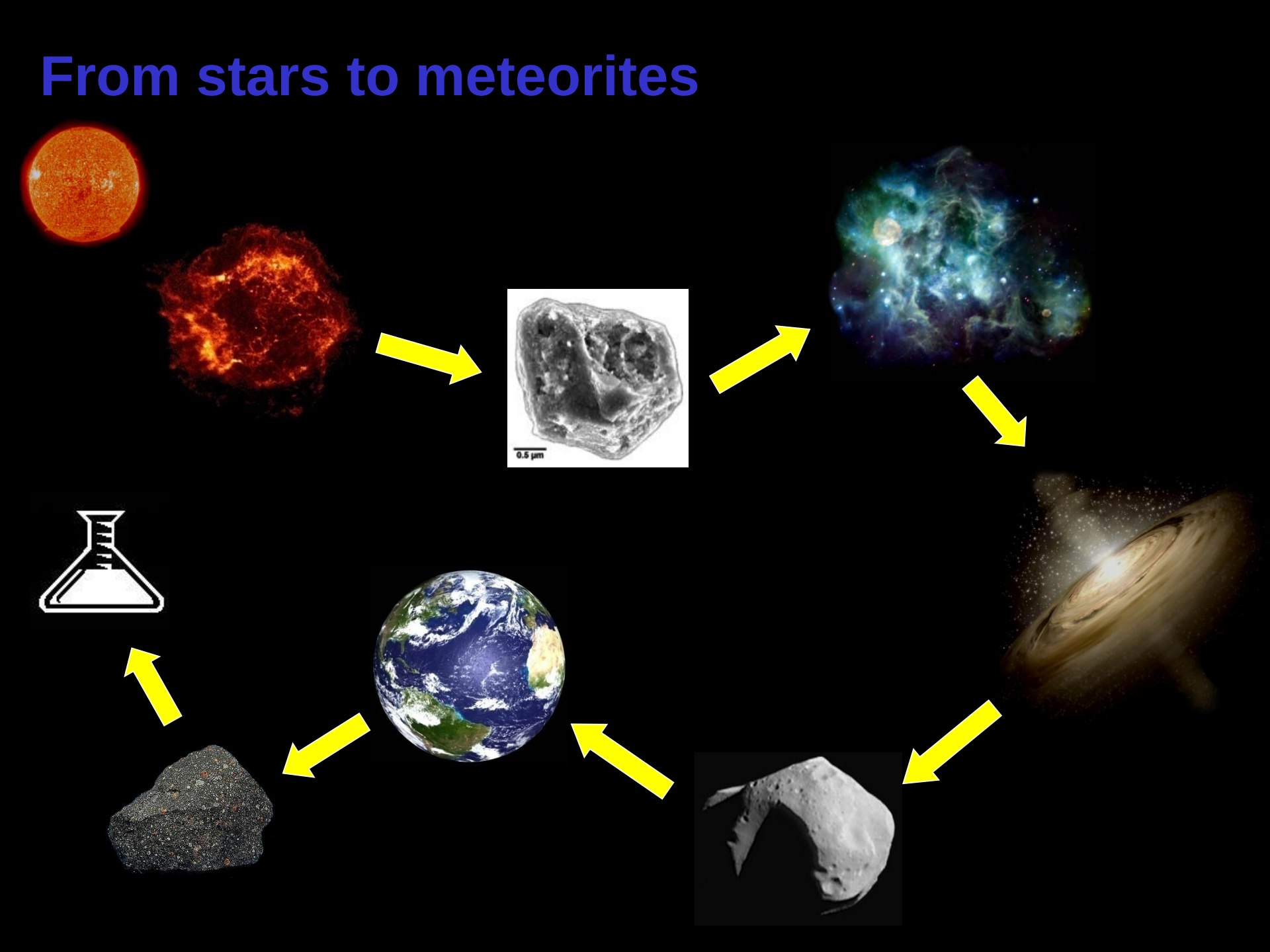
Near Earth Asteroid Sample Return Mission



Science Study Team:
M.A. Barucci (F), H. Boehnhardt (D), J.R. Brucato (I), E. Dotto (I), I.A. Franchi (UK), S.F. Green (UK), J.-L. Josset (CH), P. Michel (F), K. Muinonen (FIN), J. Oberst (D), R. Binzel (MIT, USA), M. Yoshikawa, J. Kawaguchi, H. Yano (JSPEC/JAXA, J)
ESA study team: D. Koschny, D. Agnolon, J. Romstedt

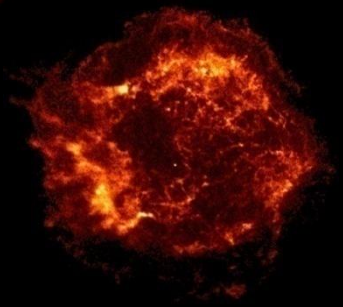

esa
SCIENCE
MARCO POLO

From stars to meteorites

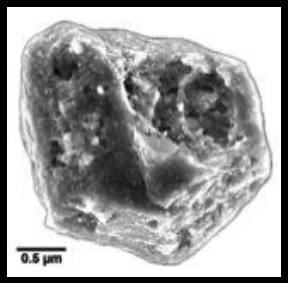


From stars to meteorites

Nucleosynthesis



Condensation
Implantation



Mantle formation
Chemical reaction
Shock
Irradiation

Accretion
Thermal/aqueous alteration
Impacts
Weathering

Evaporation
Condensation
Shock
Irradiation
Chemical reaction

after *Davidson 2009*

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