About Mars, its atmosphere and the dust

overview

* Mars in ancient culture and now

* Exploration of the Planet
  - missions
  - some discoveries

* Martian atmosphere

* Dust in Martian atmosphere, what we really know about it?

* Scattering on Martian dust

* Scattering matrix (of Martian dust analogs)

* Some results

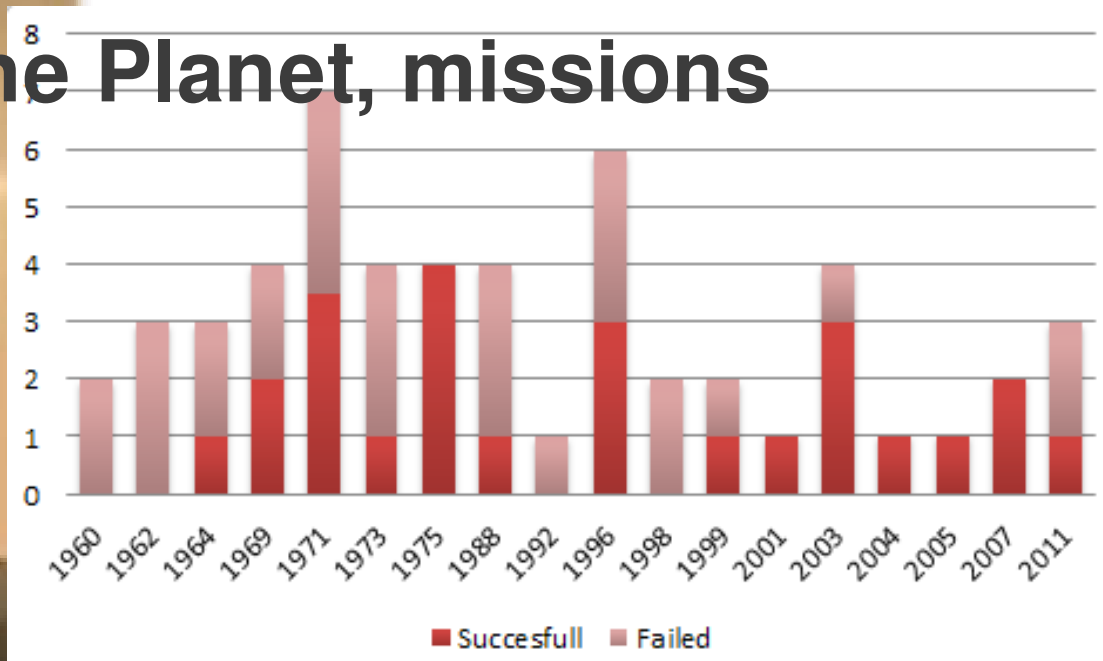
* Some conclusions

Mars in ancient culture and now

Mars in ancient culture and now

mars

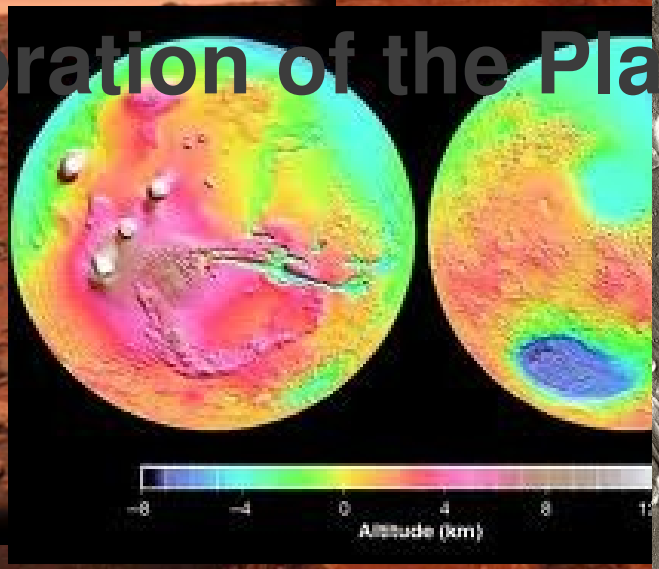
Exploration of the Planet, missions

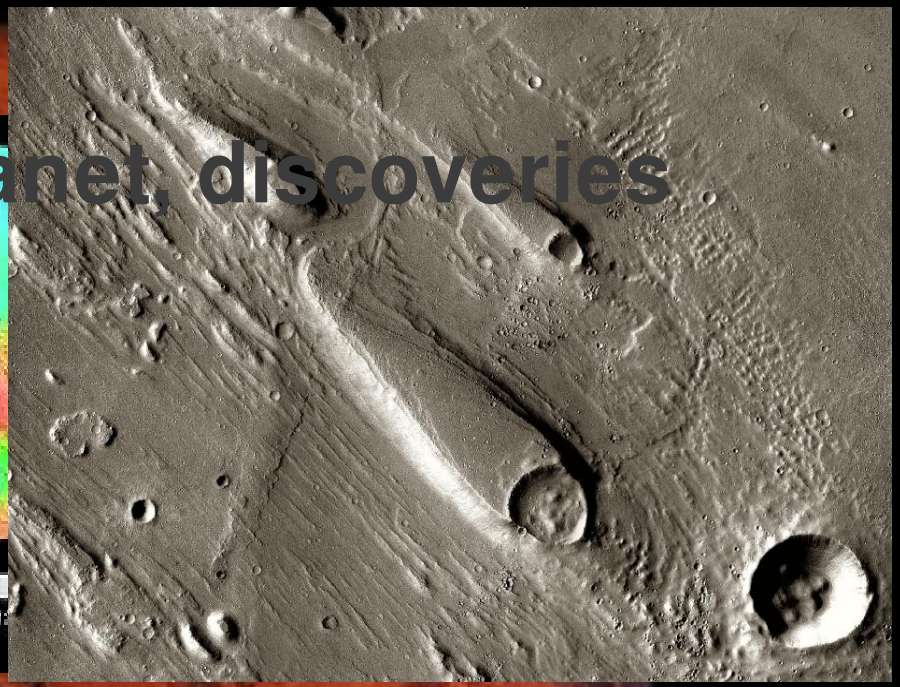


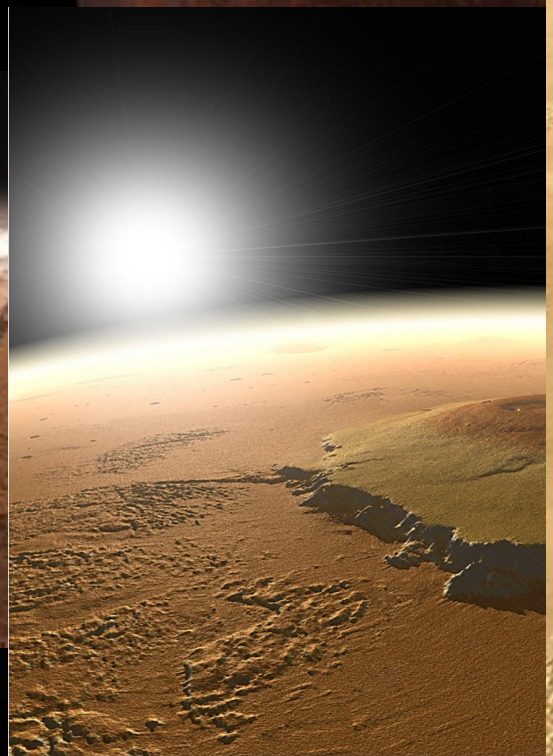
Launch/ /status	Mission	Nation/ /agency
1963	Mars 1	USSR
1964	Mariner 4	NASA
1969	Mariner 6	NASA
1969	Mariner 7	NASA
1974	Mariner 9	NASA
1975	NASA	Viking 1 Orbiter/Lander
1975	NASA	Viking 2 Orbiter/Lander
1988	Phobos-2	USSR
1996 mission ended 2006	Mars Global Surveyor (MGS)	NASA
1996 mission ended 1997	Mars Pathfinder (MPF)	NASA
2001-current	Mars Odyssey Orbiter	NASA
2003-current	Mars Express Orbiter	ESA
2003-current (Opportunity) 2003-2011 (Spirit)	Mars Exploration Rovers (MER)	NASA
2005-current	Mars Reconnaissance Orbiter (MRO)	NASA
2011-current	Mars Science Laboratory,Curiosity	NASA
2013-On way to Mars	Mangalyaan	India
2013-On way to Mars	MAVER	NASA

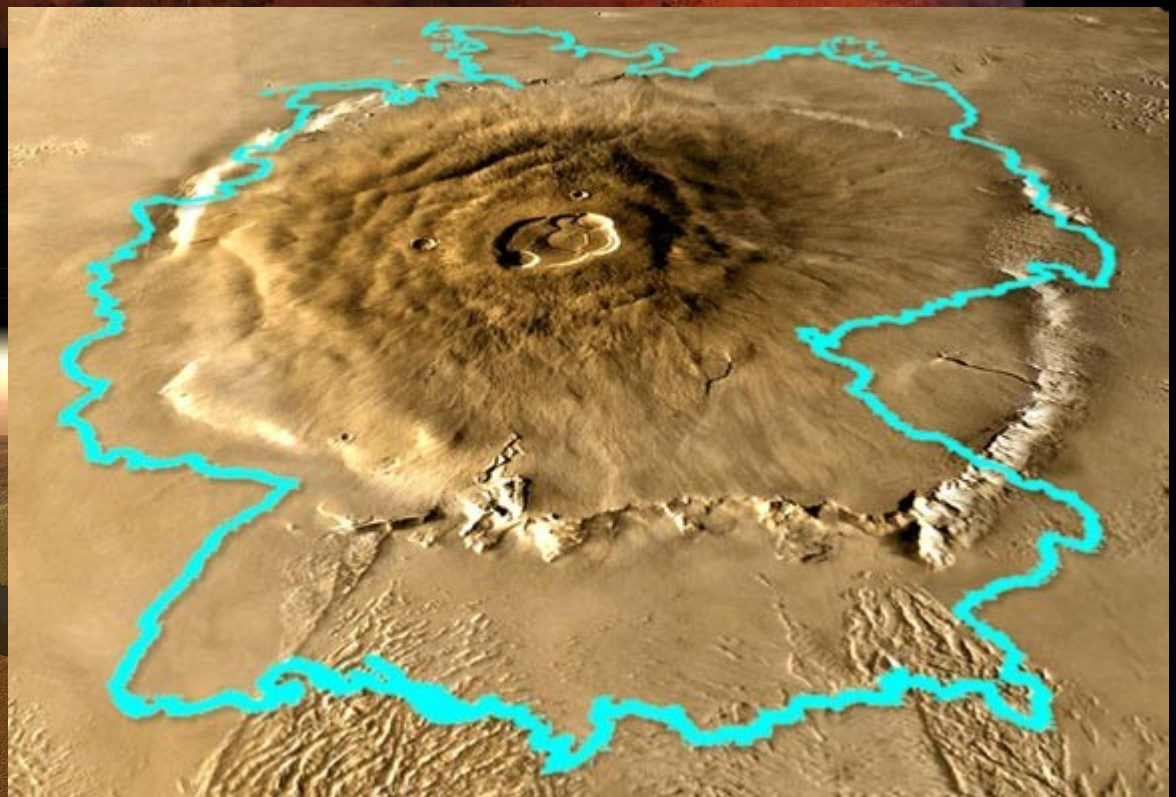
Phoenix 2008!!!!

Exploration of the Planet, discoveries

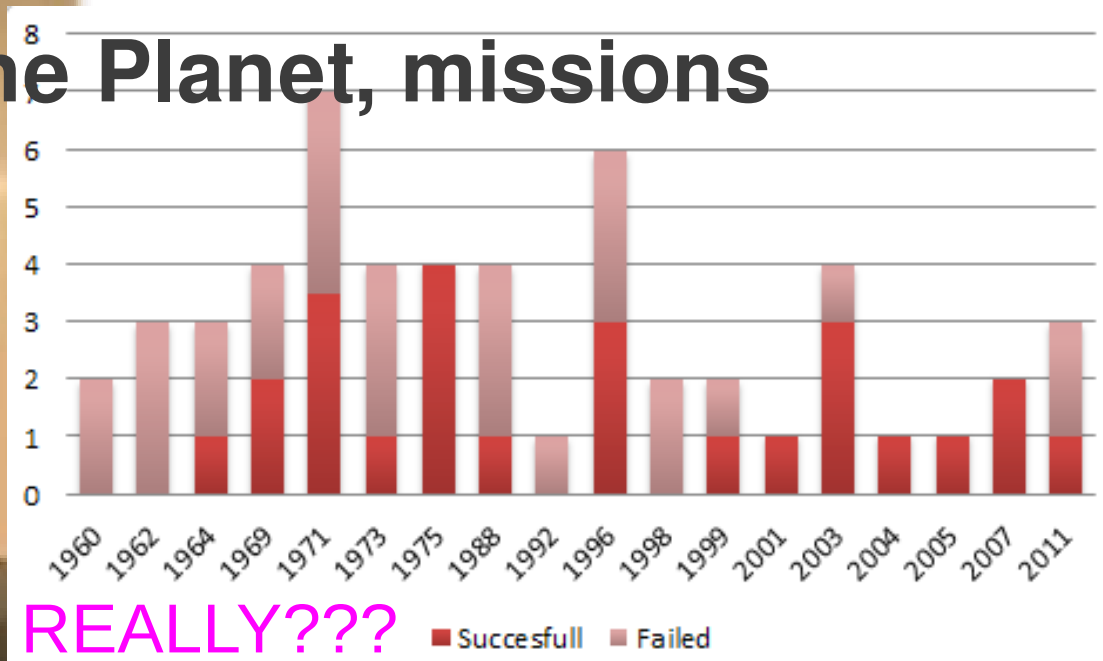








Exploration of the Planet, missions



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Phoenix 2008!!!!


NASA BOEING JPL CORNELL RED PLANET GLADIATORS
ISLS MER-B
Phoenix
Mars Lander 2007
MARS SCIENCE LABORATORY
JPL
Jet Propulsion Laboratory
MARS EXPLORATION ROVER - A
ISLS
Red Planet Gladiators
NASA BOEING JPL CORNELL
North Polar Cap
Olympia
Alba Patera
Phoenix
Arcadia
Tempe
Acidalia
Deuteronilus
Viking 2
Utopia
Olympus Mons
Arabia
Elysium
Viking 1
Pathfinder
Chryse
Tharsis Montes
Syrtis Major
Opportunity
Meridiani
Curiosity
Gale Crater
Valles Marineris
Spirit
Gusev Crater
Solis
Noachis
Hellas
Aonia
Sirenum
Arygre
PROJECT VIKING
MISSION TO MARS
South Polar Cap

Martian surface & atmosphere

* day T below 270 K
* nights below 190 K

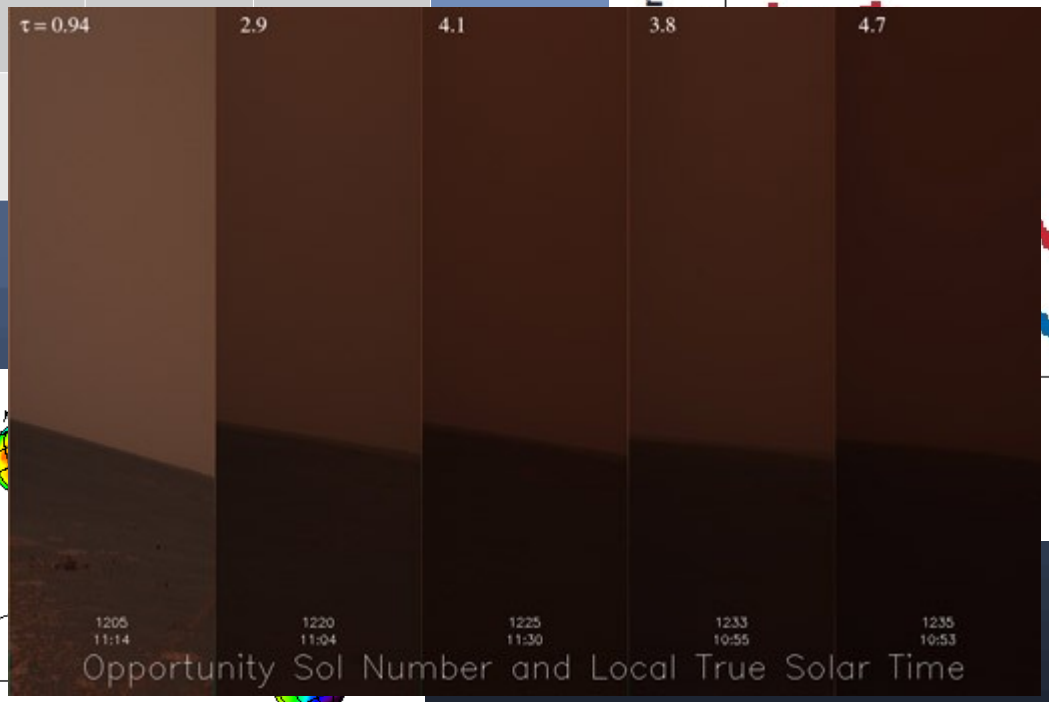
* Water – no liquid water now, permafrost polar caps, under surface

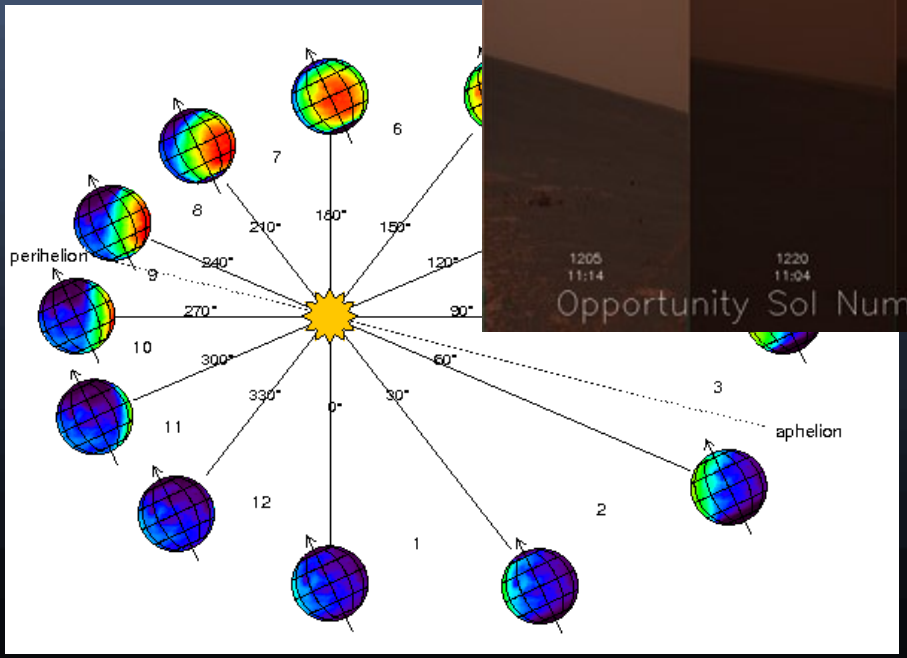
Imagination
- life?
Its origin, the same as on the Earth? exchanging the rock

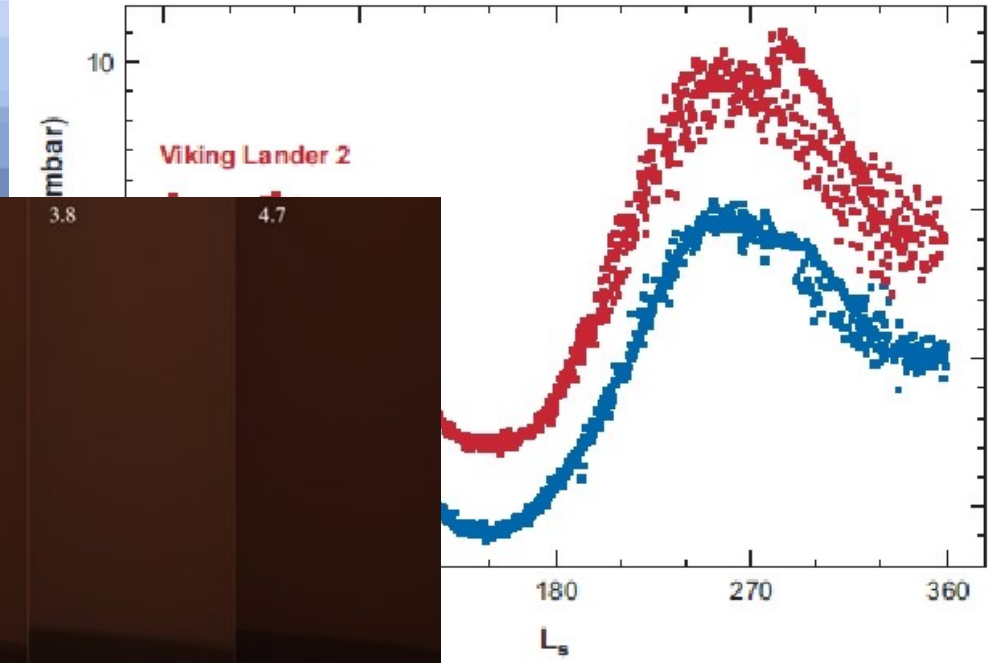
Atmosphere: thin .. very thin, 7mbar
* no UV protection
* harsh climate
* dust, dust activity

Martian atmosphere

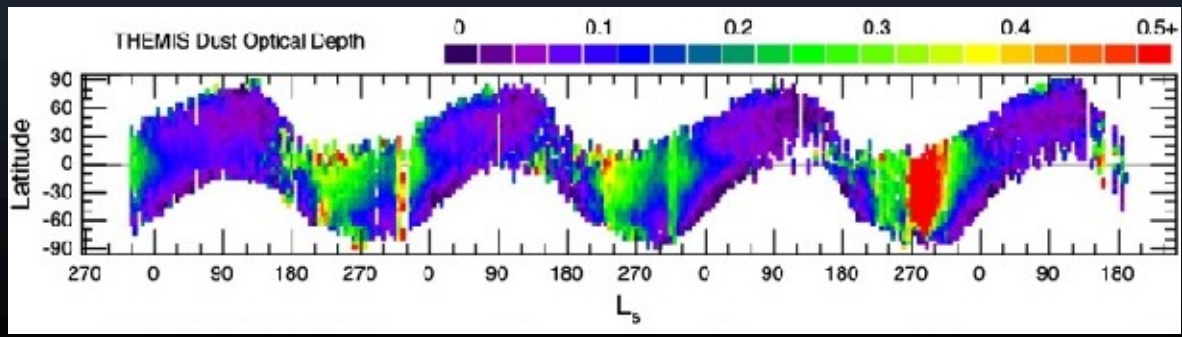
	Venus	Earth	Mars
AU	0.723		
Mass [10^24 kg]	4.87		



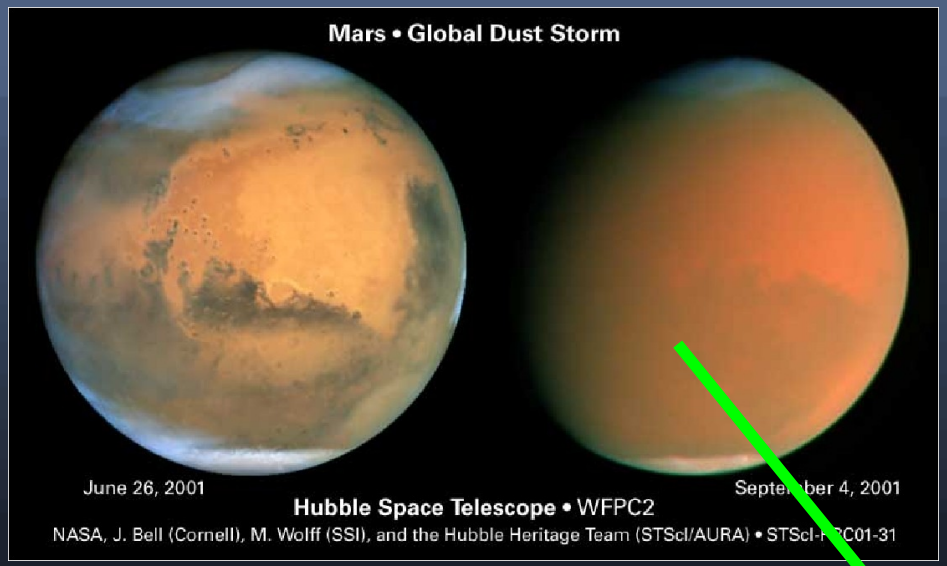


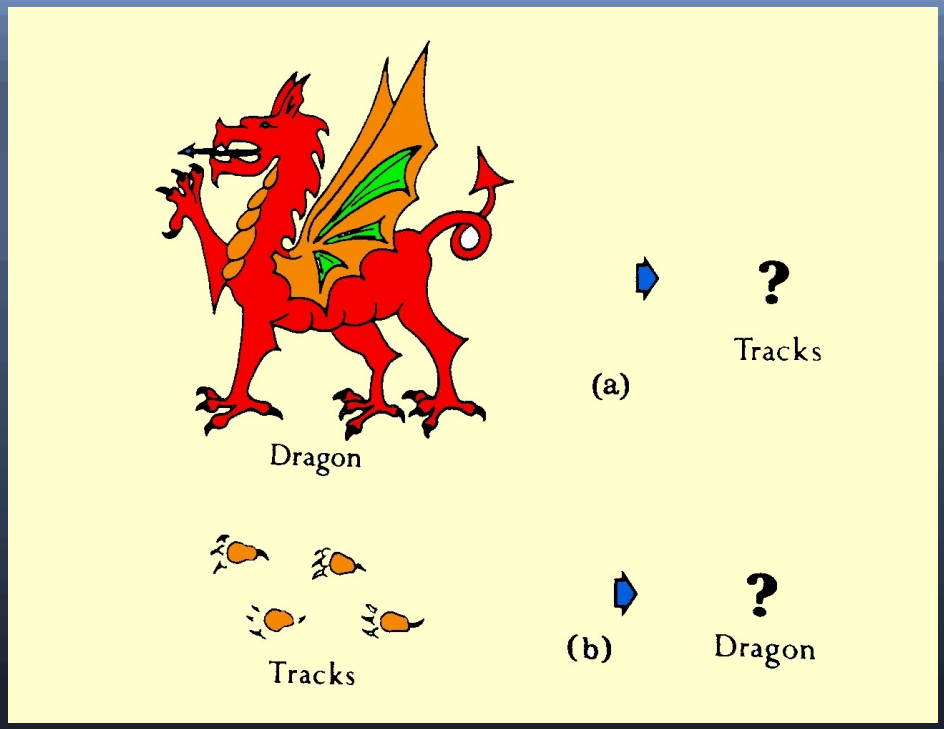


GLOBAL STORM!!!!



Dust in Martian atmosphere, what we really know about it?





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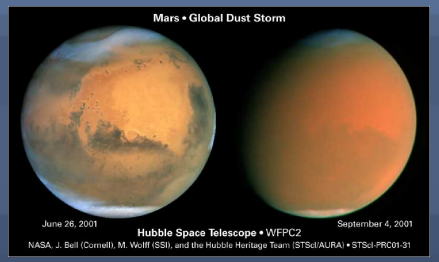
Dust in Martian atmosphere, what we really know about it?



*** size (r_{eff}, v_{eff}):** **1. conditions**
2. retrieval method r_{eff} = 0.058 µm,
1.5 µm,
> 9 µm

* composition: MEx atlas
all rovers coherent chemical results
Small influence of bedrocks
Carbonates, e.g. (few percent, Phoenix Lander, Crism on MRO)
Spectral analogs

* shapes: irregular (Phoenix microscope image)
Modeling the sky brightness changing the shape (size)

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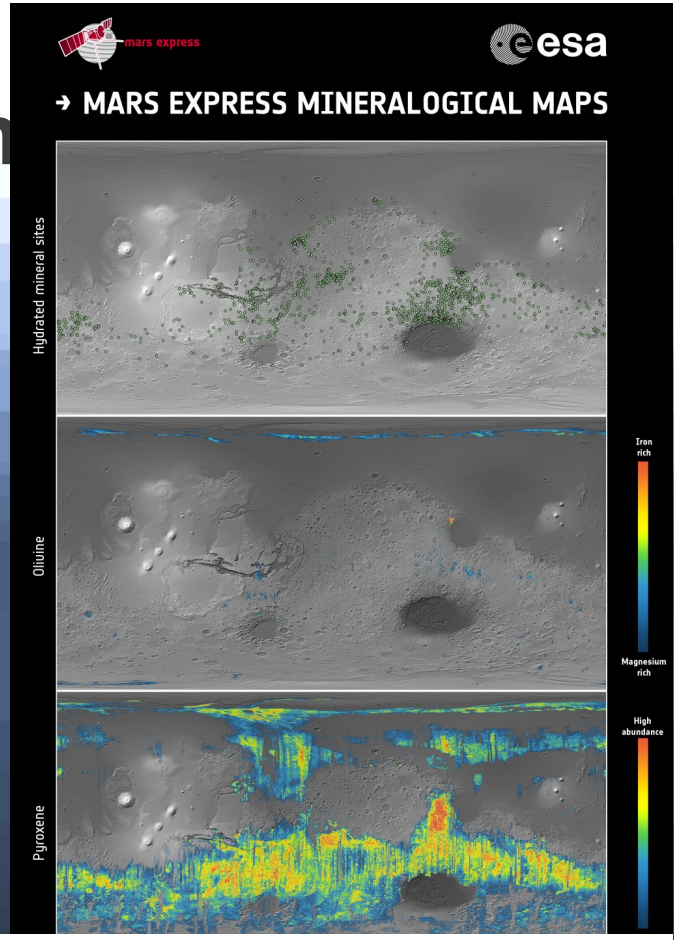
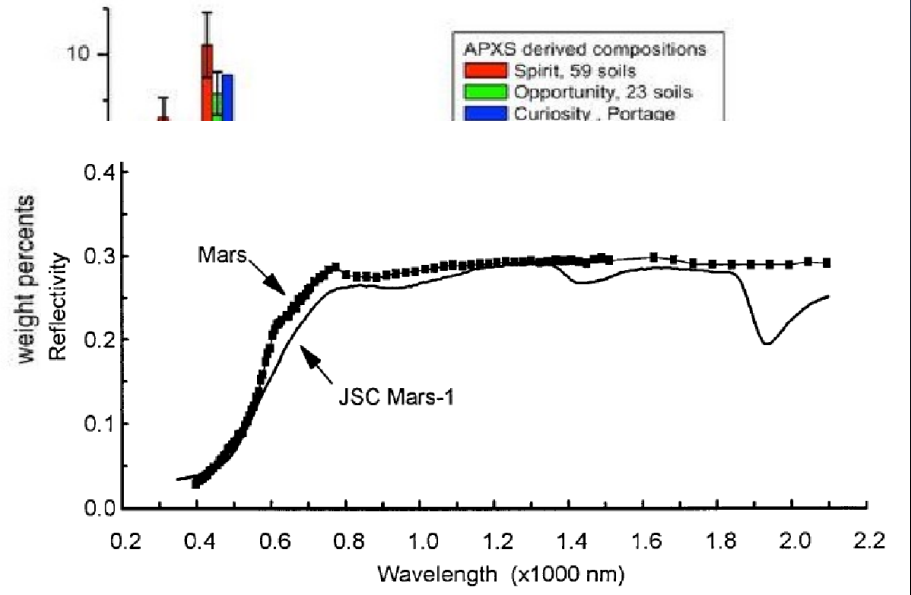
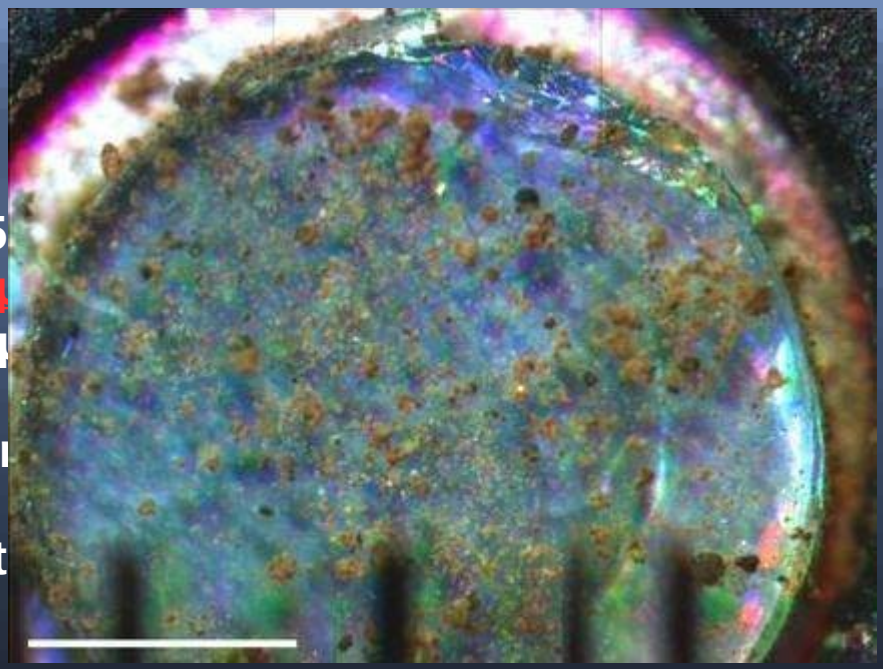




Dust in Martian atmosphere, what we really know about it?

* size (r_{eff}, v_{eff}): 1. conditions
2. retrieval method r_{eff} = 0.05
1.5 μ
> 9 μ

* composition: MEx atlas
all rovers coherent chemical
Small influence of bedrocks
Carbonates, e.g. (few percent
Spectral analogs



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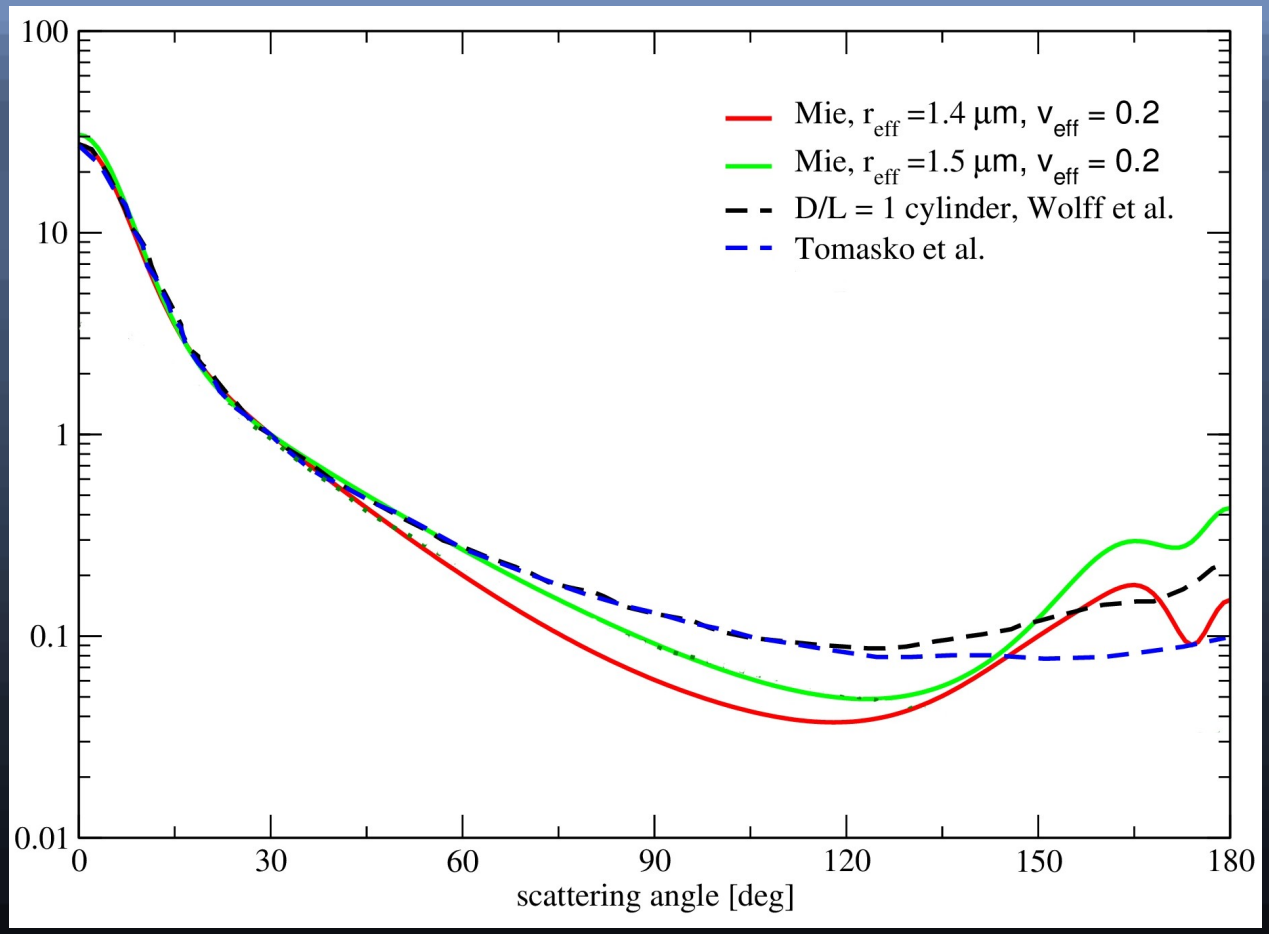
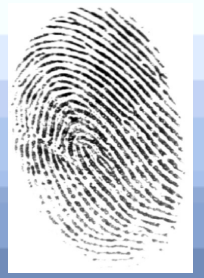
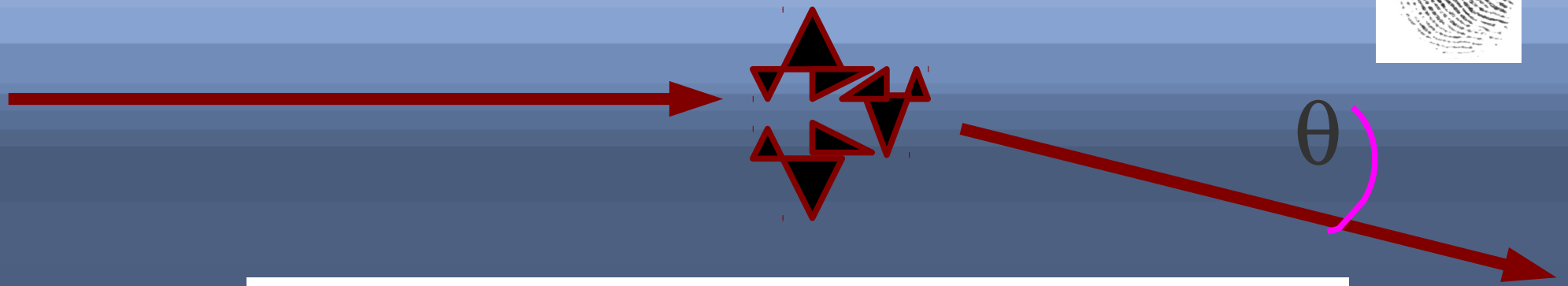
Scattering on Martian dust



Scattering matrix





Intensity

Lin. Polar.

Circ. Polar.

$$\begin{pmatrix} I_{sc} \\ Q_{sc} \\ U_{sc} \\ V_{sc} \end{pmatrix} \propto \begin{pmatrix} F_{11} & F_{12} & 0 & 0 \\ F_{12} & F_{22} & 0 & 0 \\ 0 & 0 & F_{33} & F_{34} \\ 0 & 0 & -F_{34} & F_{44} \end{pmatrix} \begin{pmatrix} I_{in} \\ Q_{in} \\ U_{in} \\ V_{in} \end{pmatrix}$$

Stokes vector — Scattering Matrix — Stokes vector

Measured scattering matrix (of Martian dust analogs)

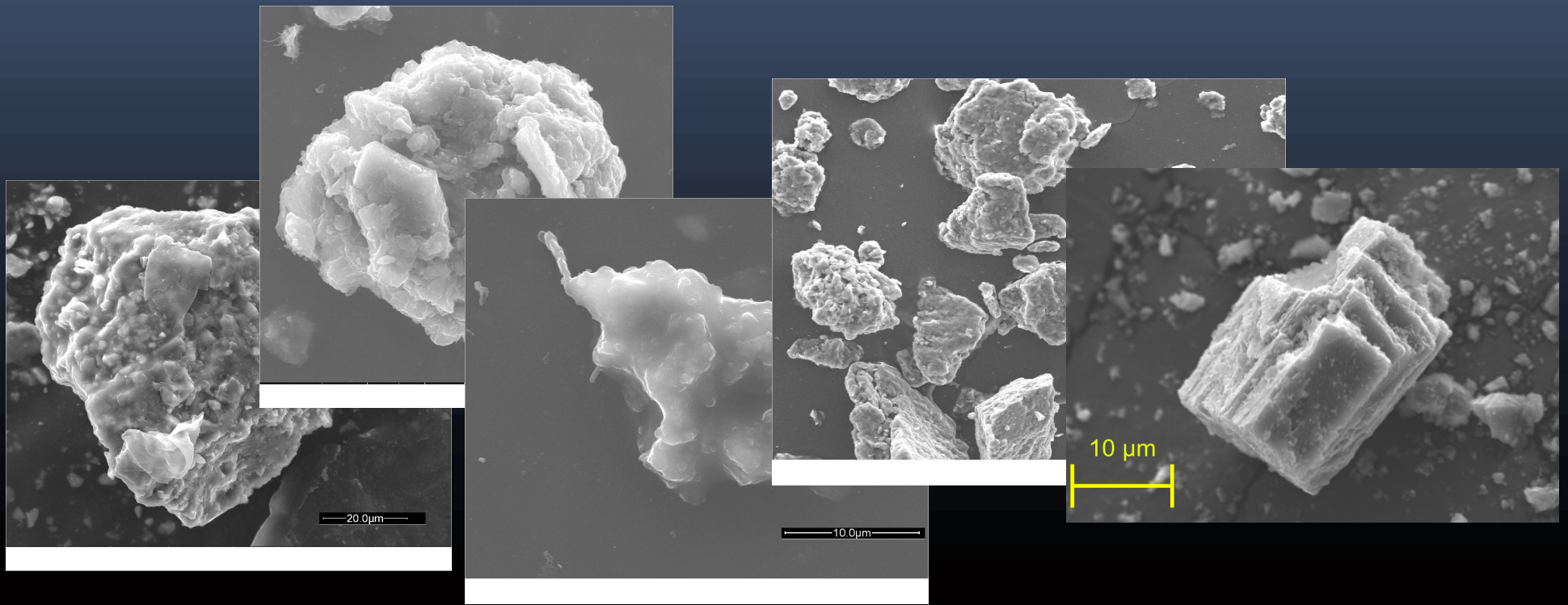
* we have measured 4x4 scattering matrix of:

- Basalt
- JSCs samples (palagonites, one dehydrated)
- Montmorillonite
- Calcite

Water interest

Past volcanic activity on Mars

Spectral analogs, palagonite weathering product of basalt

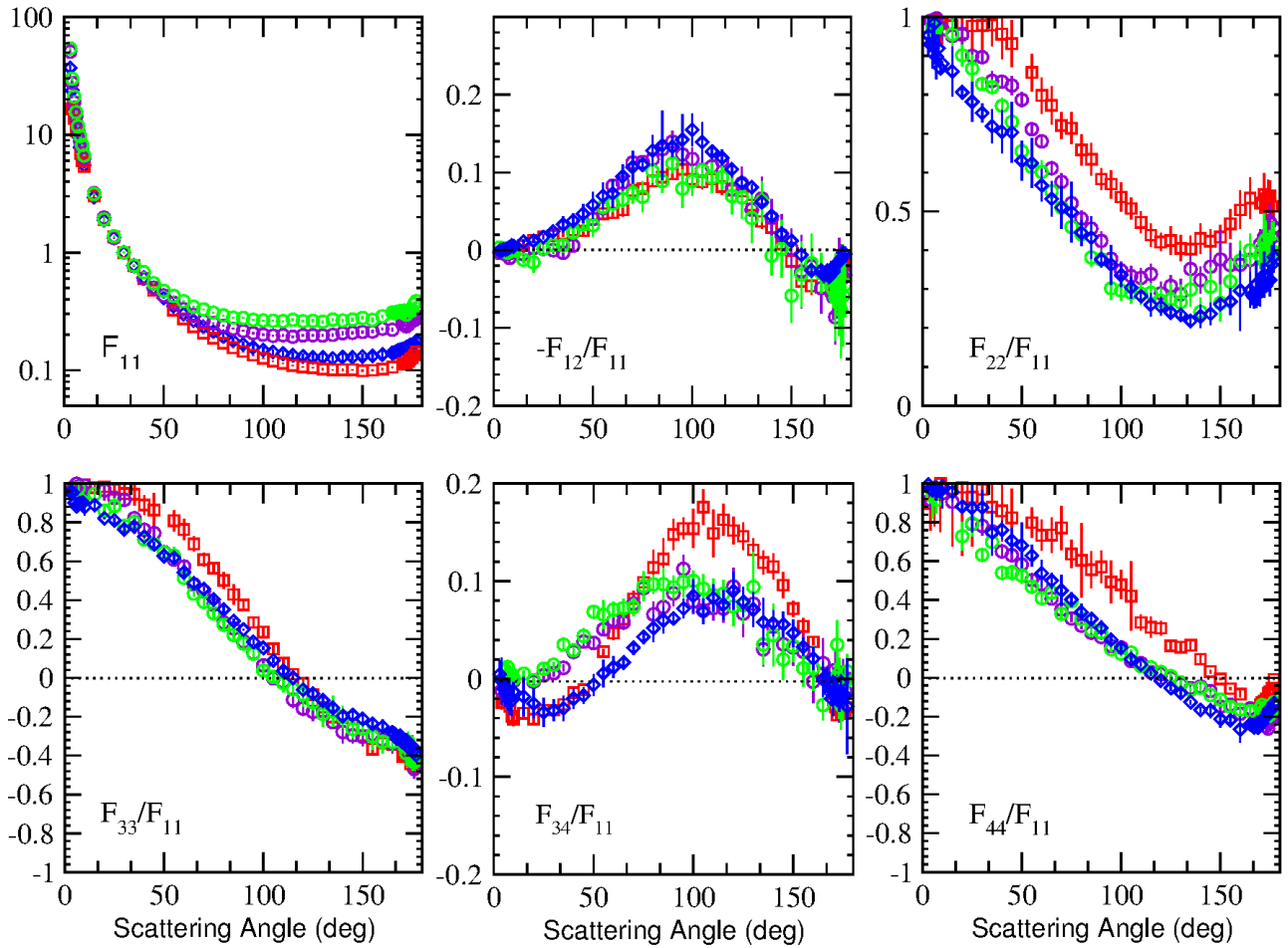


Measured scattering matrix (of Martian dust analogs). Some results.

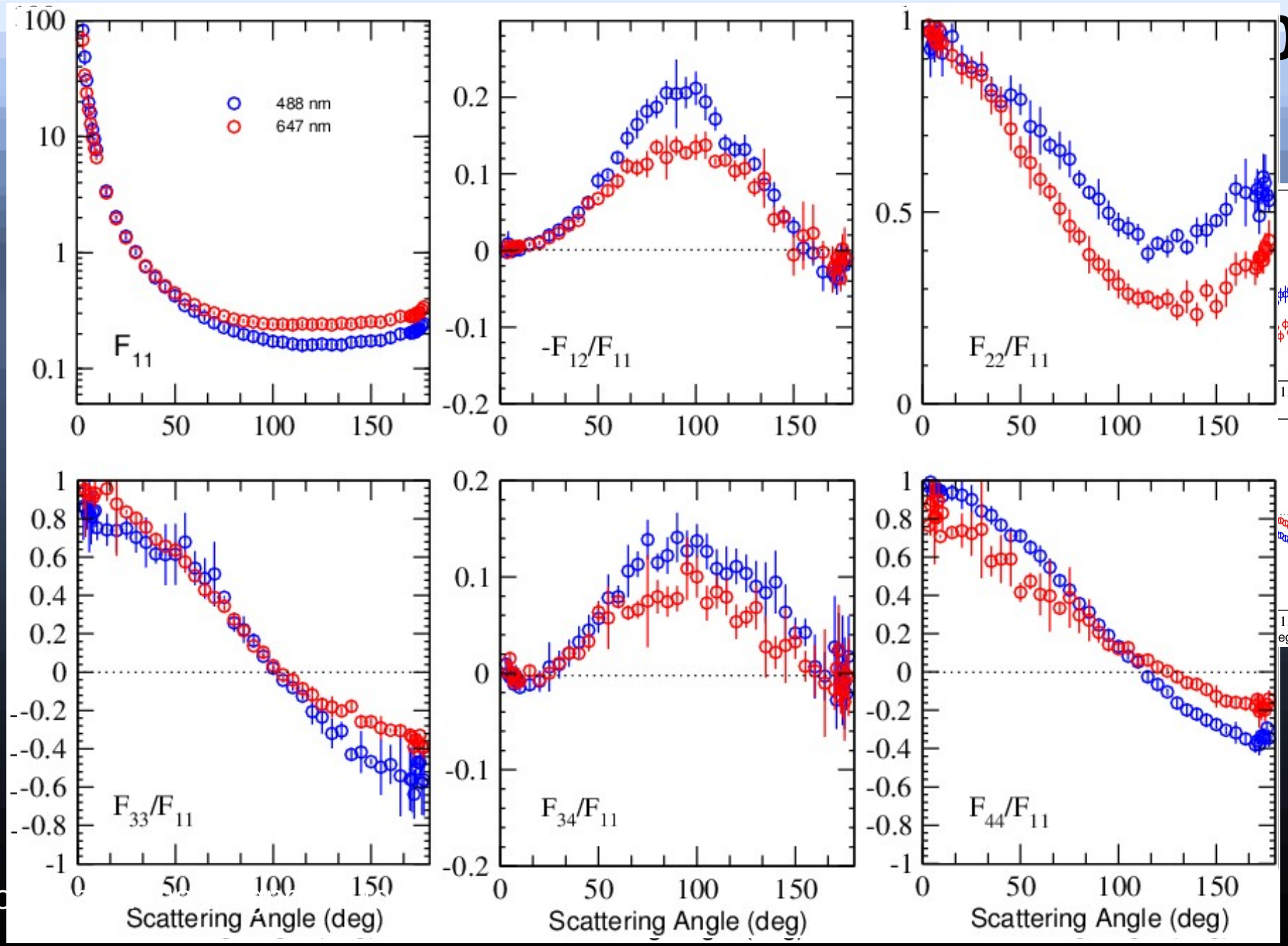
- Calcite
- Basalt
- JSC200
- JSC0

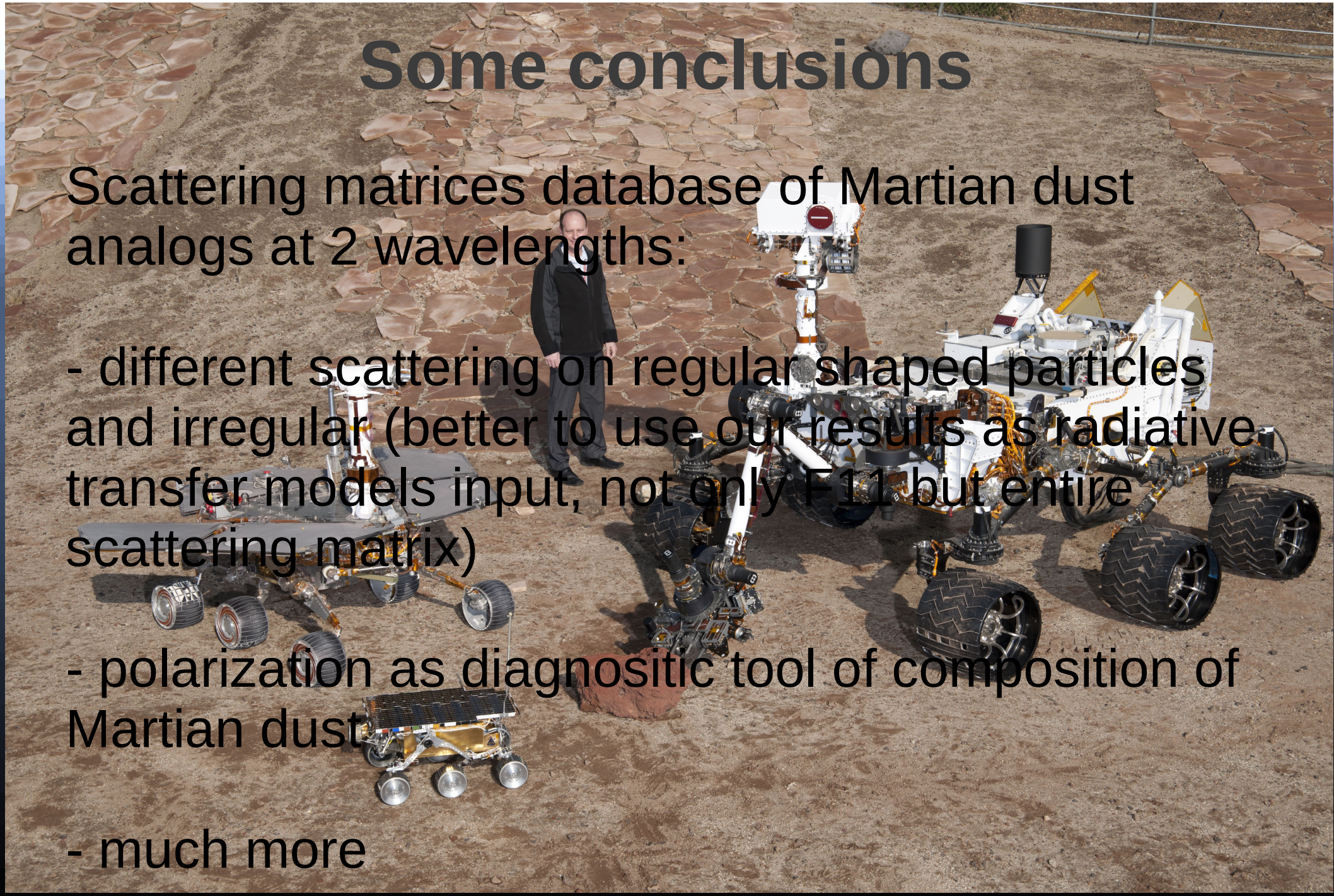
FR:
R_{eff}=1.7μm, v_{eff}=7.6
R_{eff}=3.0μm, v_{eff}=15.0
R_{eff}=18.2μm, v_{eff}=2.4
R_{eff}=20.3μm, v_{eff}=2.0

Different RI



Measured scattering matrix





Some conclusions

Scattering matrices database of Martian dust analogs at 2 wavelengths:

- different scattering on regular shaped particles and irregular (better to use our results as radiative transfer models input, not only F11 but entire scattering matrix)

- polarization as diagnositic tool of composition of Martian dust

- much more