Stepping Stones toward an International Space Exploration Program

COSPAR Panel on Exploration PEX

Chairs: Pascale Ehrenfreund & Chris McKay

COSPAR Committee on Space Research-1958

- COSPAR represents national science institutions from 44 member countries, 13 international scientific unions and 5 associated companies

- Strives to promote the use of space science for the benefit of mankind and for its adoption by developing countries and new space-faring nations

- Panel on Exploration (PEX) – 2008
  "Toward a Global Space Exploration Program: A Stepping Stone approach", June 2010

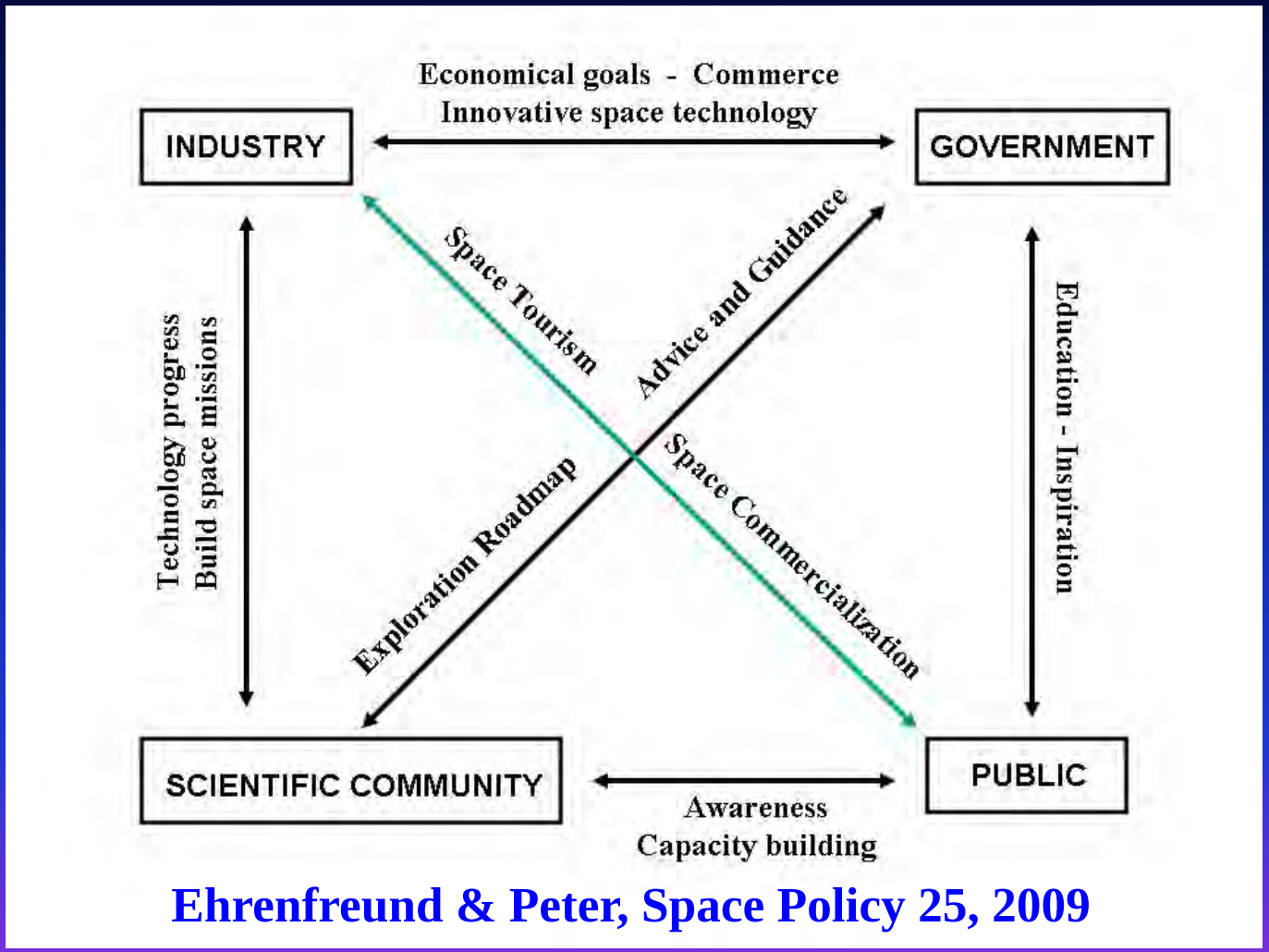
http://cosparhq.cnes.fr/

Space Exploration

Global Exploration Strategy GES
ILEWG, LEAG, MEPAG,

Emerging new space exploration context will be international, human centric, trans-disciplinary

Stakeholders in global space exploration



Ehrenfreund & Peter, Space Policy 25, 2009

→ New avenues of space commercialization may strengthen the link between industry and society

Scientific Vision for planetary exploration

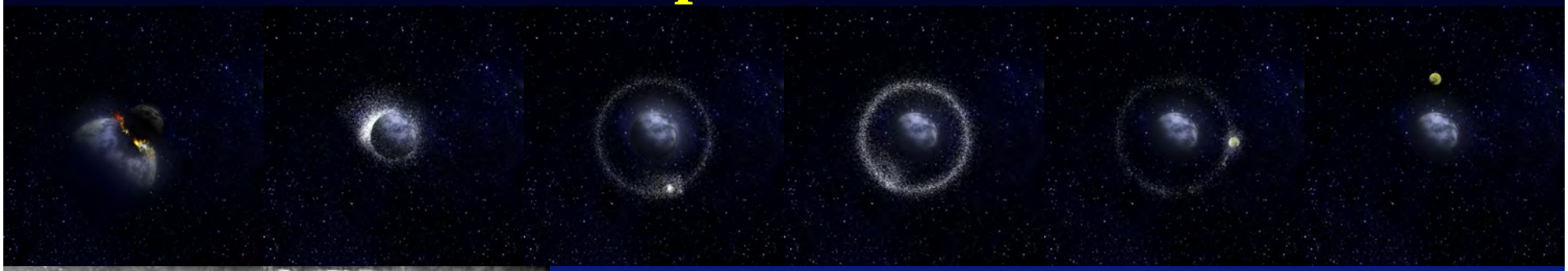
There has been ample activity concerning space exploration in recent years, e.g.:

- **IAA Cosmic study "Next steps in exploring deep space" 2004**
- **International Lunar Exploration Working Group ILEWG**
- **Lunar Exploration Analysis Group LEAG**
- **National Research Council (NRC) reports**
- **NASA Lunar Science Institute nodes LSI**
- **Mars Exploration Planning and Analysis Group MEPAG**
- **Curation and Analysis Planning Team for Extraterrestrial Material CAPTEM**
- **International Mars Exploration Working Group IMEWG**
- **International Space Exploration Coordination group ISECG**

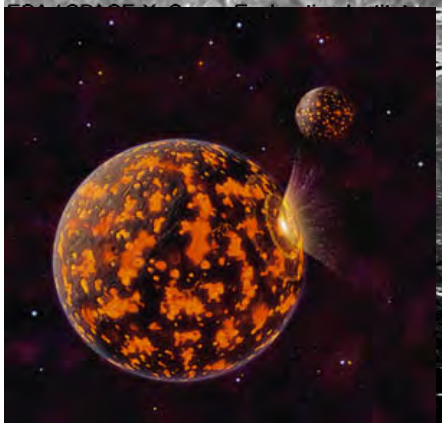
PEX provides a summary of science roadmaps and exploits synergies to support the development of worldwide space exploration programs and to safeguard the scientific assets of solar system objects

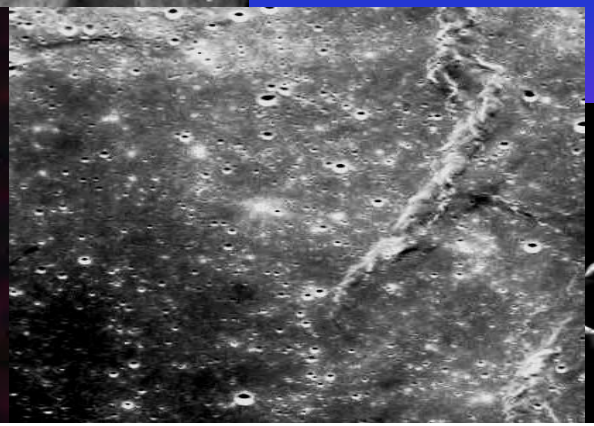
Exploring the Earth-Moon-Mars space

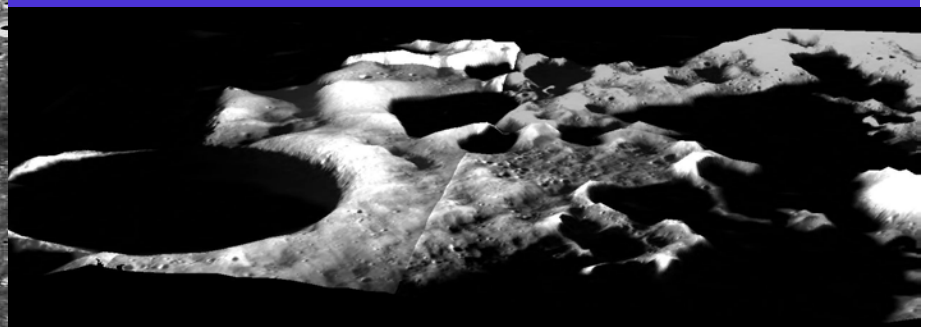
Destination Moon: a part of Earth.....



- Early Earth-Moon System
- Terrestrial Planet Differentiation and Evolution
- Solar System Impact Record
- Lunar Environment

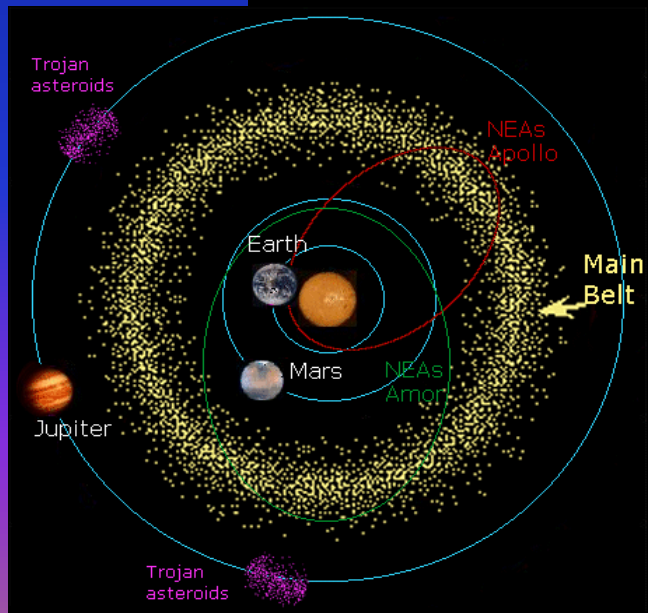






Destination Near-Earth Asteroids: tracing origins...

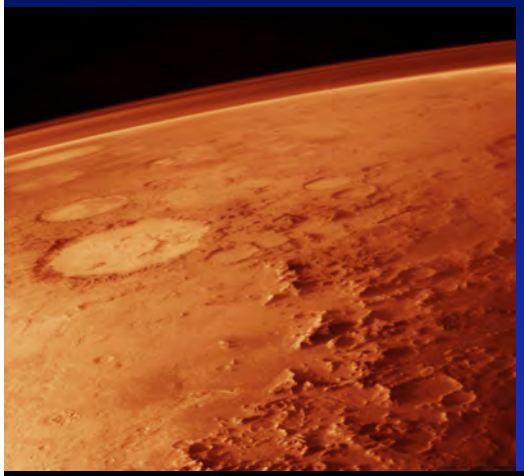
- Knowledge of formation, properties, distribution and evolution of NEOs
- Record: solar system and planet formation

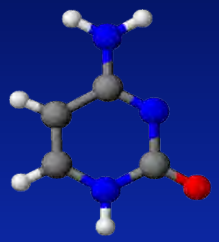


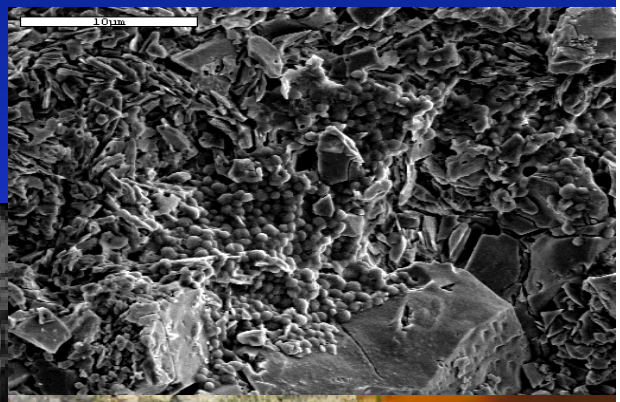
- Human NEO mission expands our spaceflight experience base beyond LEO
- Provides a milestone for exploration and for hazard mitigation

Destination Mars: searching for life……

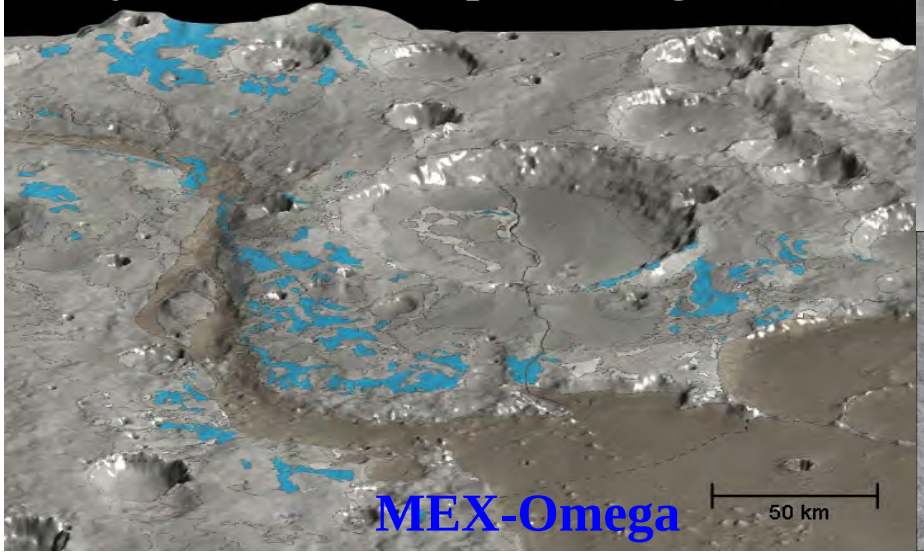
- Determine if life ever arose on Mars
- Understand climate
- Evolution of surface & interior
- Prepare for human exploration

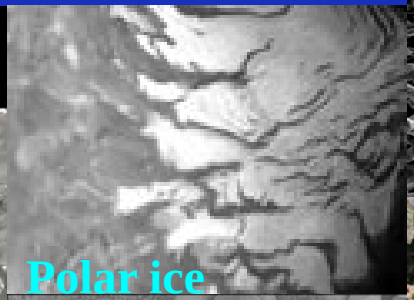


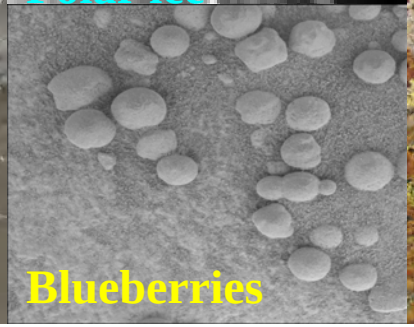


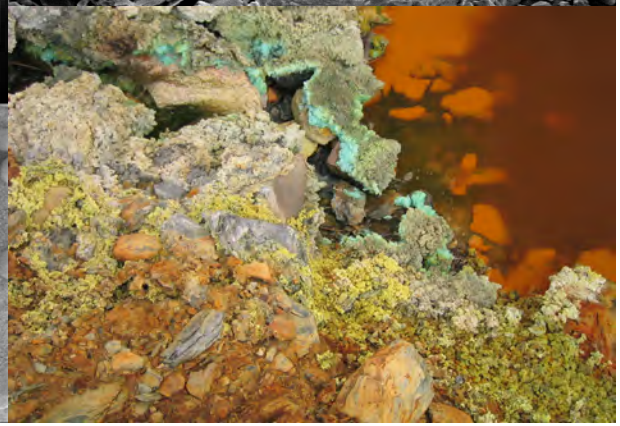


Phyllosilicates → aqueous origin









How to go from here?

COSPAR actions

Support transition period toward global space exploration:

Stepping stones conducted in synergy with several stakeholders

- International Earth based field research program
- Joint program for international research activities (e.g. ISS)
- World-wide Small-Sat program
- Global Robotic Village
- Joint Sample Return Mission
- International Human Bases

International planetary exploration analog field program

Concordia, Antarctic

Mars 500

MDRS Devon Island

AMASE

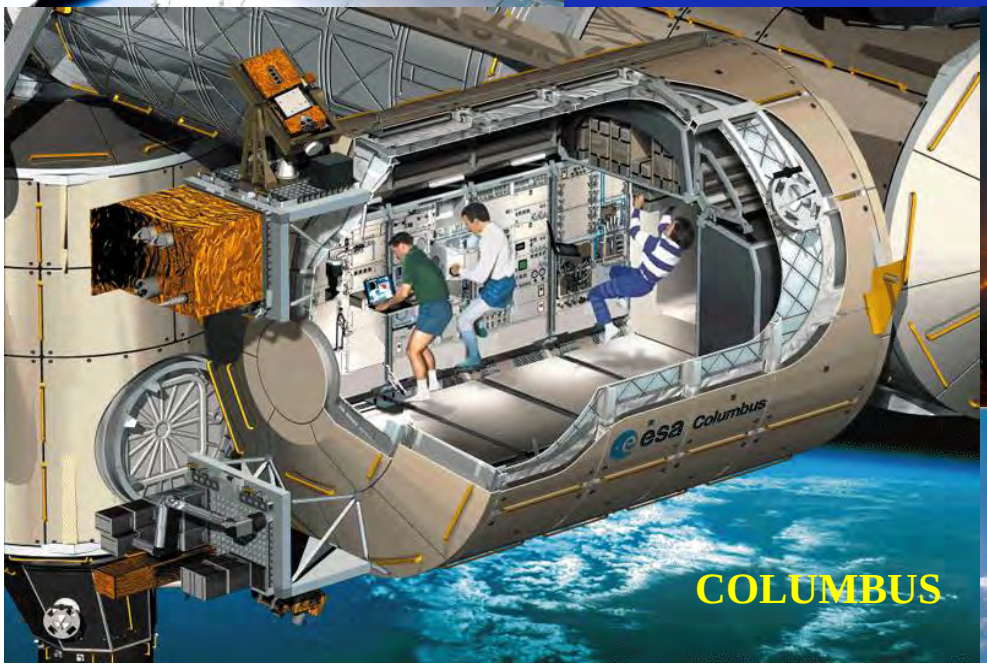
PISCES

RATS Desert

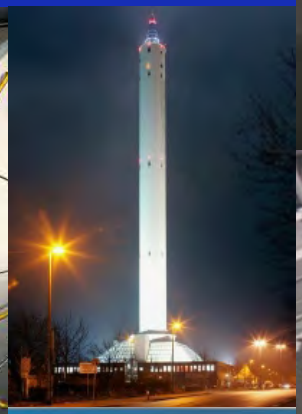
MISSE

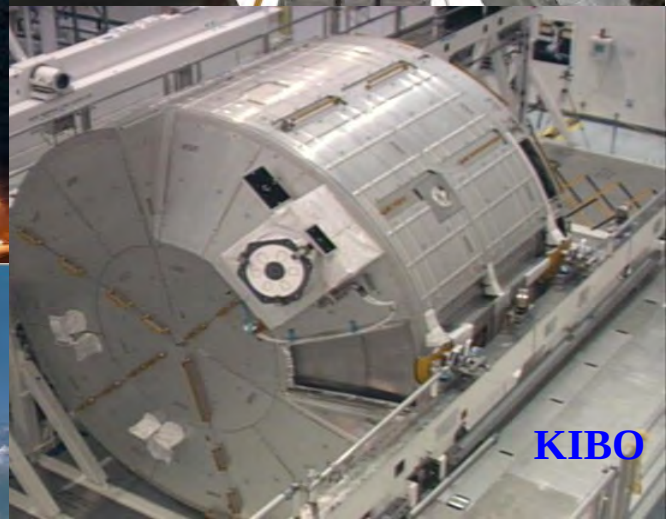
LADA

International exploitation of the ISS in preparation for exploration



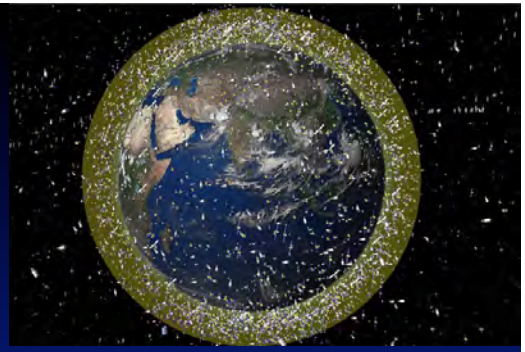
COLUMBUS

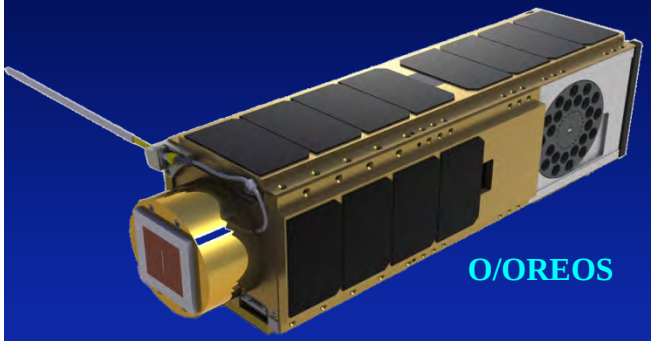




KIBO

Worldwide Small-Sat program in support of exploration





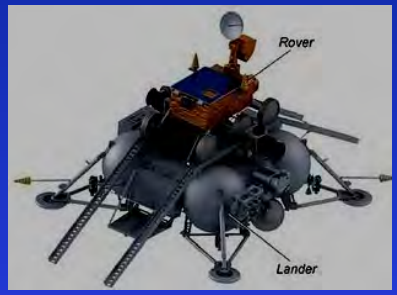
O/OREOS

- Research in biology, atmospheric science space weather, materials..
- Hitch-hikers on missions to Moon and Mars

- Academia
- Governments
- Private sector
- Developing countries

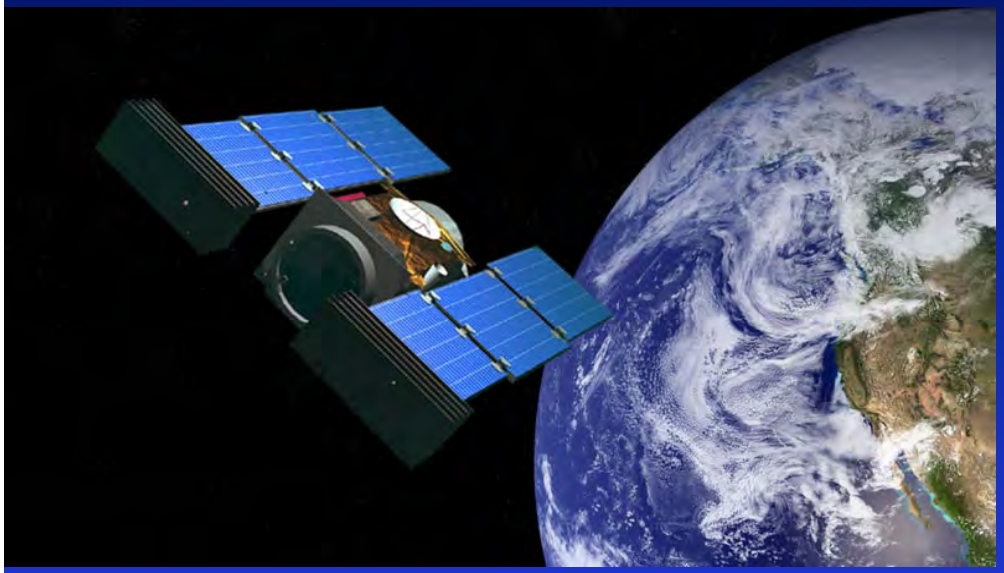
Global Robotic Village

Coordination of international surface and orbital elements for research, technology development and future human exploration

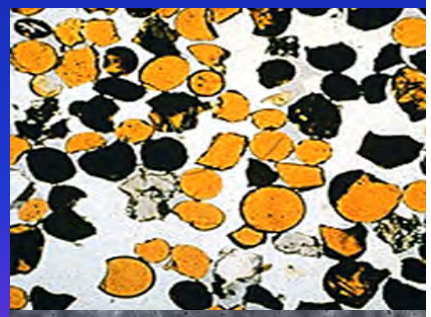


- Solar power
- Telecommunication
- Navigation beacons
- Long-range research rovers
- In-situ resource utilisation
- Robotic assistants to humans
- Landing and launch area

International Sample Return Mission



- Touch and go
- Surface collection (CAPTEM)
- SR from carbonaceous NEA
- Multi-Element MSR
- International Curation facility



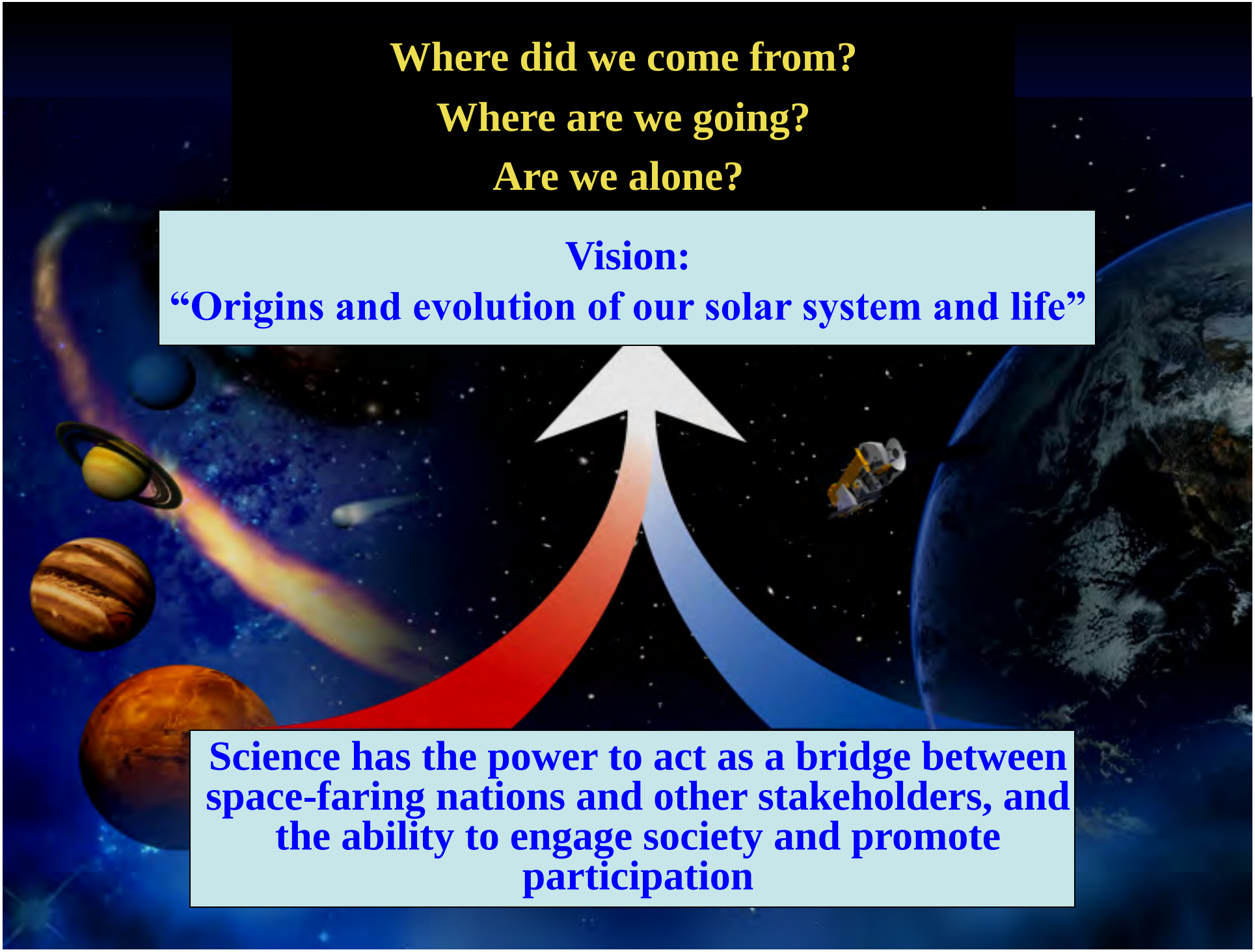
High priority in the science community
Closest simulation for human exploration

Human bases – using Antarctica as a model

- ILEWG/LEAG roadmaps
- IAF/IAA Forum
- Beijing Declaration 2008
- Multidisciplinary endeavor

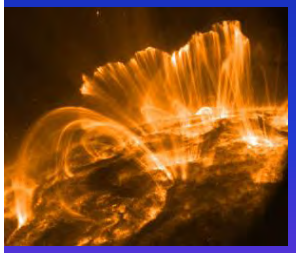
Antarctica: International Arena

- Nations compete and cooperate
- Bases, no settlement
- Long-term science platform
- Antarctic treaty

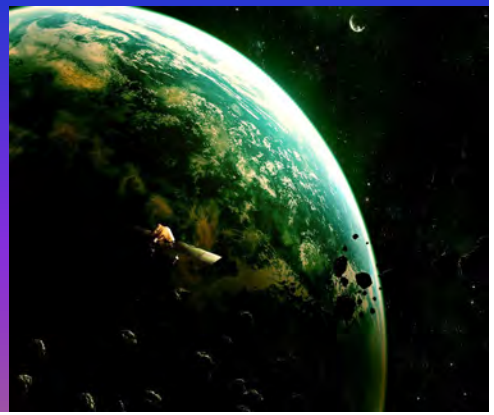

Where did we come from?
Where are we going?
Are we alone?
Vision:
"Origins and evolution of our solar system and life"
Science has the power to act as a bridge between space-faring nations and other stakeholders, and the ability to engage society and promote participation

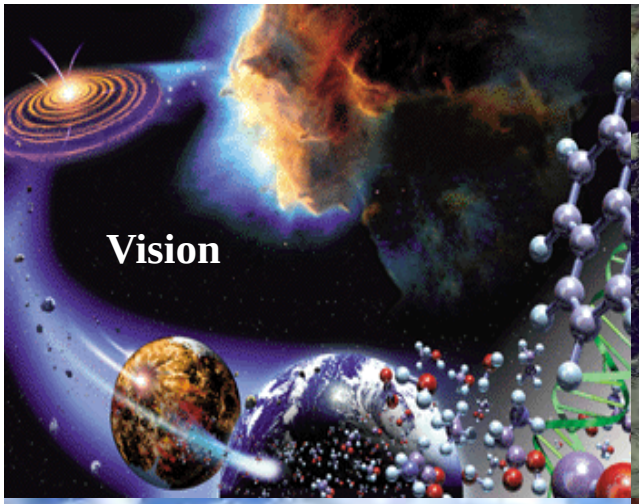
Bridging the Earth and space communities

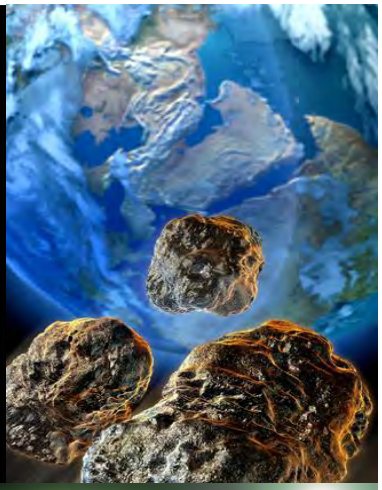
- Protecting life on Earth requires similar concepts and information as investigations of life beyond Earth
- Instrumentation, technology to probe surface/subsurface require similar methods
- Network to enable interchange of scientific insights leading to the development of new common policies



Martian climate history
Extreme life
Earth observations from ISS and Moon….







Exploring the Earth Moon Mars Space

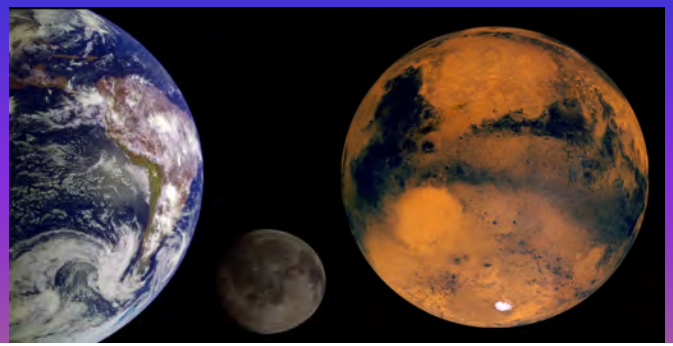
Searching for our origins …..

The role of COSPAR PEX in space exploration

- **Promote and preserve science goals** in space exploration
- Implementation of stepping stones will unite key stakeholders → **a bottom-up support structure** for a global space exploration program
- Engage emerging space nations to **generate more active members in the space community** and increase public awareness of space activities
- Support new levels of science cooperation and partnerships in space exploration **to secure political and programmatic stability**

Protecting solar system environments

- We risk losing the ability to measure and understand the subtle pristine conditions of these bodies before they are irrevocably altered by human-induced activity (i.e. from landing, lift-off, EVA's)
- Factors: dust raising, seismic disturbance, atmosphere contamination, vibration, site destruction, electromagnetic interference, radioactive contamination, nuclear power sources
- Greater need for environmental protection as commercial pressures relegate



PPP
IAA studies

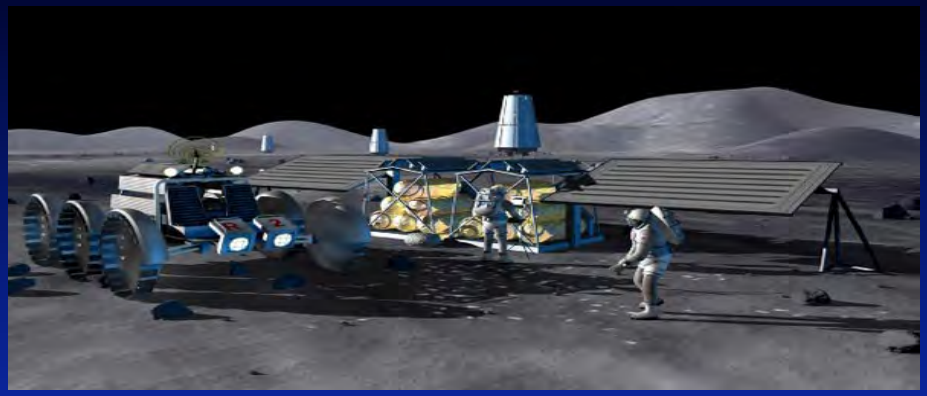
Treaties to protect the Earth-Moon-Mars space

1967 Outer Space Treaty OST
1979 Moon Agreement MA
Antarctic Treaty regime:
….. natural reserve – devoted to peace and science

- **Necessary to clarify and complement the legal regime currently regulating the exploration of the Moon and other celestial bodies**

- **Additional regulations need to be elaborated to ensure valuable, safe, economic, and broadly-based exploration that encompass and balance a diverse set of stakeholder interests and will benefit both current and future generations**

Concrete steps to environmental stewardship



- **Identify** environmental contamination issues and where possible **quantify their effects** on science and other activities

- Characterize environmentally disturbing activities **depending on the target body (Moon, Mars, asteroid, etc.),** such as construction, in-situ resource exploitation, large scale human activities, power generation, communications infrastructure, etc.

- Identify entities (both within and outside COSPAR) which have an interest and work already undertaken!

Antarctic Treaty Framework

The initial 1959 Antarctic Treaty has been supplemented by some 200 agreements and measures (via the ATCM process)

Many of the ideas identified to move forward in outer space bear striking similarities to elements of the Antarctic Treaty's framework for environmental management:

- **Designation of special management areas or protected zones**
- **Development of a comprehensive environmental protection protocol**
- **Establishment of code(s) of conduct appropriate for different types of celestial bodies and environments**

Race 2011

PEX: Future Activities

- PEX, working with COSPAR Scientific Commissions and Panels, and with the international science foundations, the IAA, IAF, UN bodies, and the IISL, will support science-driven national and international space exploration working groups in the new era of planetary exploration

- Regular workshops to promote Stepping Stones
  March 2011, Space Policy Institute:
  "International Earth-based research program as stepping stone for global space exploration"

- PEX will engage in compiling data (facts and numbers) on environmental damaging activities

2012

COSPAR PANEL ON EXPLORATION

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http://www.gwu.edu/~spi/cospar.cfm

Back-up

PEX: Synergies and Recommendations

PEX will take specific actions to:

- support a worldwide Earth based field research program
- support the international exploitation of the ISS in preparation for exploration
- support a worldwide CubeSat program for developed and developing countries in preparation for exploration
- support the ILEWG lunar Global Robotic Village
- support studies and precursor activities toward International Human Bases (Moon, Mars) using research activities in Antarctica as a model
- support synergies between Space Exploration and Earth science
- support the Panel on Planetary Exploration in protecting the lunar and martian environments for scientific research
- support updated regulations to protect the Earth-Moon Mars space
- support activities in capacity building for space exploration
- involve and engage the public stakeholder and youth in participatory ways

Engage with COSPAR commissions, ESF, NSF, IAA/IAF, UN bodies, IISL to support planetary exploration and national/international working groups

Toward an International Program …

Current robotic and human exploration scenarios
COSPAR activities
CAREX program (EU)
Europlanet TransNational Access (TNA)
NASA ASTEP Program
Canadian analog activities

Lessons learned from International Programs:

International Polar Year
The Census of Marine Life
Integrated Ocean Drilling Program
Scientific Committee on Antarctic Research

National robotic and human analog programs, ISU