

# Challenges to living on the Moon and Mars

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Theme A Panel—Hazards in Space

# Earth presents some pretty harsh environments

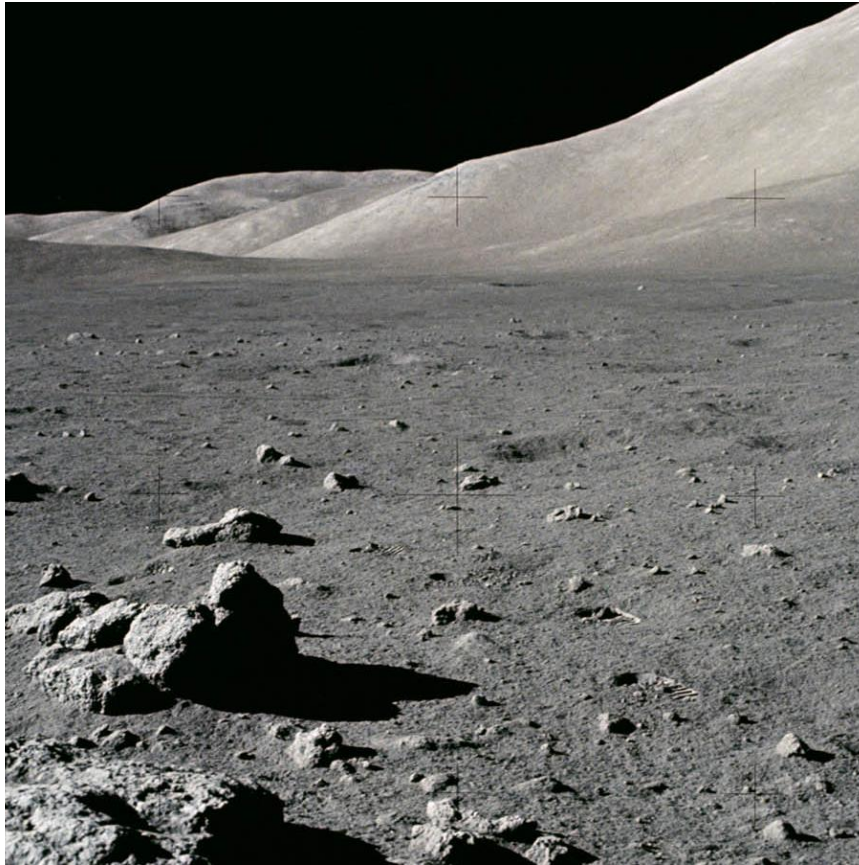


Sahara Desert Sunbake  
Highest Temperature 136° F



Antarctic Deep Freeze  
Lowest Temperature -129°F

But these are NOTHING in comparison to the surfaces of the Moon or Mars



Temperatures -298°F to 224°F



Temperatures -243°F to 68°F

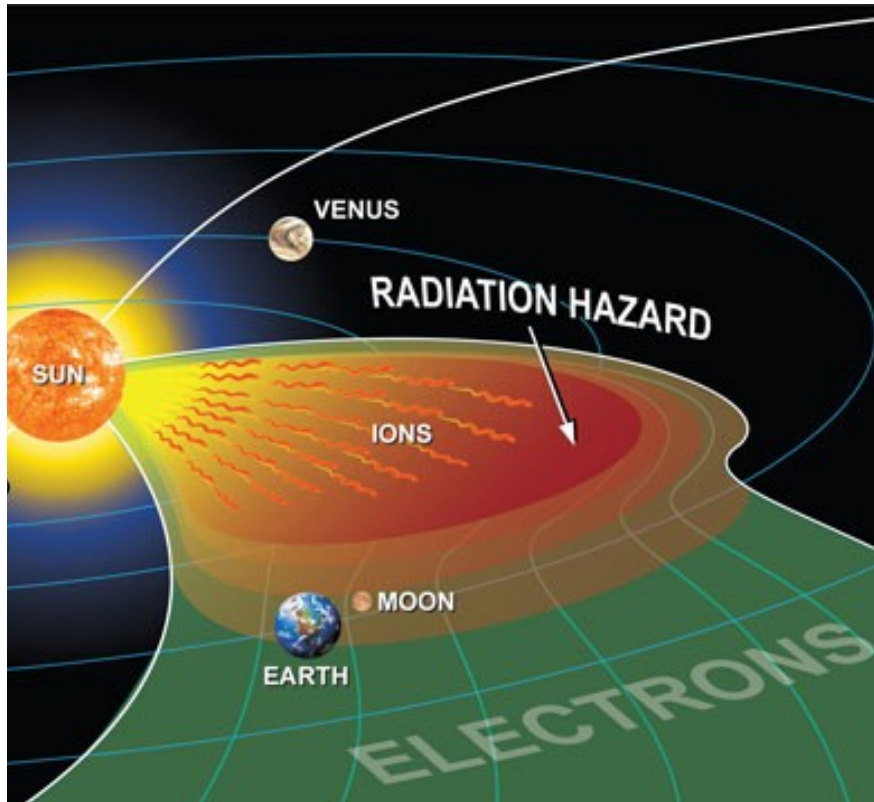
No breathable air, no water, wild temperature fluctuations, radiation....



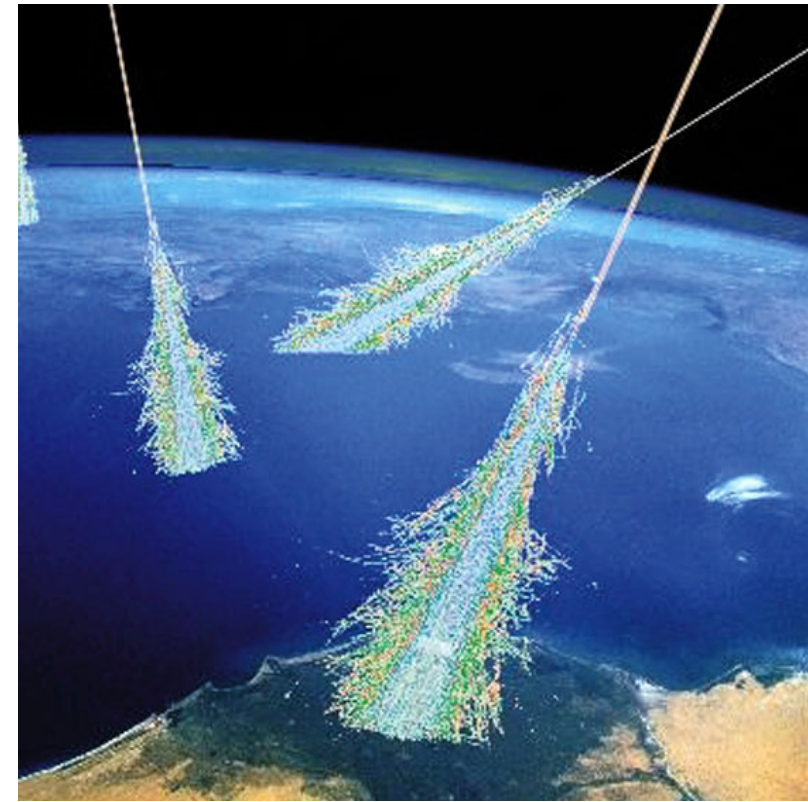
If humans are to live and work out there, they must be prepared to deal with an array of hazards



Aside from human's poor adaption to microgravity, cosmic radiation is the next big problem



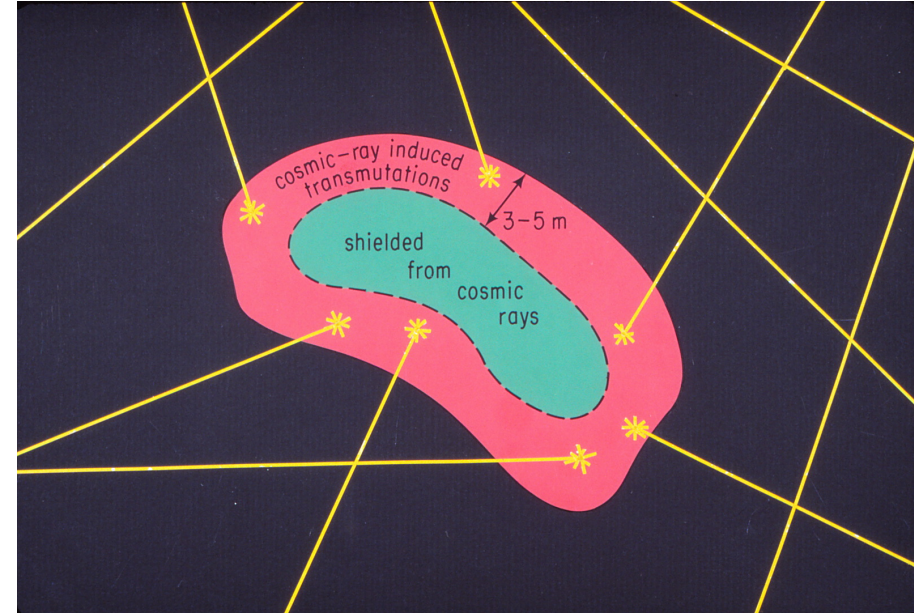
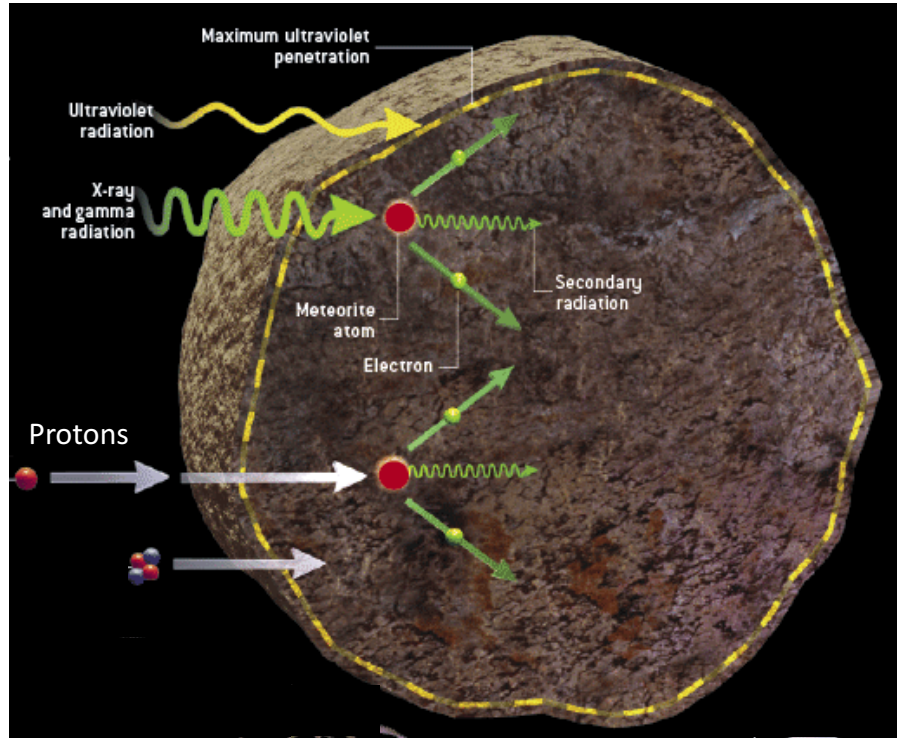
Solar Energetic Particles: Energy a few 100 MeV  
Shielded by a few cm of aluminum



Galactic cosmic rays: Energy a few GeV  
Shielded by a few m of aluminum!

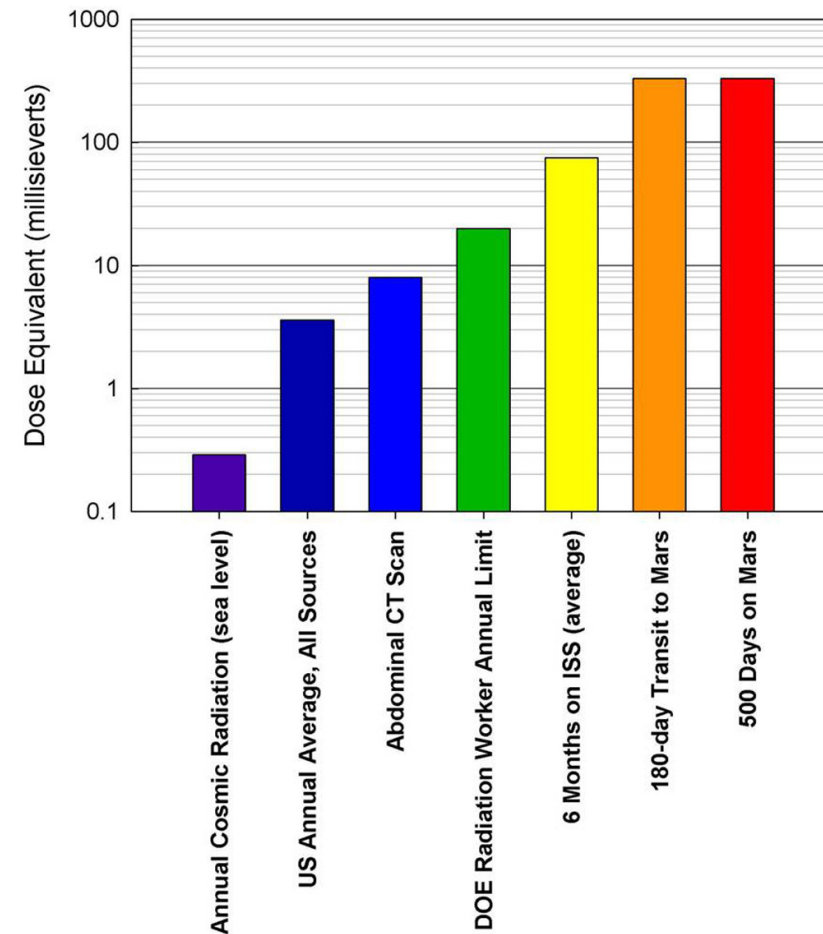
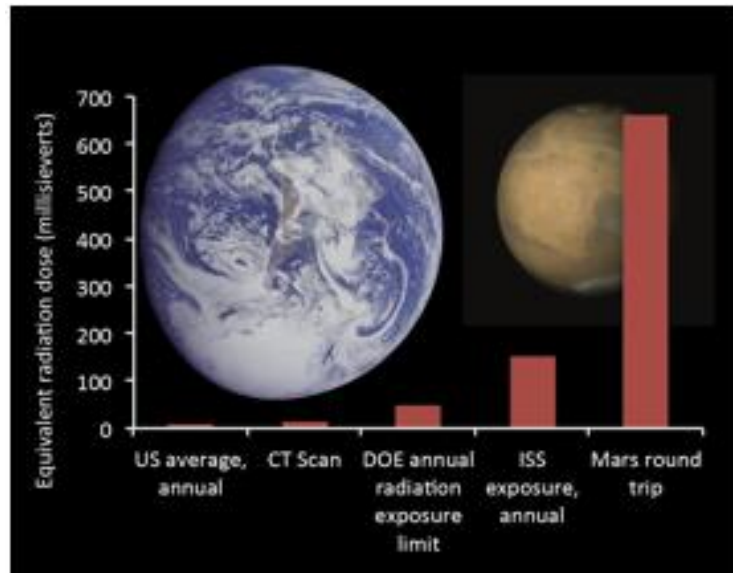
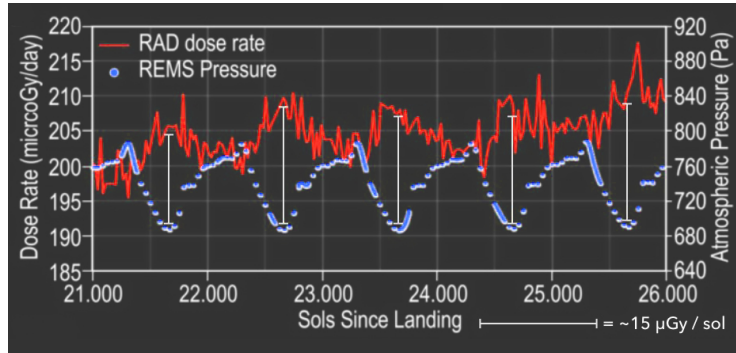


For galactic cosmic rays a little shielding is worse than none at all!

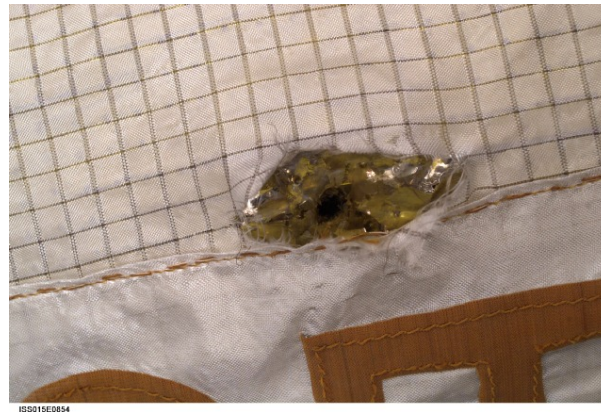
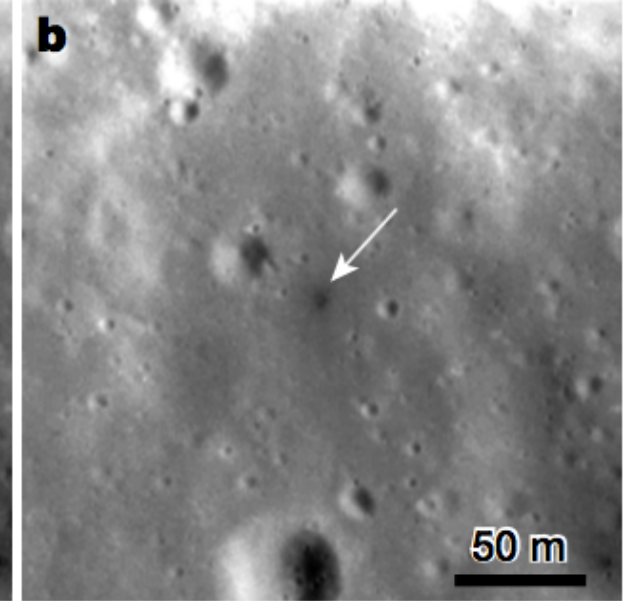
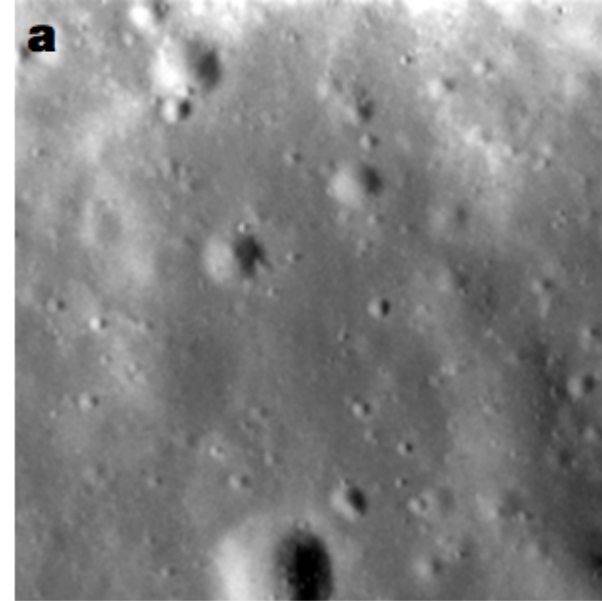
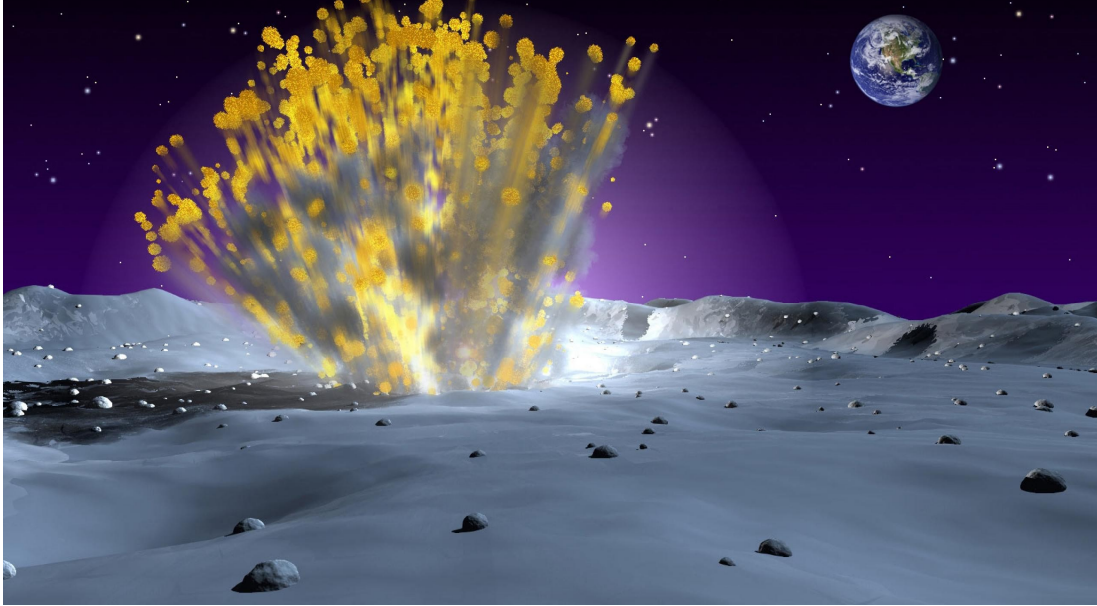


Primary cosmic rays collide, producing neutrons, which themselves join other nuclei making them radioactive in turn. Lunar and Martian soil is radioactive for this reason.

MSL carried the first ever dosimeter for both the cruise to Mars and surface exposure—and the results are not encouraging

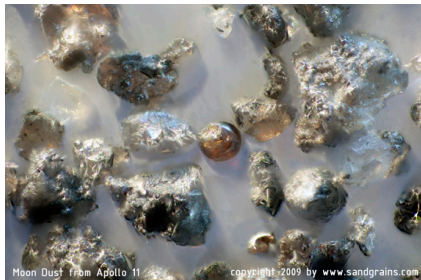


# Primary and secondary micrometeoroid impacts are serious on the Moon and in open space

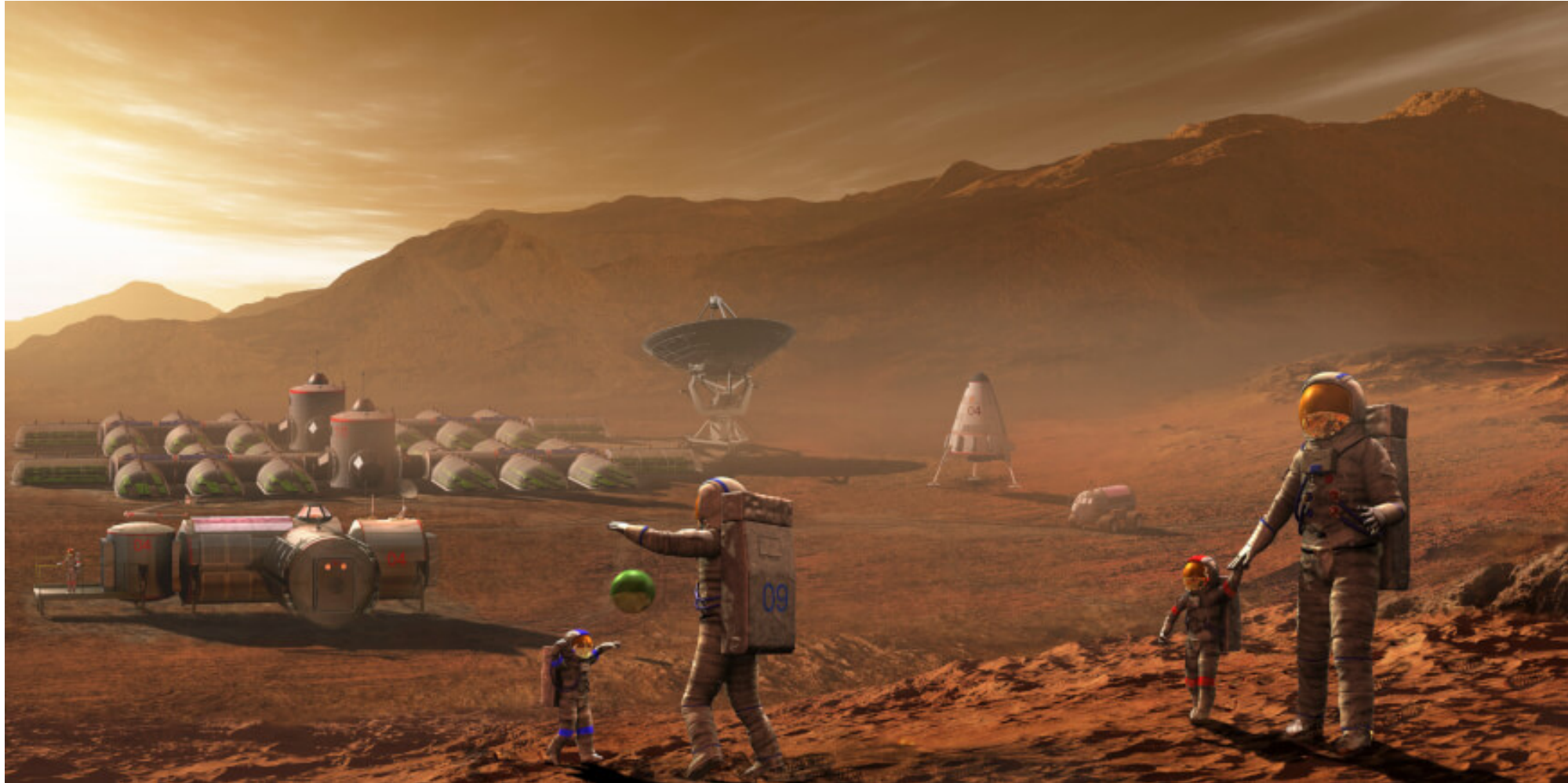




# On the Moon, lunar dust gets into everything and ruins spacesuit seals



Far from Earth, survival requires long stays  
and resilient support systems





The challenge: How to protect humans and our robotic partners from these hazards?

