National Aeronautics and Space Administration

# Beyond the Cradle: Looking Back at Human Missions to NEOs

Presented by: Laurie Leshin

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# The Beginning: 2010

"…by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the Moon into deep space.  So we'll start by sending astronauts to an asteroid for the first time in history."

*-- US President Barack Obama*
*April 15, 2010*

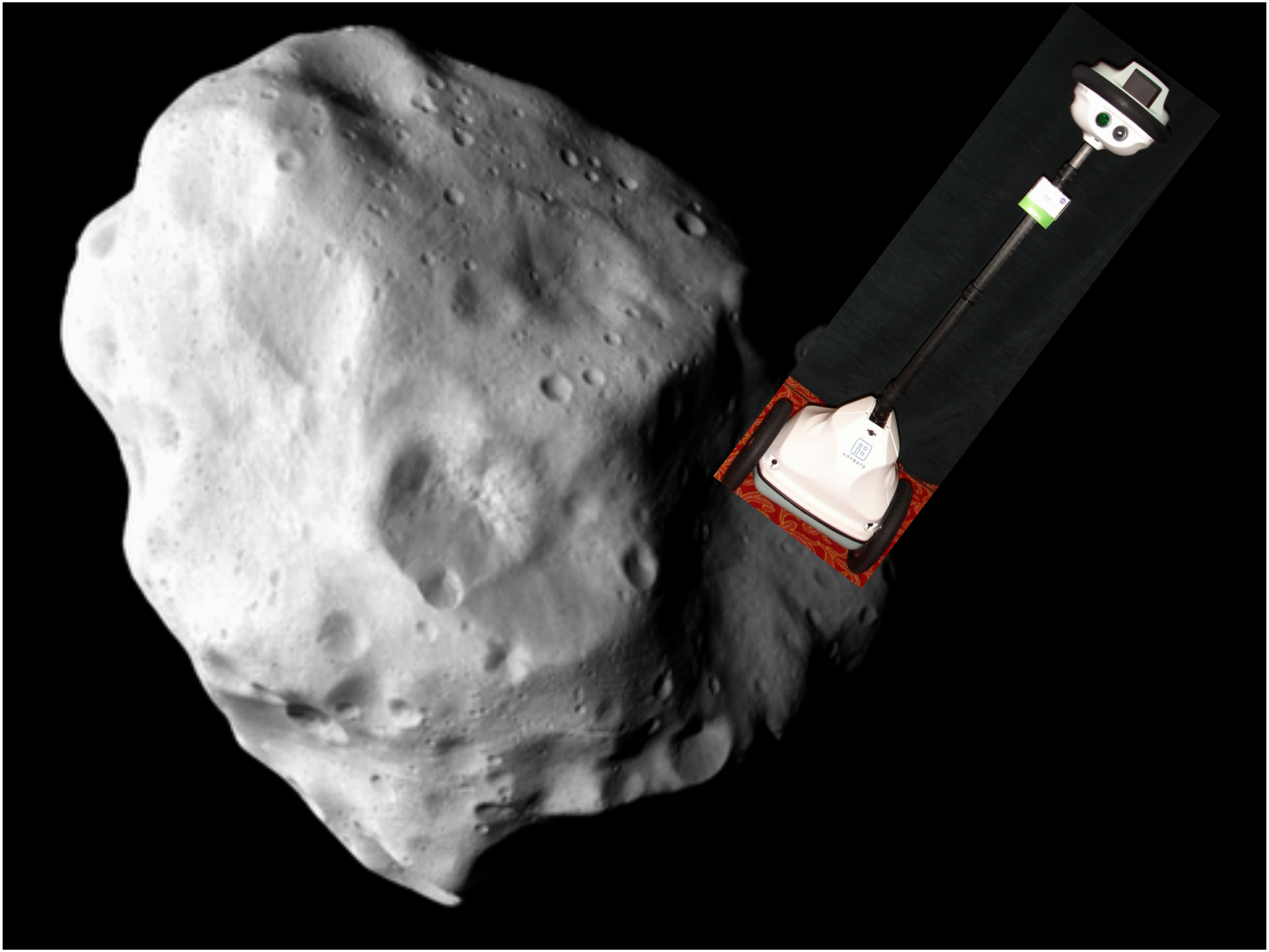
# The Beginning: 2010


"The ExploreNOW Workshop way back in 2010 really constituted our first steps toward human exploration of Asteroids. That meeting laid the foundation for our success"

*-- NASA Administrator John Olson*

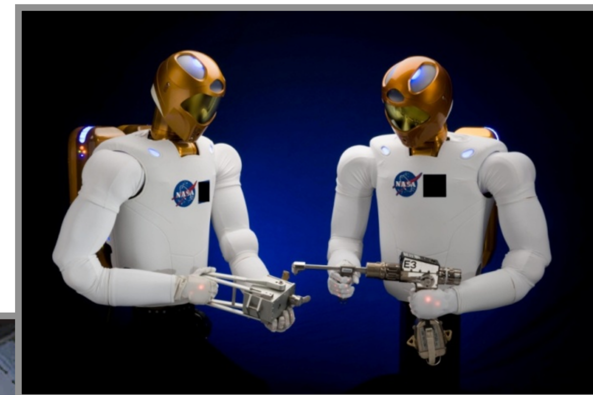
# Why Did We Boldly Go?

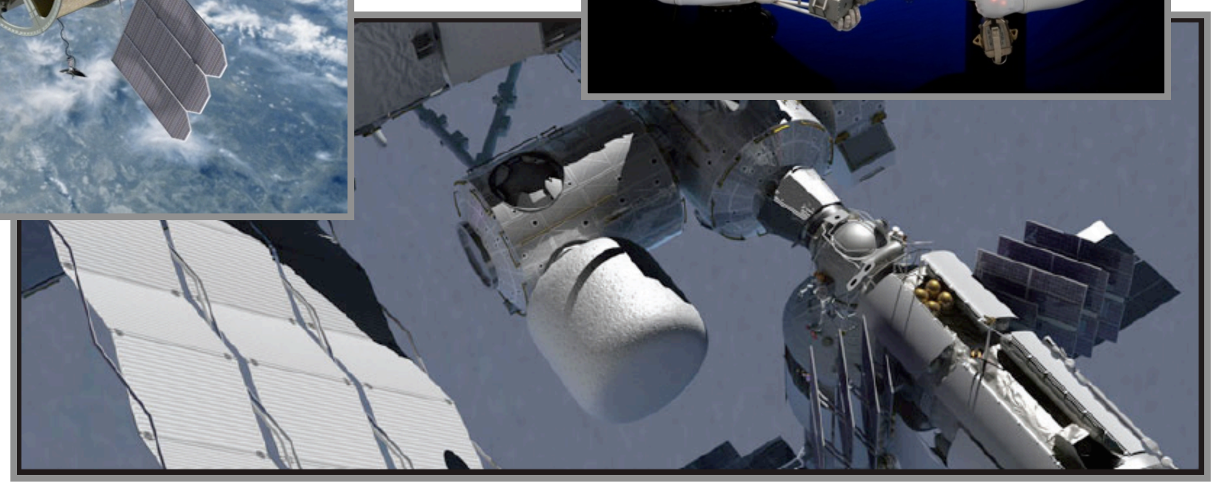
- Drive prosperity on Earth by pushing the boundaries of what humanity can achieve through innovation and cooperation
- Inspire the people across Earth to embrace science and technology as paths to a prosperous future
- Leave the Cradle for Good:  Build the capability for sustained deep space exploration with humans
- Understand the origin of the Earth, the solar system, and life
- Identify, characterize and learn to mitigate threats to Earth from asteroid impacts

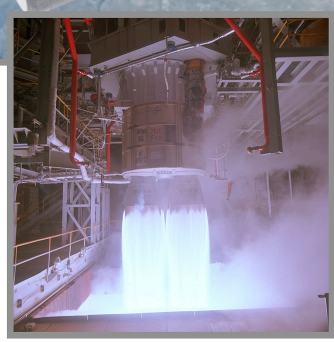


# Developing Key Capabilities for Sustainable Exploration

– Demonstrate sustainable operational deep space capabilities - including Radiation Shielding / Hazards, Closed Loop ECLSS, Power, ISRU, Microgravity Effects, Autonomous Operations, Communications, In-flight training

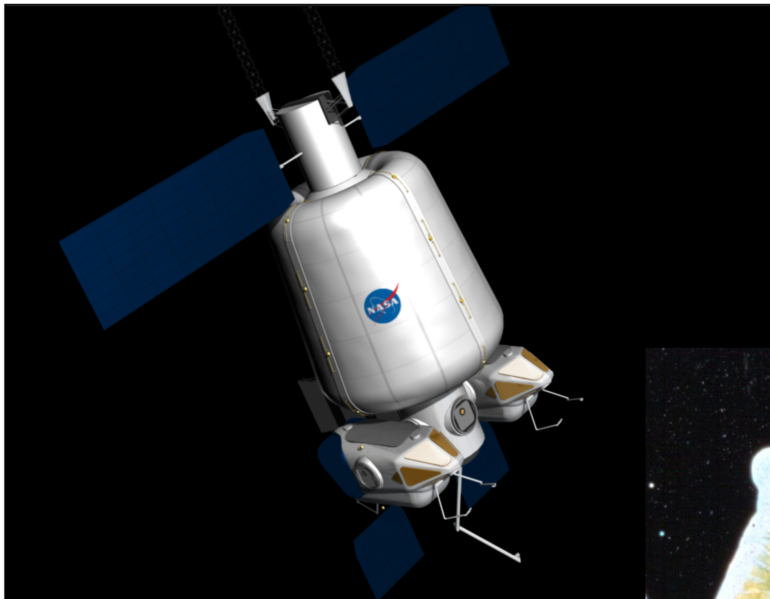


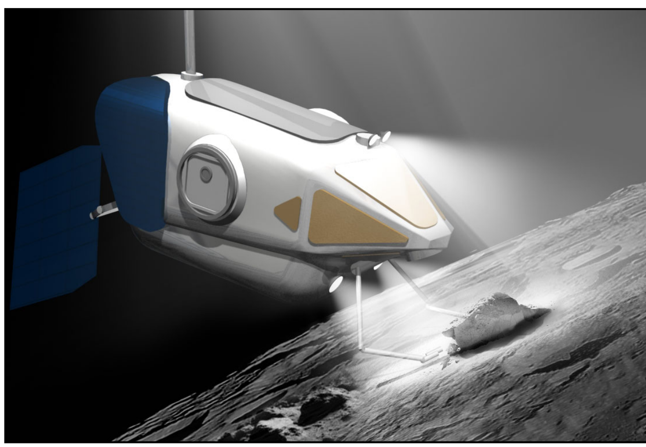




# Our Brave Explorers:  The Crews

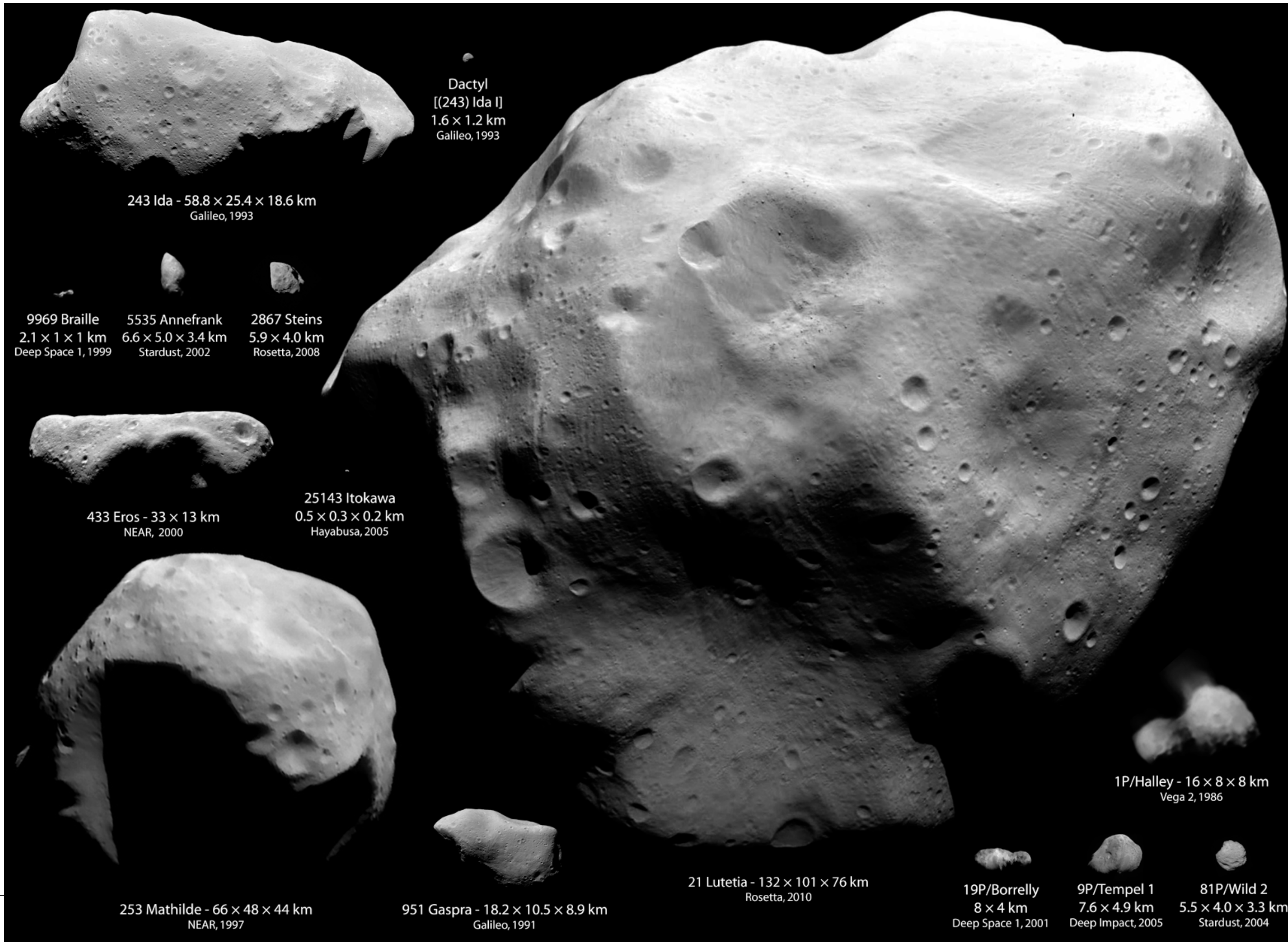
# Human Activities at NEOs



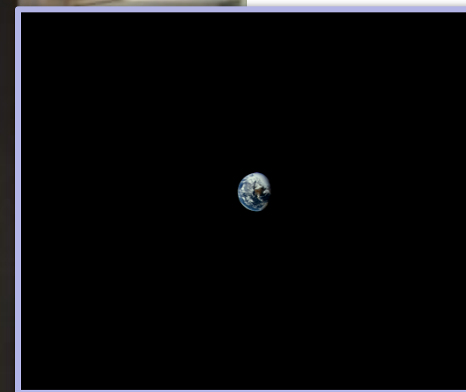


- Test Hardware Systems: High Performance Propulsion, Long Duration Habs, Radiation Mitigation, ISRU
- Sample Handling and Curation
- Deploy Scientific Instruments for On-going Operations (Subsurface Drilling, Core Sampling)
- Test potential mitigation techniques
- Characterize Physical and Chemical Properties of NEOs - mass, shape, density, porosity, spin, strength, mineralogy

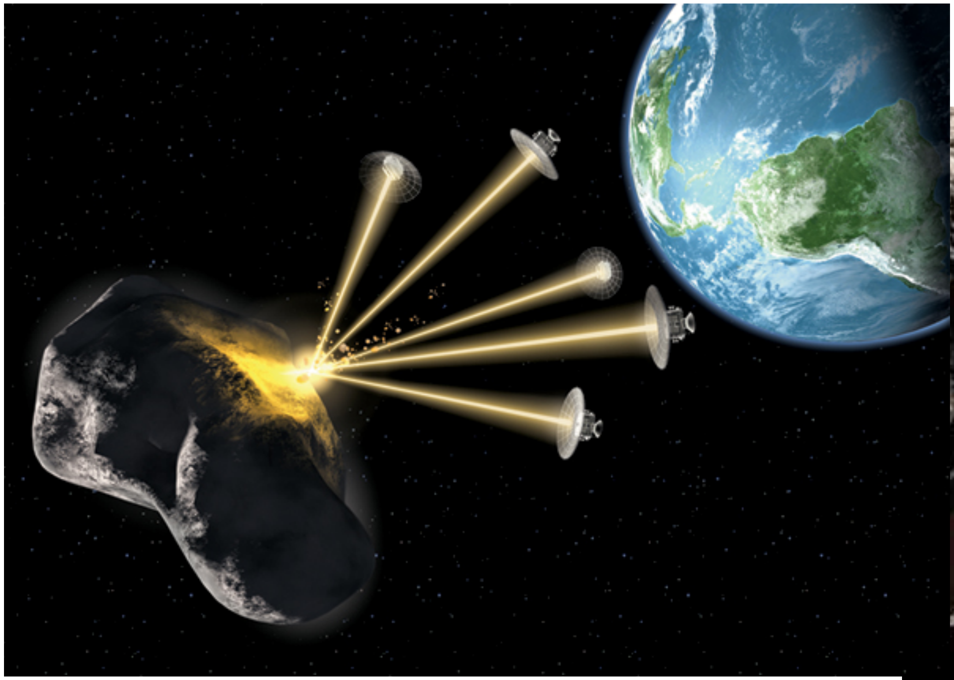
# A Bounty of Scientific Information



# Great Science, Inspiring the World



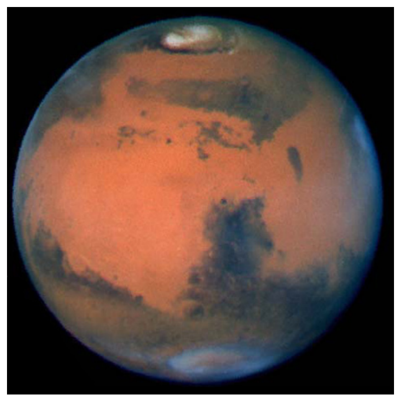
# Mitigating the Threat



- Characterization of NEOs increased key knowledge relevant to Planetary Defense
- Key tests at the NEOs demonstrated a path to Planetary Defense
  - Future missions will follow up on this critical issue

# Looking to the Future

– As planned, our NEO activities have paved the way for Lunar, Mars and other deep space exploration
  - Development of systems currently underway for Lunar and Mars missions this decade
  - Deep space capabilities already being used for advanced telescope and in-space construction activities


**NEO Exploration has succeeded in taking humanity Beyond the Cradle and we're not looking back!**

# But Seriously…

# A Few Takeaways

- This workshop has provided critical innovations, insights, and ideas that we WILL USE as we formulate both robotic precursor and human exploration missions
- Showed some (many?) synergies between goals in science, PD and HSF
  - Many communities can benefit from exploration of NEOs
  - Clear that PD provides opportunity for public and international engagement in NEO activities, but need to understand full implications of this
- Some near term questions to be answered:
  - What is a reasonable number of targets (of what characteristics) to have in our catalog? (Drives need for survey telescope)
  - What are the core set of precursor measurements needed for design?
  - What are the key precursor activities needed for ConOps?
  - What are the most important technologies?
  - How do we ensure the most flexible capabilities are developed to ensure NEO exploration feeds future Moon, Mars and Deep Space exploration?