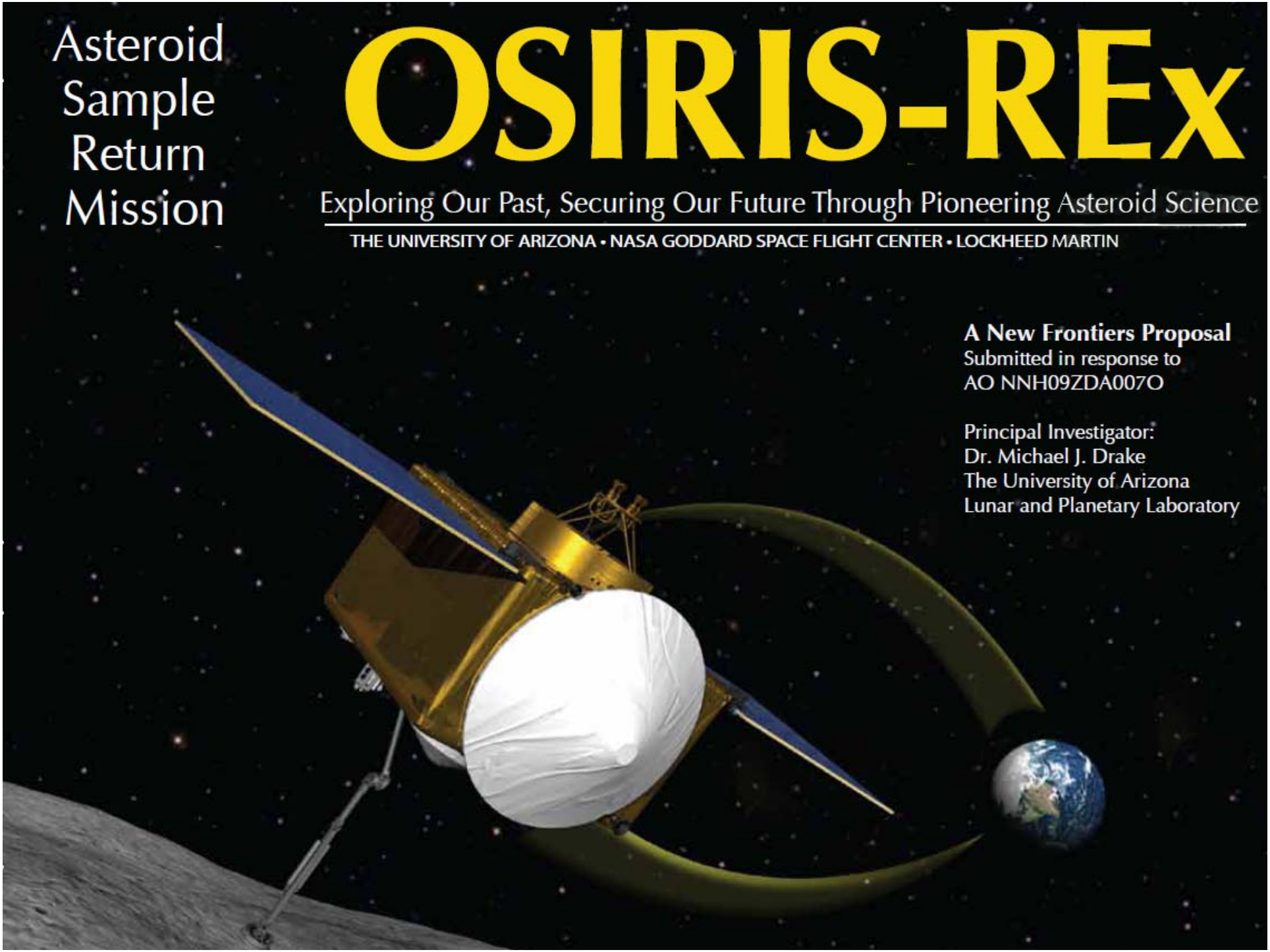
Asteroid Sample Return Mission

OSIRIS-REx

Exploring Our Past, Securing Our Future Through Pioneering Asteroid Science

THE UNIVERSITY OF ARIZONA • NASA GODDARD SPACE FLIGHT CENTER • LOCKHEED MARTIN



A New Frontiers Proposal
Submitted in response to
AO NNH09ZDA007O

Principal Investigator:
Dr. Michael J. Drake
The University of Arizona
Lunar and Planetary Laboratory

What is OSIRIS REx?

- **OSIRIS REx is a sample return mission** that returns at least 60 g (and as much as 2 kg) of **pristine carbonaceous regolith** from asteroid 1999 RQ36

- **OSIRIS REx is an acronym**
  - **Origins**
    - provide pristine sample to reveal the origin of volatiles and organics that led to life on Earth
  - **Spectral Interpretation**
    - provide ground truth for ground-based and space based spectral observations of B-type carbonaceous asteroids
  - **Resource Identification**
    - identify carbonaceous asteroid resources that we might use in human exploration
  - **Security**
    - quantify the Yarkovsky Effect on a potentially hazardous asteroid, thus providing a tool to aid in securing the Earth from future asteroid impacts
  - **Regolith Explorer**
    - Explore the regolith at the sampling site *in situ* at scales down to sub-millimeter

The OSIRIS REx Core Team – The Right Team For The Job

Principal Investigator: **Michael Drake (UA)**
Deputy PI: **Dante Lauretta (UA)**
Project Manager: **Robert Jenkens (GSFC)**
Flight System Manager: **Joe Vellinga (LM)**

University of Arizona
- Principal Investigator & Deputy PI
- Science Team Management
- Science Instruments
- Science Operations
- Data Management and Archiving
- Education & Public Outreach

Goddard Space Flight Center
- Project Management
- Project Scientist & Deputy Project Scientist
- Mission Systems Engineering
- Safety & Mission Assurance
- Science Instruments
- Navigation

Lockheed Martin
- Flight System
- Sampling System
- Sample Return Capsule
- Mission Operations

Arizona State University – Science Instrument

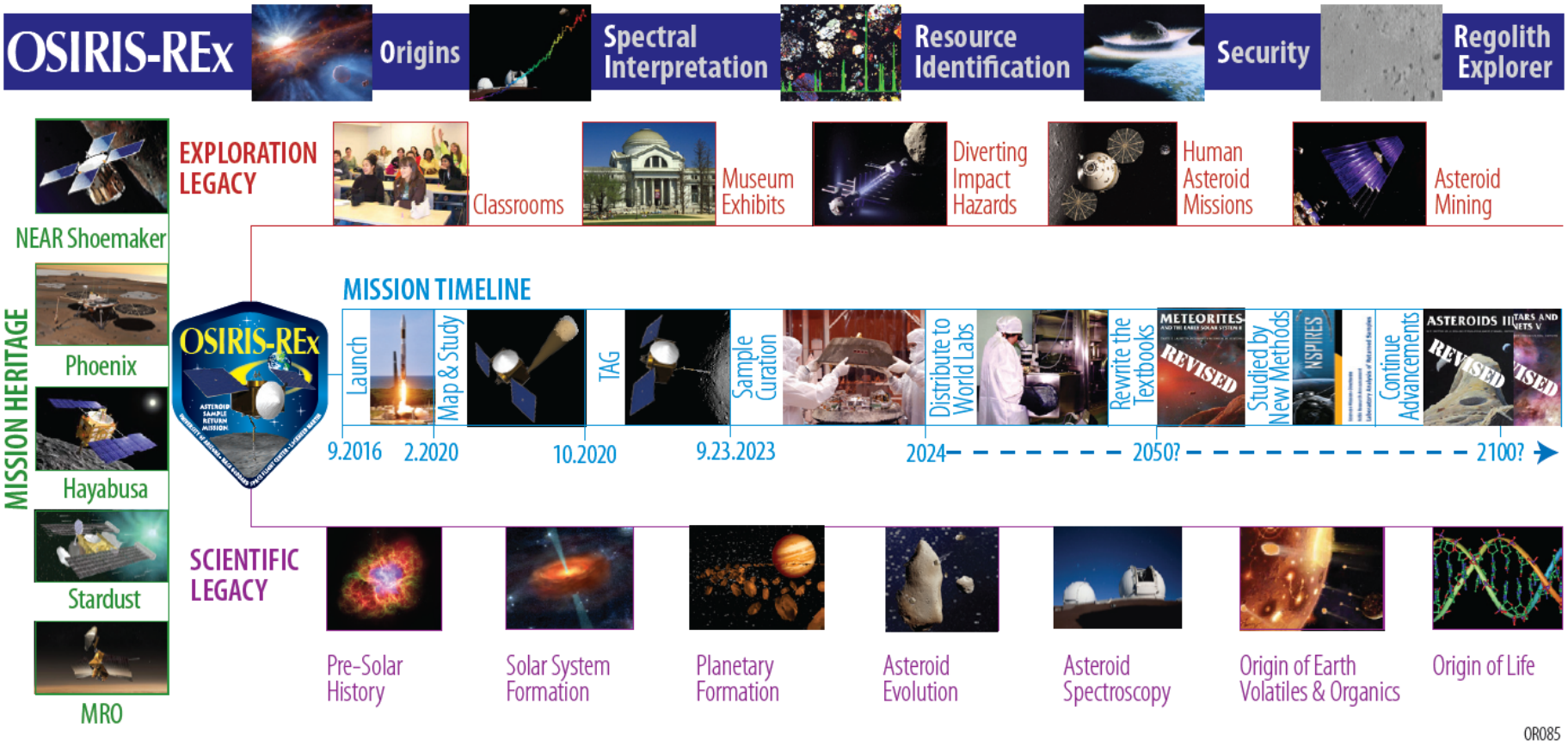
Canadian Space Agency – Science Instrument

KinetX – Navigation

Johnson Space Center – Sample Curation

Why Sample Return?

- Provides **pristine samples** with known **geologic context**
- Enables precise analyses that cannot be duplicated by spacecraft-based instruments
- Permits analyses by future generations of scientists using instruments not yet conceived of or developed, answering questions as yet unasked

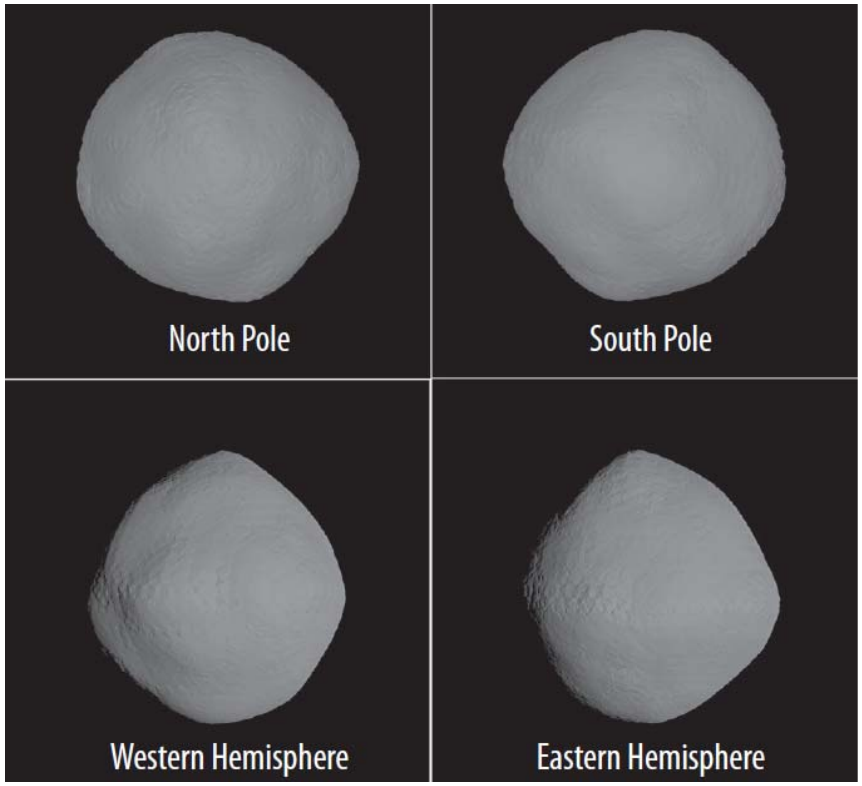


OSIRIS-REx achieves *all* of the Science Objectives for the NF-3 Asteroid Sample Return Mission Concept

1. **Return and analyze a sample** of pristine carbonaceous asteroid regolith in an amount sufficient to study the nature, history, and distribution of its constituent minerals and organic material.
2. **Map the global properties, chemistry, and mineralogy** of a primitive carbonaceous asteroid to characterize its geologic and dynamic history and provide context for the returned samples.
3. **Document the texture, morphology, volatile chemistry, and spectral properties of the regolith** at the sampling site *in situ* at scales down to the submillimeter.
4. **Measure the Yarkovsky effect** on a potentially hazardous asteroid and constrain the asteroid properties that contribute to this effect.
5. **Characterize the integrated global properties** of a primitive carbonaceous asteroid to allow for direct comparison with ground-based telescopic data of the entire asteroid population.

Asteroid 1999 RQ36 is an Excellent Sample Return Target

- It provides for the **most exciting science**
  - The lowest albedo of any known asteroid (0.03) and a spectral signature suggesting a carbon- and volatile-rich surface
- It is a class of object **never before visited** by a spacecraft
  - Primitive B-class carbonaceous asteroid, a class that has never been studied up close
- Its size, shape, and rotation state are **known**
  - Extensively characterized by the Arecibo Planetary Radar System, resulting in detailed, high resolution shape and rotation-state models
- There is **abundant regolith** on the surface available for sampling
  - Arecibo and Spitzer data provide strong evidence of a regolith-rich surface
- Study of this target is **strategically important** to NASA and Congress
  - 1999 RQ36 has the highest probability of impacting the Earth of any known Potentially Hazardous Asteroid

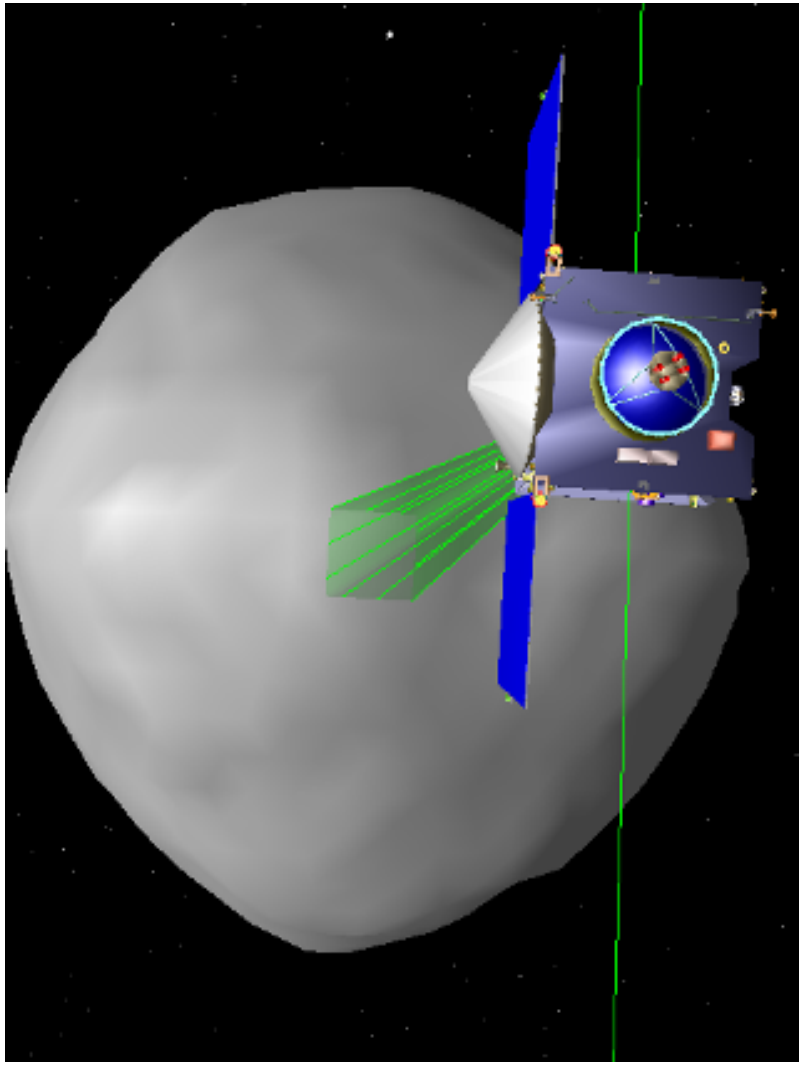


OSIRIS-REx Provides Exceptional Science Return

- For the **first time in space-exploration history**, a mission will return a large, pristine sample of a carbonaceous asteroid, a unique time capsule from the birth of our Solar System.
- Samples of 1999 RQ36 are critical to understand **the initial stages of planet formation and the origin of life**.
- The geological context is critical to linking the chemical and physical nature of the sample to the bulk properties of 1999 RQ36 and the **broader asteroid population**.

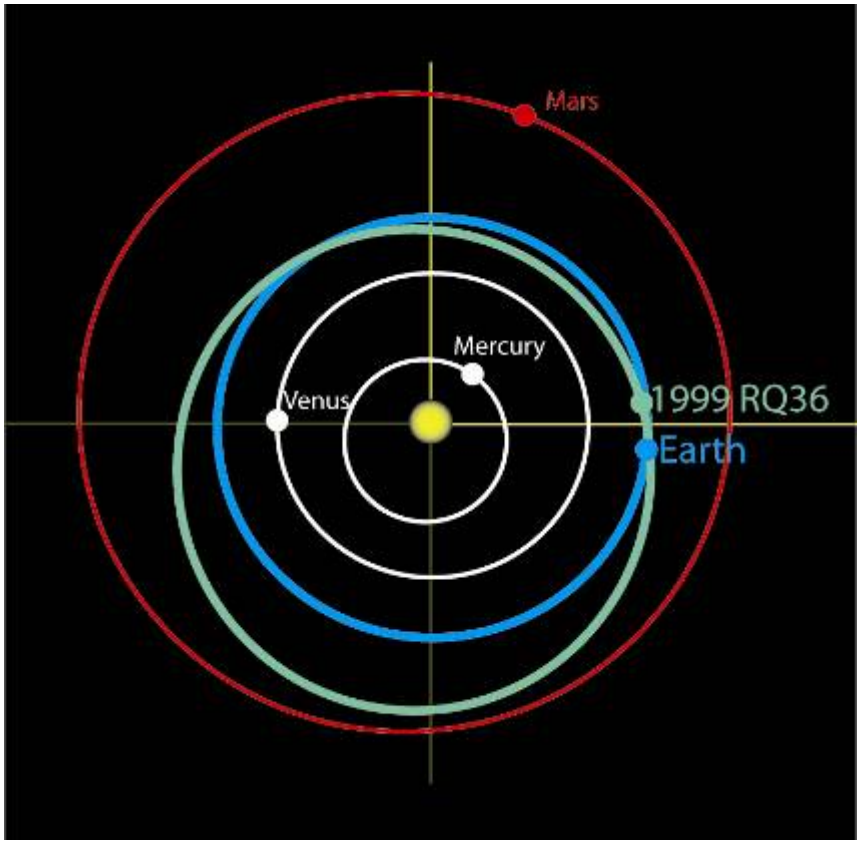
OSIRIS-REx ushers in a New Era of Planetary Exploration

- This team will apply their **key flight experience** from NEAR & Hayabusa navigation to perfect **essential operational capabilities** in small-body proximity operations.
- OSIRIS-REx **executes precise S/C navigation** to acquire samples of 1999 RQ36 with no time critical events.
- We have developed a **low-risk operations approach** utilizing existing flight-system and payload hardware, to enable sample acquisition and return
- These operational capabilities are **essential as humanity explores near-Earth space** to increase our understanding of Solar System bodies and develop *in situ* resource utilization processes.



OSIRIS-REx addresses the Impact Hazard

- 1999 RQ36 is the ***most*** **Potentially Hazardous Asteroid known**.
- Its orbit is precisely determined by multiple radar ranging measurements (Arecibo and Goldstone in 1999 and 2005).
- The probability of an impact in 2170 is 1 in 1,800.
- OSIRIS-REx serves as a "**transponder mission**."
- It has the dual objectives of refining the orbit to ascertain whether an impact is impending and characterizing the object to facilitate a possible deflection mission.



The OSIRIS-REx Team is Multi-generational

- Our organizational structure **directly supports NASA's stated desire** to expand the pool of well-qualified Principal Investigators and Program Managers for implementation of future missions.
- Major management positions are filled with **highly experienced individuals** assisted by **capable younger deputies**.
- The team includes many of the **most promising young planetary scientists and engineers** in the world.
- Participating scientist programs provide opportunities for additional scientists to join the team.

OSIRIS REx is…

Exactly the type of mission that makes NASA great

- Exciting, ground-breaking science!
- Strong team from academia, industry, and NASA Centers!
- Totally within our capabilities!
- Enhances future exploration capabilities!
- Prepares the next generation of mission leaders!
- The mission that keeps on giving - samples studied in 2023 and many more times as new instruments and techniques are developed in the future!
- Incredible return on the funding invested!