Autonomous Operations at Small Solar System Bodies

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Industry Partners are identified and will be used to support:
LiDAR and sensing assumptions
Evaluation of on-board GNC algorithms
Realism of mission and operations
Implementation of surface sampling autonomy

Involvement of industry partners will ensure technology transition pathways are open

Approach is based on small body science

- **Fundamental Dynamic Operational Modes**

Motion in the small body environment can be reduced to fundamental modes of operation that all exploration and characterization approaches can be built up from

- *Slow hyperbolic flybys*: Minimal interaction with body
- *Hovering*: Relative to sun-line or rotating body
- *Stable orbits*: Enable long-term observations
- *Surface motion*: Long-term or short-term contact

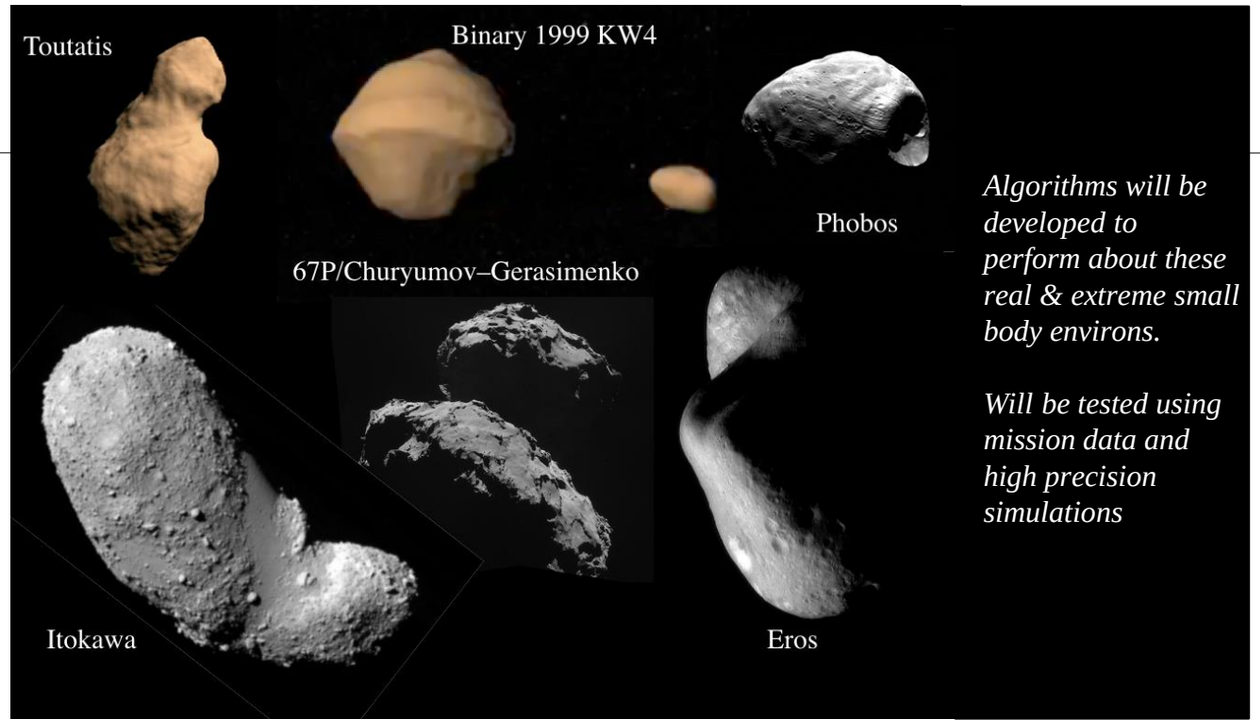
- **Modal Approach to Autonomy in the Small Body Env.**

- We apply in situ observations to define autonomous navigation algorithms for and between each operational mode
- We leverage current research to develop autonomous map creation and utilization, utilizing optical and LiDAR sensors
- We develop autonomous planning approaches to achieve goal-driven mapping and measurement missions

Research Objectives to achieve autonomy:

1. **Map Creation and Use**: Autonomous construction and utilization of small body shape and spin models using optical and LiDAR sensors
2. **Autonomous Navigation of Fundamental Modes**: Necessary navigation measurements and algorithms to support each flight mode
3. **Autonomous Planning**: Goal-driven autonomous planning and guidance to achieve specified mapping or measurement missions
4. **Advanced Navigation Techniques**: Analysis of advanced approaches to address identified short-falls in accuracy or information content

- **SOA Comparison**: Current approaches use ground-intensive models and measurements to enable navigation, even for autonomous actions
- **Innovation**: We implement proven navigation techniques using in situ measurements, leveraging the documented small body environment
- **TRL & Transition**: Raise autonomous mapping / nav to TRL 2



Potential Impact:

- **Benefits**: Enables 1st generation autonomy exploration spacecraft to be developed and tested in realistic environments
- **Outcomes**: Develops autonomous approaches for small body navigation and mission operations that have their roots in tested deep space navigation principles and approaches.