SmallSat Reactive Flyby to Oort Cloud Comets and Interstellar Objects

Benjamin Donitz[1], Steve Matousek[1], Julie Castillo-Rogez[1], Tibor Balint[1], Robert Miller[1], David Tuman[1], Matt Kowalkowski[1], Alessandra Babuscia, Roger Klemm[1], John Mann[1], Aadil Rizvi[1], Kevin Ortega[1], Mark Wagner[1], Autumn Lui[1], Anne Marinan[1], Diana Chu[2], Cassandra Smith[3], Taylor Sun[4], Lauren St. Hilaire[1], Kyle Waters[1], Eric Lundgren[5], Zubin Olikara[1], Stewart Sherrit[1]

[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States

[2]Cornell University, Ithaca, NY, United States

[3]Rensselaer Polytechnic Institute, Troy, NY, United States

[4]University of Michigan, Ann Arbor, MI, United States

[5]Aerospace Corporation, El Segundo, CA, United States

Oort Cloud Comets (OCC) are pristine objects from the edge of the protoplanetary disk. Their exploration opportunities would provide unique insight into the formation of our solar system. About once per decade, a large (10s km) OCC passes into the inner-solar system, which makes it potentially reachable with small spacecraft. Assessing the chemical make-up of these objects via Earth-based telescopic observations remains limited. A flyby mission utilizing small spacecraft with a carefully designed payload suite would enable observation of these OCC and their volatile and refractory material up close.

OCC flybys were previously presumed to be impossible or unaffordable due to the unpredictable occurrence and orbits of these bodies. Moreover, the short lead time between detection and encounter of these bodies would require a reactive mission with a large launch vehicle. Recently, due to the convergence of increased capabilities to discover OCC years ahead of their perihelia, and advancing SmallSat capabilities, a reactive mission to an OCC is now becoming achievable.

A recent study at JPL determined that OCC C/2017 K2 could be encountered by two SmallSats launched in February 2022 for a high-speed encounter of the OCC in August 2022. The same capabilities that would enable fast-response to visit OCC could also be applied to Interstellar Objects (ISO) that are passing through the inner-solar system like Oumuamua or Borisov.

The technical capabilities required to achieve an OCC and ISO flyby exist today. Shorter development schedules as demonstrated by MarCO (Mars Cube One); emerging small payloads (e.g., visible imagery, volatile isotopes, and mineralogy mappers); maturing SmallSat deep space propulsive capabilities; and increasingly capable on-board computing resources to process science data - all make it possible to return meaningful science from an OCC or ISO flyby. However, the programmatic elements required to launch a reactive mission are not in place. NASA's current competitive planetary proposal solicitations follow a prescribed cadence that precludes rapid response following an OCC discovery.

We present the results of a reactive mission concept study on the C/2017 K2 OCC that demonstrates the readiness of technical capabilities and highlight the programmatic shortfall in this category of rapid response mission architectures. As SmallSat technologies and instrumentation continue to improve, the opportunity to explore OCC and ISO using SmallSats is within our reach.

This work is being carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA. Government sponsorship acknowledged.