Paper ID: 48424
oral
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 1) (4A)

Author: Mr. Andrea Capannolo
Politecnico di Milano, Italy, andrea.capannolo@polimi.it

Mr. Vincenzo Pesce
Politecnico di Milano, Italy, vincenzo.pesce@polimi.it
Prof. Michèle Lavagna
Politecnico di Milano, Italy, michelle.lavagna@polimi.it

BINARY ASTEROID REDIRECTION: SCIENCE OPPORTUNITY FOR NANOSATS

Abstract

Although just few tens of binary asteroid systems are known, still they represent an intriguing natural facility for both planetary and universe science further understanding and technology in orbit demonstration. In particular, one of those, the Didymos system, recently captured the space community interest as a perfect target to test capabilities in deflecting natural objects, for planetary protection. Indeed, JHU/APL, supported by NASA, are designing the Double Asteroid Redirection Test (DART) mission to impact on the Didymos secondary moon, and assess the kinetic impactor strategy performance to deflect a 150 m wide small asteroid. The impact effects, being DART a single spacecraft mission, will be monitored only remotely from Earth. However, to possibly be in close view of the impact point just before and after the kinetic event occurrence would offer the chance to collect unique scientific data: potential fragmentation of Didymoon could be registered, and plume material in situ analyzed. A simple plume evolution imaging may even offer fundamental information on the natural bodies composition and the deflection effectiveness. Assuming the possibility for the main spacecraft to host a small piggyback nanosat, the paper assesses the science opportunities offered by releasing the nanosat at the Didymos system arrival, to witness the impact and post-impact events in the didymoon proximity. The time-to-impact nanosat release, the release relative velocity direction and magnitude are assumed as degrees of freedom to generate families of trajectories to maximize the post-impact environment monitoring, under the multi-body non-uniform distributed gravitational field of the binary system. The effectiveness of a low authority on board propulsion unit is also considered to widen the trade space for the nanosat trajectories in the binary proximity which maximize the time of residence in the impact region vicinity. Analyses showed that, even with a cm/s relative velocity release few hours before the impact occurrence, the nanosat trajectory can be tuned so that the impact expected fragments plume generation can be imaged and passed through from different perspectives, depending on the scientific payload requirements. If the further authority of a tens m/s propulsion unit is available, the nanosat permanence in the plume environment can be further extended making the piggyback nanosat a very interesting added value to the kinetic impactor mission. The paper synthetizes the different opportunities the proposed piggyback cubesat offers if the limited engineering and operational degrees of freedom merged with the peculiar irregular gravity field are carefully exploited.