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A NETWORK OF IMMINENT IMPACTOR SENTINELS

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ABSTRACT

The ASI LICIAcube and ArgoMoon missions have represented an important in-flight test for cubesats to be employed for lunar and interplanetary missions. The former has successfully imaged the plume generated by the impact of the US DART spacecraft on asteroid Dimorphos, the latter has allowed to perform several lunar flybys before getting into interplanetary space. In both cases extended missions were envisaged. Planetary Defence applications were therefore studied in order to evaluate the possibility of profiting of the near-future Cubesat increasing access to interplanetary space.
The possibility of accessing Distant Retrograde Orbits (DRO) either as a nominal or as an extended mission profile offer several advantages from the engineering point of view since the spacecraft never leaves the surrounding of the Earth beyond a certain distance. This allows for example to keep the telecommunication requirements under control as well as being less demanding for operations. Among the various applications of a spacecraft in a DRO, it has been already shown that Planetary Defence could benefit of the favourable phase angle of observing NEOs coming from the direction of the Sun. It has been also evaluated the minimum DRO altitude needed for a spacecraft pointing in the anti-solar direction to ensure a significant warning time. This, in turn, could be extremely helpful in detecting the so-called “imminent impactors” (i.e. objects in the 10-40 m range in route of collision with the Earth) that are likely to represent in the short run the most probable asteroid threat. This is why their challenging observation is going to be specifically addressed both, from the ground (e.g. ESA Flyeye telescope) and from space (e.g. NASA NEO Surveyor).
Although LICIAcube lost contact a few weeks after the DART impact, an extended mission scenario has been proposed which implied to use it as precursor imminent impactor sentinel, since its post-encounter orbital path was remarkably close to a DRO having an altitude consistent with a 5-day warning time. Without performing any further manoeuvre the Cubesat was already in the DRO-like trajectory branch between the Earth and the Sun, thus fulfilling the right observing geometry, which would have covered the 6-month extended mission foreseen. Insertion in a stable DRO could be also achieved with a reasonable delta-V budget of about 150m/s. Similar considerations apply for the Argomoon case: after travelling on highly

elongated elliptical paths with apogee beyond the Moon, the spacecraft performs a lunar swing-by to reach interplanetary space. The latter event is foreseen also for reaching a nominal DRO configuration with suitable altitude.

Lessons learned are that when designing a Cubesat mission which is likely to fufill its primary objective in an orbital configuration close enough to the orbit of the Earth, DROs appear to be the best candidates for turning extended mission or end-of-life disposal into an imminent impactors sentinels. This in turn would allow the build up of a network which, in close coordination with ground-based observations, could contribute to an integrated rapid response system based on existing assets.