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# Exploring dwarf planets and TNOs: cost-efficient strategies for maximizing the science return

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The last decade has suddenly seen the doubling of the number of known bodies above 500km in diameter in the Solar System, from 35 to about 70. Combined with predictions of differentiated states for a large fraction of the largest newcomers, this calls for a better knowledge of these bodies, not just as massless dots in n-body codes simulations or as a cloud of objects to be classified in taxa, but also as full-fledged planetary bodies with an evolution, a structure and sometimes an extant geological or atmospheric activity. The recent white paper from Grundy, McKinnon et al. reporting the SBAG community recommendations for the decadal survey [1] has stressed the importance of advances in the field. However, getting such an enhanced knowledge for those planetary science targets represents huge challenges mainly due to their large distance from the Earth and due to their number. Whether at-a-distance or in-situ, their exploration requires innovative thinking to address those needs in a cost-efficient manner.

Thales Alenia Space has explored these two main paths in recent preliminary studies that are briefly recalled as an introduction to this presentation. Observation at a distance from Earth's orbit has been considered, including strategies for chasing stellar occultations [2], which bring highly valuable results on a large list of targets. As far as in-situ exploration is concerned, the only dwarf planet for which a mid-term landing is achievable is Ceres, where a post-Dawn polar lander mission has been studied by Thales Alenia Space [3]. In-situ exploration of more distant targets would be best served by orbiters, but our study of what an orbiter around Haumea [4] would mean on the performance of propulsion and mainly power generation specific mass has confirmed that such a mission lies beyond the next decade.

For the transneptunian dwarves, a fly-by therefore still represents the most efficient short-term in-situ exploration strategy although it raises the issue of its science return-to-cost ratio. We have investigated strategies enabling a significant enhancement of such a science return with respect to a New Horizons-like mission and develop them in this presentation. We dwell in particular on how a mid-sized spacecraft can be efficiently complemented by ancillary micro-satellites so as to provide for a considerably increased spatial and/or time coverage and probing of the magnetic field, gravitational field, atmosphere or exosphere of the targets. We place constraints on the time at which such ancillaries should be released taking into account navigation uncertainties and power supply considerations. We conclude by comparing the different science-enhancement strategies.

References:
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