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CASTALIA – A MAIN BELT COMET MISSION

Abstract

The Castalia mission will explore a member of a new class of small bodies in the solar system, the Main Belt Comets (MBC). MBCs are expected to provide unique insights into the distribution of volatiles in the early stages of planet formation and the interrelation of water and organics in the asteroid belt with life on Earth. They are considered a new class of objects, as they have orbital properties like typical asteroid belt objects, but appear as comets with their dust comae and tails.

The science goals of the Castalia mission are:

I Characterize a new Solar System family, the MBCs, by in-situ investigation

II Understand the physics of activity on MBCs

III Directly detect water in the asteroid belt

IV Test whether MBCs are a viable source for Earths water

V Use MBCs as tracers of planetary system formation and evolution

The Castalia mission is intended to be proposed as candidate for the M4 launch opportunity in the ESA Cosmic Vision 2015-2025 programme. Mission and system design were elaborated in a dedicated mission study performed in 2013 by a consortium of OHB System AG, DLR Institute of Space Systems and a consortium of scientists from different institutes and organizations using concurrent engineering techniques.

As main belt comets cannot be closely investigated from ground based observations, an in-situ orbiter mission was identified as the most promising option to get detailed information about these objects. The mission is designed for launch in the 2024-2026 timeframe with a Soyuz Fregat class launcher. The baseline target is MBC 133P/Elst-Pizarro, which has repetitively observed activity. This target bears the challenges of a high deltaV demand for the transfer and also the high maximum distance to Earth reducing the downloadable data volume. Science goal IV adds also the complexity of a close-to-surface hovering phase in order to fetch sufficient outgassed material for on-board compositional investigation. This scientifically highly interesting but also challenging mission was analysed from technical, programmatical and cost point of view and found to be feasible. It is providing a reasonable step forward in terms of exploration technology and is compatible to the cost and schedule constraints of an ESA M-class mission.

This paper will contain a description of the intended Castalia mission. It will address an overview of the science case, but focuses on mission and system design, addressing especially the specific technical challenges of this mission.