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THE CASTALIA MISSION TO A MAIN BELT COMET

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Abstract

Castalia is a proposed ESA M-class mission to rendezvous with a Main Belt Comet (MBC), in order to investigate this new population and test whether or not the asteroid belt could be the source of Earth's water. We describe the scientific motivation for the mission, the spacecraft and payload needed to achieve our goals, and the various options and trades that should be considered in a phase A study.

1. Introduction – the MBCs

MBCs constitute a recently identified class of solar system objects [1]. They have stable, asteroid-like orbits and some exhibit a recurrent comet-like appearance (Fig. 1). It is believed that they survived the age of the solar system in a dormant state and that their current ice sublimation driven activity only began recently. Buried water ice could survive under an insulating surface: Excavation by an impact can expose the ice and trigger the start of MBC activity.

2. The Castalia mission

We present the case for a mission to a MBC, which was submitted to the European Space Agency's M5 call for a medium-class mission. The specific science goals of the Castalia mission are:

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

2. Understand the physics of activity on MBCs

3. Directly sample water in the asteroid belt

4. Test if MBCs are a viable source for Earth's water

5. Use the observed structure of an MBC as a tracer of planetary system formation and evolution.

These can be achieved by a spacecraft designed to rendezvous with and orbit an MBC for a time interval of some months, arriving before the active period for mapping and then sampling the gas and dust released during the active phase.

3. Spacecraft and Instruments

Given the low level of activity of MBCs, and the expectation that their activity comes from only a localized patch on the surface, the orbiting spacecraft will have to be able to maintain a very close orbit over extended periods - the Castalia plan envisages an orbiter capable of 'hovering' autonomously at distances of only a few km from the surface of the MBC. The strawman payload comprises four packages, each containing two instruments:

- MBC surface reconnaissance package: vis/NIR cameras, thermal cameras

- MBC body interior package: radars and radio science

- MBC material and composition package: mass spectrometers for gas and dust, dust counter

- MBC plasma environment package: plasma instruments & magnetometer

The instruments are based on heritage from Rosetta, including the ROSINA, COSIMA and GIADA instruments (the latter two combined into a single dust instrument for Castalia). Various optional elements, including a simple surface science package, are being considered. At the moment, MBC 133P/Elst-Pizarro is the best-known target for such a mission. A design study for the Castalia mission has been carried out in partnership with OHB System AG. This study looked at possible missions to 133P, and found that this, and backup MBC targets, are reachable by an ESA M-class mission (figs. 2 & 3). More details are available at http://bit.ly/mbcmission

Acknowledgements

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References

[1] Hsieh, H. & Jewitt, D. (2006) *Science* 312, 561

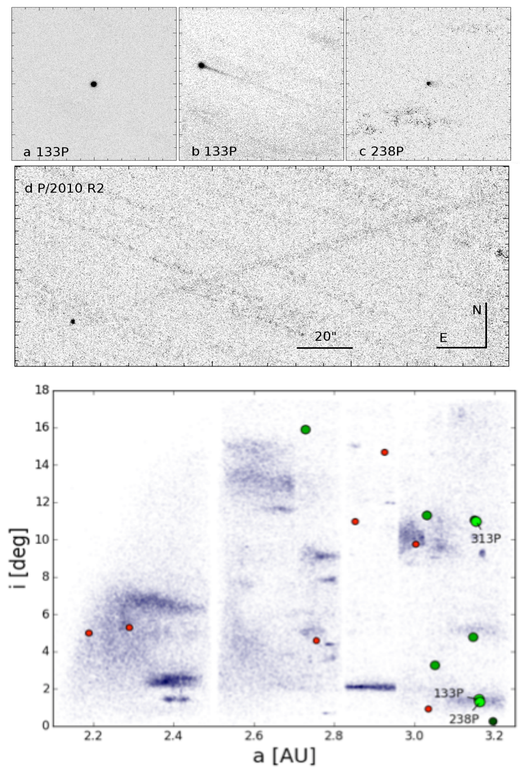

Figure 1. *Top:* Images of MBCs with active and inactive appearance, showing their comet-like morphology. *Bottom:* Orbital distribution of MBCs (green), including those with repeated activity at more than one orbit (bright green), and other active asteroids (red), within the main asteroid belt (points).

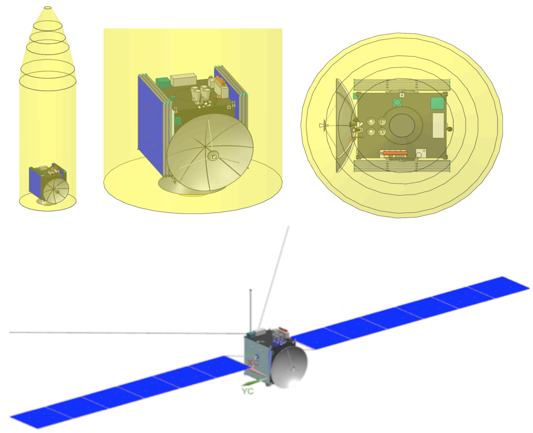

Figure 2. The proposed Castalia spacecraft, in its stowed configuration within the Ariane 6.2 fairing (top row) and in deployed configuration.

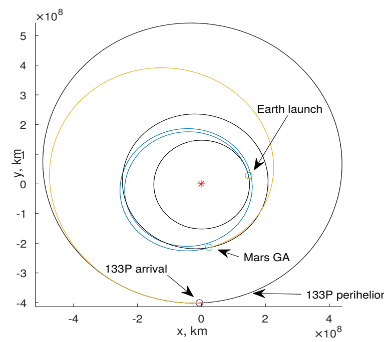

Figure 3. Trajectory to reach 133P for ESA M5 launch window, departing Earth in late 2028 to arrive before the 2035 perihelion.