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PALISA-Observation and Sample Return Mission to the M-Type Asteroid (216) Kleopatra

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During the Alpbach Summer School 2008, entitled "Sample Return from the Moon, Asteroids and Comets", our team proposed a mission to the M-Type asteroid Kleopatra. The PALISA mission would be a pioneering approach to trace back the evolution of the solar system and planetary bodies. Observing and sampling an M-Type asteroid will give a unique insight into the metallic core of a planetary body.

The advantage of the PALISA mission is the obvious multiplying effect of the observations. For example, a sample return is the only way to accurately classify M-Type objects and link them to iron meteorites. Knowing the geological context of iron meteorites will significantly advance the understanding of the formation and structure of planetary cores. Determining the formation age of the asteroid and its exposure age would give an insight into the evolution and dynamics of the asteroid belt. Furthermore, a sample return is crucial to calibrate the ground observation instruments enabling M-type asteroids to be precisely mapped. This mission may also clarify if asteroids have been able to retain a magnetic field. Since the strength of the magnetic field decreases over time after the crystallization of the core, it is crucial to return a sample to measure the natural remnant magnetization.

Following the launch of a two-part spacecraft (orbiter/landing-return module) with an Ariane 5ECA launcher, low-thrust electric propulsion is used to reach Kleopatra within 4 years. With no detailed gravitational models available, a two-year observation period in a 5000 km orbit is foreseen before the orbiter/lander can descend to lower orbit and separate. The landing-return module will land, while the orbiter ascends to a safe orbit to ensure communication and provide further observations. The landing procedure is fully autonomous and two harpoons ensure a safe stay during the drilling procedure. Due to uncertain surface characteristics an ultrasonic drill core will be used. The drilling power comes from two primary batteries and the whole sampling procedure should not take longer than 24h. After the return vehicle escapes from the asteroid with the help of hydrazine thrusters, solar arrays are deployed and an electric propulsion system brings the return capsule back to Earth.

The PALISA sample return mission is the obvious next step after the planned and ongoing missions to comets and primitive asteroids and it will give answers about the planetary formation processes that are of immense value for the scientific community.