GAUSS - A Sample Return Mission to Ceres

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Ceres, the largest resident in the main asteroid belt and the innermost dwarf planet of the solar system, shares characteristics with a broad diversity of solar system objects, making it one of the most intriguing targets for planetary exploration. The recently completed Dawn mission through its 3.5 years of in-orbit investigation has furthered our understanding of Ceres, yet at the same time opened up more questions. Remote sensing data revealed that Ceres is rich in volatiles and organics, with fresh traces of cryovolcanic and geothermal activities. There is potential evidence of Ceres’ past and present habitability. Findings by Dawn suggest that Ceres might once be an ocean world and have undergone more complicated evolution than originally expected. Thus, Ceres encapsulates key information for understanding the history of our solar system and the origin of life, which has yet to be explored by future missions.

We present the GAUSS project (Genesis of Asteroids and EvolUtion of the Solar System), recently proposed as a white paper to ESA’s Voyage 2050 program. GAUSS is a mission concept of future exploration of Ceres with sample return as the primary goal. It aims to address the following top-level scientific questions concerning: 1) the origin and migration of Ceres and its implications on the water and volatile distribution and transfer in the inner solar system; 2) the internal structure and evolution of Ceres; 3) Ceres’ past and present-day habitability; and 4) mineralogical connections between Ceres and collections of primitive meteorites. We will discuss scientific objectives of Ceres exploration in post-Dawn era as well as instrumentation required for achieving them. We will explore candidate landing and sampling sites of high scientific interest based on Dawn results. We will also consider technical and financial feasibility of different mission scenarios in the context of broad international collaboration.

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