GAUSS: Towards Sample Return from Dwarf Planet Ceres

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GAUSS (Genesis of Asteroids and EvolUtion of the Solar System) is a mission concept for the future exploration of Ceres. As both the largest resident of the main asteroid belt and the only dwarf planet in the inner Solar System, Ceres holds critical information for probing the evolution and habitability of our Solar System. NASA’s DAWN mission performed the by far most comprehensive investigation of Ceres during its over three year in-orbit operation around this unique world. Data collected by remote sensing instruments revealed an amazingly diverse landscape comprising different types of geological features. Beneath its volatile- and organic-rich surface, Ceres might have once possessed a global ocean, the remnants of which possibly still exist today as pockets of brine between the mantle and the crust. Hydrothermal activities that took place in recent geological time transferred materials deep inside Ceres to its surface, forming several outstanding surface features that are optimal for future sampling. Similar processes could occur on other ocean worlds in the Solar System, making Ceres a benchmark case for studying the evolution and habitability of these objects in general.

To fully understand the physical and chemical evolution of Ceres, high resolution analyses of samples are necessary. With cryogenic sample return as its final step, the GAUSS project aims to answer the following key questions:

- What is the origin of Ceres and the origin and transfer of water and other volatiles in the inner solar system?
- What are the physical properties and internal structure of Ceres? What do they tell us about the evolutionary and aqueous alteration history of icy dwarf planets?
- What are the astrobiological implications of Ceres? Was it habitable in the past and is it still today?
- What are the mineralogical connections between Ceres and our current collections of primitive meteorites?
