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Radar observations of the asteroid's structure from deep interior to regolith

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Our knowledge of the internal structure of asteroids entirely relies on inferences from remote sensing observations of the surface and theoretical modeling. Is the body a monolithic piece of rock or a rubble-pile, how high is the porosity? What is the typical size of the constituent blocs? Are these blocs homogeneous or heterogeneous? The body is covered by a regolith whose properties remain largely unknown in term of depth, size distribution and spatial variability. Is it resulting from fine particles re-accretion or from thermal fracturing?

After several asteroid orbiting missions, theses crucial and yet basic questions remain open. Direct measurements of asteroid deep interior and regolith structure are needed to better understand the asteroid accretion and dynamical evolution and to provide answers that will directly improve our ability to understand the formation and evolution of the Near Earth Asteroids (NEA), that will allow us to model the mechanisms driving NEA deflection and other risk mitigation techniques.

Radars operating at distance from a spacecraft are the only instruments capable of achieving this science objective of characterizing the internal structure and heterogeneity from submetric to global scale for the benefit of science as well as for planetary defense or exploration.
The AIM mission will have two complementary radars on-board, operating at different frequencies in order to meet the objectives requirements. The deep interior structure tomography requires a low-frequency radar (LFR) in order to propagate throughout the complete body (this LFR will be a direct heritage of the CONSERT radar designed for the Rosetta mission).
Ihe characterization of the first ten meters of the subsurface with a metric resolution to identify layering and to reconnect surface measurements to internal structure will be achieved with a higher frequency radar(HFR), the design of which is based on the WISDOM radar developed for the ExoMars mission. Both radars are currently under phaseA/B1 study funded by ESA. We will present the performances of both instruments on realistic environements and their operating modes.