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Composition of primordial asteroids: remnants of the planetesimal populations and members of the oldest asteroids families

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The small bodies of the Solar System represent remnants of the building blocks of the planets. As such, they are our best tracers for the processes that occurred during the earliest history of the Solar System. For instance, asteroids cast light on the planetesimals composition, on the location of the snow line, on the thermal conditions of the early solar System, on planetary migration theories and on the alteration processes acting on the Solar System. They also have a high biological importance, because the bombardment of the planets by comets and asteroids (belonging to the B, C and D spectroscopic classes corresponding to carbonaceous rich asteroids) could have brought some organic material. These objects have a composition that have not change much since their formation. They represent a significant part of the planets' histories and, for Earth, they possibly have delivered organics and volatile materials which might have favored the appearance of life.
To cast light on the planetesimal size distribution and composition, we proposed the ORIGINS project. The latter is based on a new method developed by Delbò et al (2017) : it consists in determining the correlation of points in the plane of the inverse of the diameter (1/D) versus semimajor axis (a). The resulting slope, look like the letter « V » and called V-shapes, indicates family age. Thanks to this method, we had already identify a new 3.5 Gyr old family in the inner belt and around 17 asteroids remnants of the original planetesimals. In the future, this method will be applied to the whole main bet, and we will thus identify and characterize the composition of the primordial asteroids.
This thesis is dedicated to the investigation of the composition of primordial asteroids both members of old families and remnants of the original planetesimals. During the thesis, I will actively participate to the spectroscopic survey in the visible and IR range (0.5-2.4 μm) to characterize the composition of both families' members and leftover planetesimal. Many observations nights are planed, mainly at the DCT telescope (USA, Arizona), IRTF (USA, Hawaii) and Copernico Telescope (Italy, Asiago).
The goal is to characterize the composition of 120-150 asteroids members of old families and remnants of planetesimals during 2019-2022. We expect to observe several absorption features associated to silicates, aqueous altered minerals, organics, sulphide, and eventually ices. If any, in the 0.4-2.5 μm range, we can detect the presence of a given compound, constrain the mineralogical abundances, the grain size of the compounds, and the global composition of the investigated asteroids. Strong interactions are needed between dynamical and compositional studies to establish families' memberships of asteroids. In fact, compositional homogeneity of family members is one of the working hypothesis needed to separate members of a given family from background objects. For this reasons, composition and physical properties such as albedo are fundamental parameters both to characterize the composition of a family and strengthen or reject family memberships.
Moreover, to enlarge the available sample of data, we will use the low-resolution spectra from ESA's Gaia space mission (BP-RP instruments), which will be released in early 2021. Several tens of thousands of asteroids should have Gaia visible spectra (0.4-1 μm range). This thesis work will provide fundamental clues on the compositional gradient and on the size distribution of the primordial planetesimals across the asteroid main belt.

Field

Planetology (incuding small bodies and exoplanets)

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