Are Interstellar objects representative of their home systems?

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The discovery of the first two interstellar objects (ISOs) passing through our solar system, 1I/'Oumuamua and 2I/Borisov, has sparked some intense interest from both the general public and the scientific community. These two objects were very different. 1I/'Oumuamua was so faint and fast, that only a week-long time window was available for observations. As a result, our knowledge of this object is very limited, yet consistent with known characteristics of small bodies. If anything, some of the extreme properties of 1I might serve as a reminder of how little we know of the smallest objects in our solar system. On the other hand, 2I/Borisov displayed a cometary activity similar to that typically observed in the solar system, a behavior actually anticipated for interstellar objects.

In our planetary system, small bodies like asteroids or comets are the remaining witnesses of the early stages of the solar system formation. They preserve a record of the conditions and processes that formed solar system bodies, including themselves (like collisions, orbital evolution, thermo-physical processing). However, the bulk of small bodies or planetesimals were ejected in the process of shaping the solar system as it is observed today, due to gravitational interactions with migrating giant planets for example. During the formation of other planetary systems, it is also expected that a significant portion of their planetesimals should be ejected into interstellar space. As reviewed by Knight et al. (2019), several processes can actually strip a system from planetesimals, at distinct stages of their history.

As a consequence, ISOs offer an unprecedented opportunity to closely study remnants of the star and planet formation process from systems other than our own. In this work, we study the thermo-physical evolution of ISOs both in the solar system (as one example of a close passage to a star) and in the ISM. We assess whether these objects, when they are observed in the solar system, can actually be representative of their home systems. We show that it can be the case, depending on the process that resulted in their ejection from their home systems. Because the architectures of extrasolar planetary systems are remarkably diverse, characterizing planetesimals from other stars can thus help to contextualize the formation and evolution of our own system, through comparison to our small body populations.