First direct detection of large aromatic molecules on asteroid (162173) Ryugu sample C0083 and A00145: an interstellar heritage

Hassan Sabbah[1], Ghylaine Quitté[1], Karine Demyk and Christine Joblin[1]
[1]*IRAP, Université Toulouse III – Paul Sabatier, CNRS, CNES, 31028 Toulouse Cedex 4, France*

Although meteorite analysis has revealed various types of pre-solar grains, the presence of large polycyclic aromatic hydrocarbons (PAHs) of interstellar origin has not been firmly established. Here we present a search for these compounds in the C0083 and A00145 grains from the Ryugu asteroid. The experiment takes advantages of the ultra-sensitivity of the AROMA (Astrochemistry Research of Organics with Molecular Analyzer) setup to target these species.

The AROMA setup was developed specifically for studying the carbonaceous molecular composition of meteorites and cosmic dust analogues [1]. It consists of a laser desorption ionization (LDI) source combined with a segmented linear quadrupole ion trap (LQIT), all connected to an orthogonal time-of-flight mass spectrometer (oTOF). The ion source is at a low pressure of 10^{-6} mbar and can be operated using a two-step laser desorption ionization scheme. This L2MS analysis provides ultra-sensitivity for PAHs and fullerenes as demonstrated in our earlier study [2]. This laser technique also requires little or no sample preparation and uses very little material.

Subsamples of the two Ryugu grains have been isolated and used either as bulk or crushed in the form of powder to improve sensitivity. The data obtained are compared to previous AROMA analyses of carbonaceous chondrites (CCs) such as Murchison and Orgueil. This reveals a number of peculiarities in the distribution of PAHs in Ryugu grains. In particular we report the presence of PAHs containing as much as 50 carbon atoms, which can be considered as interstellar candidates. Moreover, we have identified aromatic compounds that incorporate nitrogen (N) and oxygen (O) heteroatoms, with carbon atoms extending up to 48. These findings impact our view on the complexification of organic matter in the cycle of matter from the interstellar matter to the Solar System. It also motivates the research for these large compounds in other CCs

References

[1] Sabbah et al. 2017. The Astrophysical Journal, 843, 34. [2] Sabbah et al 2022. The Astrophysical Journal, 931, 91.