Large Polycyclic Aromatic Hydrocarbons in Ryugu Samples C0083 and A00145

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Polycyclic aromatic hydrocarbons (PAHs) play a key role in the physical and chemical processes in regions where stars and planets form. The interstellar PAH hypothesis, based on the detection of aromatic infrared bands (AIBs), proposes that large, free PAHs (containing 50 or more carbon atoms) are major contributors to these emissions. However, laboratory analyses of primitive carbonaceous chondrites (CCs) and Ryugu samples have primarily identified smaller PAHs, with up to 24 carbon atoms. In this study [1], we report the first detection of large PAHs—up to 61 carbon atoms—in C0083 samples from the carbonaceous asteroid Ryugu (Hayabusa2 mission). Using two-step laser desorption ionization mass spectrometry (L2MS) available on the AROMA setup, we uncovered a diverse molecular composition, including both peri-condensed and non-condensed aromatic compounds.

Our findings provide direct evidence supporting the interstellar PAH hypothesis in which large compact aromatic molecules are the carriers of the AIBs. This discovery also offers new perspectives on the formation and evolution of organic matter in star-forming regions and the early solar system.

Following the detection of large PAHs in grain C0083, we investigated their presence in grain A0145 to get insights into the distribution and concentration of these molecules in Ryugu samples. The AROMA setup is now used to analyze both soluble and insoluble organic matter from carbonaceous chondrites, including Murchison, Orgueil, and Paris, using the same L2MS method as used for Ryugu samples. This work lays the groundwork for the future use of the μL2-HRMS instrument, which will enable us to combine L2MS with very high mass resolution and get a more precise view of the chemical diversity of aromatics in meteorite samples and samples from return missions.

References

[1] Sabbah H., Quitté G., Demyk K., Joblin C. 2024. Natural Sciences, e20240010.