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Constraining the Cosmic Origin of Micrometeorites from the Atacama Desert, Chile

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Multiple Micrometeorite (MM) collections (e.g., from deep-sea sediments, Antarctic ice and sediments) have been analyzed to reconstruct the past MM influx and determine their origins within the Solar System. However, these geological records provide only limited time windows, and sedimentation rates are often poorly constrained (see [1] and references therein). We will analyze 21 MMs from a time-resolved sedimentary record in the Atacama Desert. Stable, hyper-arid conditions facilitate sedimentation rates of only mm/kyr and reduce weathering-related sample bias.

We employed various analytical techniques for MM classification and investigate their irradiation histories to aid in determining their origins (e.g., [2, 3]). After liberation from their parent body, MM progenitors spiral towards the Sun, while being exposed to cosmic radiation generating long-lived radionuclides (e.g., ^{10}Be, ^{26}Al), as well as stable noble gases such as ^{21}Ne.

We developed a numerical model to determine the transport of MM progenitors in space and the simultaneous production of cosmogenic (radio)nuclides due to irradiation by solar and galactic cosmic rays (SCRs and GCRs, respectively). Like prior frameworks, our model considers a variety of orbits, progenitor sizes, compositions, and densities. A novelty lies in non-isotropic SCR and GCR profiles, depth-dependent production rates, as well as spherical evaporation during atmospheric entry [3, 4, 5, 6].

The radionuclide concentrations in individual MMs will be measured with accelerator mass spectrometry (AMS), with detection limits sufficient to resolve concentrations even for MMs with high terrestrial ages of Myr and masses of a few µg. A comparison with the model will provide the opportunity to constrain their heliocentric distances of origin in the Solar System.

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