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Development of a Liquid Jet Target to Probe Early Crystallization

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The freezing of a liquid begins with the random formation of a tiny crystalline seed, often consisting of only a few atoms. For over a century, the theory describing this crystal nucleation process has been remarkably difficult to verify experimentally. In our earlier studies with krypton and argon, we observed striking discrepancies between theoretical predictions and measured nucleation rates [1]. Building on our long-standing expertise in target development at GSI—particularly in producing micrometer-scale liquid jets—we have now carried out a dedicated experiment focused solely on krypton. Using the European X-ray Free-Electron Laser Facility in Germany, we collected data that enables us to probe the early stages of crystallization. Looking ahead, we plan to refine our liquid jet techniques further to rigorously test key hypotheses of nucleation theory. These efforts will not only deepen our fundamental understanding of crystallization but also contribute to more accurate climate models, where such processes play a critical role.

[1] **Crystal nucleation in supercooled atomic liquids**; Phys. Rev. Lett. 132, 206102 (2024); Featured in Physics Magazine and Nature Physics

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