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Nucleation of Hard Sphere Colloidal Crystals[1]

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Colloids, micron-sized particles suspended in a molecular solvent, are much larger than atoms or molecules, such that confocal microscopy allows to track individual particles in a dense three dimensional system, in real time. The colloids minimize their free energy, mimicking atoms and molecules; thus, colloidal suspension is a perfect model system, where both the collective behavior and the behavior of individual particles are experimentally accessible. Hard sphere colloids are among the simplest systems which exhibit crystal nucleation; therefore, this system provides an important insight onto the basics of nucleation, which are very poorly understood. I will present our recent studies of the three-dimensional morphology of crystal nuclei in a system of hard sphere colloids. The nuclei, observed by direct confocal imaging, are not compact or spherical, as most theories of nucleation assume. Instead, the nuclei adopt a wide range of somewhat ramified morphologies; the existence of these morphologies modifies the free energy of the nuclei and results into an enormous increase in the rates of crystal nucleation. The applicability of these results to a wider range of atomic and molecular systems will be discussed.

[1]In collaboration with Peter J. Lu, Physics Department, Harvard University and David A. Weitz, Physics Department and SEAS, Harvard University.