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Formation of ordered, nonperiodic structures: Icosahedral quasicrystals, hexagonal limit-periodic systems, and confined hard spheres[1]

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The discovery in the early 1980s that certain metallic alloys can form quasicrystalline phases challenged our understanding of the formation of long range translational order in atomic (or colloidal) systems. Both the thermodynamic stability and the kinetic accessibility of ordered, nonperiodic structures have received considerable attention, but fundamental questions remain open. I will present recent results on the emergence of nonperiodic order in three systems: tiling models that achieve nearly perfect growth of an icosahedral quasicrystal [2]; a one-dimensional quasiperiodic structure that maximizes the density of hard spheres confined to a cylinder [3]; and model systems composed of a single structured particle with only nearest neighbor interactions in which a slow quench induces formation of a limit-periodic phase [4]. For the icosahedral system, there are known materials that motivate the questions about growth dynamics. For the limit-periodic system, the theory suggests new possibilities for colloidal phases that may have a novel hierarchy of vibrational modes [5].

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