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Commensurate-Incommensurate Transitions in Colloidal Crystals

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COMMENSURATE-INCOMMENSURATE TRANSITIONS
IN COLLOIDAL CRYSTALS

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Colloidal crystals are aggregates of small particles in solution which have become periodically ordered in one-, two-, or three-dimensions. Such systems are small enough to be susceptible to Brownian motion and yet large enough to be studied by video microscopy. For this reason, they serve as model systems for studying crystallization. Moreover, when the particle size is comparable to the wavelength of light, these materials hold potential as optical filters and switches, and as photonic bandgap materials. Recently workers elsewhere¹ have attempted to nucleate such structures via sedimentation of particles onto a template (lithographically patterned substrate or container walls). In such situations, the presence of multiple length scales (e.g., multiple particle sizes and/or a mismatch between the scale of the particles and the period of the template) results in the development of defect structures in the aggregate. We have, at Illinois Wesleyan, developed new techniques allowing fine control over aggregation. Rather than using a physical substrate, we will create an "optical substrate" which will allow us to dynamically tune the length scales of the template. This experimental design is intended to aid our study of the transition from commensurate aggregation to what happens as the length scales slowly become incommensurate. Here, we describe the larger context supplied by the scientific literature on colloidal crystals as well as the design of our own experiment, including our efforts to establish a system for automated video microscopy and image.

¹Dinsmore, et al., Phys. Rev. Lett. 80, 409 (1998).