Condensed Matter & Biophysics Seminar

THURSDAY

NOVEMBER 19

4:00 P.M.

RM 184 NSH

Avalanches, Plasticity, and Ordering in Colloidal Crystals Under Compression

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Collectively interacting colloidal particles are often used to model various features of equilibrium and non-equilibrium phenomena. Due to their size scale, colloids provide the advantage that microscopic information on the individual particle level can be directly accessed, something which is normally difficult or impossible in smaller scale systems such as atoms or superconducting vortices. Certain studies that may be difficult to undertake in other systems become feasible with colloids, such as observations of changes in the particle configurations and dynamics during compression. Using numerical simulations we examine colloids confined in a two-dimensional trough potential undergoing dynamical compression. The depth of this confining well potential is gradually increased and the colloids respond with two behaviors: elastic distortions and intermittent bursts (or avalanches) of plastic motion. The interparticle interaction between colloids - which is attractive at short range and repulsive at long range - yields a rich variety of patterns as the system is compressed [1,2] which we compare to the purely repulsive case [3]. The avalanches allow the colloids to rearrange to minimize their colloid-colloid repulsive interaction energy. These avalanches often take the form of shear banding events; however, the short ranged attractive force leads to unusual defect patterns, such as quadrupoles, that interact and form patterns. At larger compressions, the avalanches are associated with a reduction of the number of rows of colloids that fit within the confining potential, and between avalanches the colloids can exhibit partially crystalline or even smectic ordering. The colloid velocity distributions during the avalanches have a non-Gaussian form with power law tails and exponents that are consistent with those found for the velocity distributions of gliding dislocations. We observe similar behavior when we subsequently decompress the system, and find a partially hysteretic response reflecting the irreversibility of the plastic events.

[1] C. J. Olson Reichhardt, C. Reichhardt, and A.R. Bishop, Physical Review E 82, 041502 (2010)
[2] D. McDermott, C. J. Olson Reichhardt, and C. Reichhardt, Soft Matter, 2014,10, 6332-6338
[3] D. McDermott, C. J. Olson Reichhardt, and C. Reichhardt, http://arxiv.org/abs/1503.02690