Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **2755** Type: **Invited Speaker / Conférencier(ère) invité(e)**

Droplets as model systems for investigating 2D crystals, glasses, and the growth dynamics of granular aggregates

Tuesday, 4 June 2019 09:30 (30 minutes)

Over the last years we have developed a method to produce monodisperse oil droplets in an aqueous environment. By carefully tuning the adhesion forces between the droplets they provide model systems for studying various physical phenomena that are not accessible by investigating the molecular counterpart. Here I will present recent work on the transition from 2D crystalline aggregates, prepared from monodisperse droplets, to disordered glassy aggregates prepared from a bidisperse blend of large and small droplets. The aggregates are compressed between two parallel boundaries; crucially, one of the boundaries acts as a force sensor. The compression forces provide a signature of the aggregate composition and give insight into the energy landscape as the system transitions from the crystal to glass. In addition to the idealized 2D aggregates the same system of droplets can be used to investigate the formation of 3D clusters if the adhesion between droplets is sufficiently strong. The buoyant droplets accumulate underneath a glass slide which acts as the top of a liquid cell, forming 3D aggregates. Droplets initially arrange to form crystals growing along the vertical direction. As a critical height is reached, the aggregate collapses and spreads horizontally on the glass slide, in an event analogous to avalanches in sand piles. We find that the geometry of such clusters is controlled by the balance between the adhesion strength and buoyancy.

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Session Classification: T1-1 Soft Matter AM-1 (DCMMP) | Matière molle AM-1 (DPMCM)

Track Classification: Symposia Day - Soft Matter Canada 2019