The Physics of Soft and Biological Matter

## Circularly confined quasi-hard-discs: the role of boundary adaptivity

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The behaviour of materials under spatial confinement is dramatically different from that in the bulk. The exact nature of behavioural modification in confined systems is strongly dependent on the boundary enclosing the system with soft walls inducing different phenomena than similar hard walls. In two dimensions, confinement within a hard circular boundary inhibits the hexagonal ordering observed in bulk systems at high density. Using colloidal experiments and Monte Carlo simulations, we investigate two model systems of quasi hard discs under circularly symmetric confinement.

The first system employs an adaptive circular boundary, defined experimentally using holographic optical tweezers [Fig. 1 (a)]. Deformation of this boundary enables mechanical pressure measurements to be made and allows hexagonal ordering in the confined system leading to the observation of a novel structural bistability between concentric particle layering and locally hexagonal configurations at high density [1]. Additionally, shearing the confined system drives this bistability resulting in the observation of a novel oscillatory state characterised by periodically self-similar structural organisation. Under varying conditions, both shear melted and rigid-body-like flow behaviour is observed.

The second system employs a circularly symmetric optical potential to confine particles without a physical boundary [Fig. 1 (b)]. We show that, in the absence of a curved wall, near perfect hexagonal ordering is possible. It is proposed that the degree to which hexagonal ordering is suppressed by a curved boundary is determined by the 'strictness' of that wall.

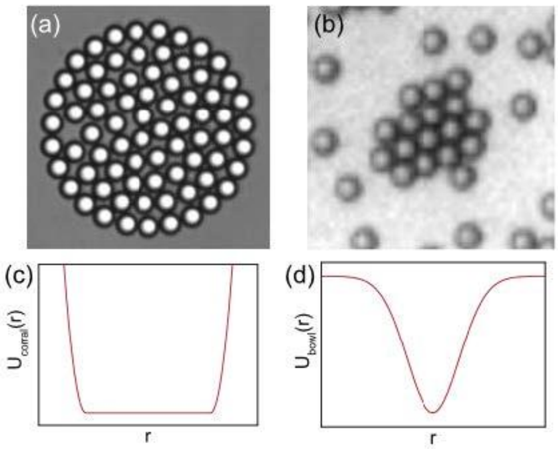


Fig. 1: (a,b) Micrographs illustrating experimental model systems. (c,d) Schematics of circularly symmetric potentials employed in experiments depicted in (a) and (b)

[1] I. Williams, E. C. Oğuz, P. Bartlett, H. Löwen, and C. P. Royall, Nature Commun. 4, 2555 (2013)