THE CHINESE UNIVERSITY OF HONG KONG

Department of Physics

SEMINAR

Confinement-Induced Columnar Crystals: A Route to New Architecture in the Scientific World

by

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Time: 2:00 - 3:00 p.m.
Place: Rm G25, Science Centre North Block, CUHK
Join ZOOM Meeting: https://cuhk.zoom.us/j/92915219731

ALL INTERESTED ARE WELCOME
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Abstract

Identical spheres in cylindrical confinement exhibit a complex variety of densest-packed columnar structures. Such densest-packed structures can serve as theoretical models for the structures of a variety of quasi-one-dimensional physical systems, such as nanotube-confined fullerenes, nanochannel-confined copolymers, colloidal crystal wires, capillary-tube-confined thermoresponsive microspheres, capillary-tube-confined microbubbles, and fluid-driven self-assemblies of polymer beads. On the other hand, there have been comparatively few studies of this kind for shape-anisotropic particles. Thanks to their rotational degrees of freedom, shape-anisotropic particles in cylindrical confinement exhibit densest-packed structures with non-trivial orientational order, and therefore they demonstrate a greater variety of densest-packed crystal structures than their spherical counterparts.

In this talk, I will present a historical overview of research on the densest-packed structures of identical hard spheres in cylindrical confinement [Phys. Rev. Lett. 106, 115704 (2011)], and then present our recent extensions of such research to shape-anisotropic particles [Phys. Rev. Lett. 124, 248002 (2020); Phys. Rev. Research 3, 013053 (2021)]. For packings of spheres, I will introduce a variety of columnar crystals as discovered computationally in the past two decades, and explain how a wide range of such structures can be obtained through a method of sequential deposition [Phys. Rev. E 84, 050302(R) (2011)]. I will also discuss how some ordered but non-densest crystal structures can be discovered through this specific method of sequential deposition. For packings of shape-anisotropic particles, I will present a variety of densest-packed columnar crystals as discovered recently for identical spheroids in cylindrical confinement and for identical ellipses within a parallel strip. For the case of spheroids, I will explain how the corresponding densest-packed structures arise from a competition between confinement-induced chiral ordering and shape-anisotropy-induced orientational ordering. For the case of ellipses, I will explain why the corresponding densest-packed structures are all affine transformations of particular densest-packed structures of circular disks. It is believed that the confinement-induced crystal structures presented in this talk could constitute a basis for the development of novel low-dimensional materials with tailored translational or orientational order.

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