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Engineering columnar crystals: A novel, template-based method of sequential deposition

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Identical hard spheres inside an infinitely long cylinder exhibit a rich variety of densest columnar phases, where many of them are helical. These phases exhibit spatial periodicity, and for this reason such periodic structures are referred to as columnar crystals. The densest structures of such confined systems, and also the corresponding packing fraction and chirality, are independent of length scales, and they depend solely on the dimensionless diameter-ratio D between the cylinder and the spheres. Like the face-centred cubic (fcc) and hexagonal close-packed (hcp) densest structures of hard spheres, such columnar crystals can also serve as models for structures of matter, where notable examples include the quasi-one-dimensional systems of nanotube-confined fullerenes and colloidal crystal wires. It is therefore believed that a detailed study of this problem of sphere packing would lead to new insights into structures of matter and new inspirations for the design and fabrication of low-dimensional materials. In this talk, I will give an introduction to such densest columnar structures of hard spheres as predicted by computer simulations [Mughal A., Chan H.-K. and Weaire D. (2011) Physical Review Letters 106: 115704] for a diameter ratio up to D = 2.7013, and will present a template-based method of sequential deposition [Chan H.-K. (2011) Physical Review E 84: 050302(R)] that can be used for the construction of such structures. As structures constructed via this method of sequential deposition depend sensitively on the configuration of the underlying template, some novel columnar structures that exhibit unexpected ordering, for example a hybrid structure [Chan H.-K. (2013) Philosophical Magazine 93, 4057] of the single and double helices, have also been discovered from this method, and they will be covered in this talk as well.

Biography

Ho-Kei Chan is an Associate Professo duate degree at the Hong Kong Polytechnic University, Chan moved to the University of Manchester for a PhD in physics. This was followed by post-doctoral research in the Hong Kong Baptist University, Trinity College Dublin, and then the University of Nottingham. Chan has published a variety of scientific articles in the fields of statistical, nonlinear, and soft matter physics, most notably his work on a template-based method of sequential deposition for generating a wide range of densest columnar packings of spheres.

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