Van der Waals interactions — their role in molecular recognition and self-assembly

By

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Abstract

Van der Waals (vdW) interactions emerge from the correlations of fluctuating dipoles in polarizable media. They are expected to be significant in the nano- to micron-scale world. In this Seminar we examine two examples of practical relevance in which vdW interactions can play an important role. We first look at the case of short double-stranded (ds) DNA molecules in salt solution. We show how vdW interactions can result in a stronger attraction between a pair of such molecules, if the chemical sequences of the two molecules are identical and more heterogeneous, and/or the two molecules are oriented in parallel. For our second example, we consider two dielectrically anisotropic plane-layered media made of the same material interacting across a dielectrically isotropic solvent, the optic axes of the layers being perpendicular to the plane of the layers. The optic axes of the oppositely facing anisotropic layers of the two interacting slabs generally have an angular mismatch, and within each multilayered slab the optic axes may either be the same or undergo constant angular increments across the anisotropic layers. We show that a vdW torque is induced in addition to a vdW force. For the case of weak, uniaxial anisotropy, we examine how the behaviours of the van der Waals torque and force can be “tuned” by adjusting the layer thicknesses, the relative angular increment within each slab, and the angular mismatch between the slabs.

Short Biography

Bing-Sui Lu obtained his BA in Physics and Certificate of Advanced Study in Mathematics from the University of Cambridge, UK, in 2004, and Ph.D. in Physics from the University of Illinois at Urbana-Champaign in 2012. Just prior to joining SPMS as a Research Fellow, he was working as a postdoctoral researcher at the Institut “Jozef Stefan” (Ljubljana, Slovenia) on theories of fluctuation-induced forces, of which the Casimir/van der Waals interactions are an important example. His research interests also include fluid and biological membranes, liquid crystals, polymers, elastomers and electrostatic interactions in biological systems.