Condensation, clustering and self-assembly of patchy colloids

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Recent advances in the chemical synthesis and fabrication of nanometer-to-micrometer sized particles have produced a wide variety of new designs. These new particles are poised to become the 'atoms' and 'molecules' of tomorrow's materials if they can be successfully assembled into useful structures. One challenge is to organize them into structures for functional materials and devices. A promising approach is self-assembly, which is the spontaneous organization of matter into ordered arrangements. To tailor the material behavior at the macroscopic level, through control of the interactions and of the self-assembly process requires a deep understanding of the modification to the phase diagram induced by the presence of patchy or specific interactions as well as effect induced by the anisotropy in shape and particle surface composition.

In the lecture, I will review some of the most recent attempts to engineer non-isotropic colloidal particles, moving beyond the case of hard-sphere colloids, short-range attractive colloids and symmetrically charged colloids. I will then discuss the effect of the anisotropy on the phase diagram of the system, highlighting the role of the particle valence. Finally, I will show how unconventional phase diagrams can arise in extreme cases of colloids interacting with a significant non-isotropic potential (Janus particles) and in the case of competing interactions.