From colloids to liquid crystals and back again

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Combining the world of partially order fluids with that of nanometer-sized particles has in recent years attracted wide reaching interest, not only from a fundamental physics point of view, but also in light of possible applications. The reasons are fourfold: (i) the tuning of liquid crystal properties, (ii) addition of functionality to liquid crystals, (iii) the formation of lyotropic liquid crystals from nanoparticles, and (iv) the templating of liquid crystalline order onto nanoparticle assemblies.

We will start our journey with a look at some systems which form liquid crystal phases from rod-like nanoparticles[1], such as inorganic liquid crystals, tobacco mosaic viruses and clays, before a closer look at two-dimensional systems such as graphene oxide will be taken, which forms a lyotropic nematic phase in the presence of solvents[2,3]. We discuss some of the properties of lyotropic graphene oxide liquid crystals, and then shift our attention towards the dispersion of graphene oxide in thermotropic nematics. Especially, evidence for a thermotropic to lyotropic phase transition will be presented[4], which may represent a first step towards developing a unified understanding of both classes of anisotropic fluids.

Some further recent results of nanoparticles in nematics[5] and frustrated Blue Phases will be summarized. The effect of Blue Phase stabilization by nanospheres, nanotubes and fullerenes will be discussed[6], also with respect to possible novel display applications, as well as the more academically related growth of B7 helical filaments in the presence of nanotubes.

The circle from colloids to liquid crystals and back, will be closed by a presentation of our recent results on liquid and liquid crystal-ferrofluid dispersions[7], systems of anisotropic colloidal particles, dispersed in an isotropic liquid which in turn is suspended in a liquid crystal. We show how these systems can be employed as a microscopic probe for viscosity measurements and demonstrate chaining and other effects.

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