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Editorial

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The central theme in this EJP-ST issue is **cooperative particle phenomena** involving simultaneous collective interactions among many objects leading to various order-disorder transitions and transformations. Such behavior can be found in different types of matter:

A. **Patchy colloids** have patterned surfaces that make new building blocks in a bottom-up approach for self-assembled bulk materials with predefined functionalities.
B. **Active matter** deals with self-moving units and their interactions and collective dynamics in both living or synthetic systems, like self-propelled colloidal particles, swimming bacteria, muscles, ant colonies and flocking birds.
C. **Nanofluids** are colloidal suspensions of nano-sized particles in a carrier fluid with a wide range of potential applications.

Patchy colloids have patterned surfaces that make new building blocks in a bottom-up approach for self-assembled bulk materials with predefined functionalities. Such materials relate to the next generation of materials and devices for molecular electronics, photonics, and drug delivery and sensing, which rely on the self-assembly of synthetic nanostructures with the precision of biological organization processes. But despite tremendous advances in the fabrication of a wide range of organic and inorganic nanoscale building blocks of various sizes and shapes, control over their assembly into ordered structures remains the main obstacle to the bottom-up fabrication of these novel materials and devices.

The term **active matter** describes diverse systems, spanning macroscopic (e.g. schools of fish and flocks of birds) to microscopic scales (e.g. migrating cells, motile bacteria and gels formed through the interaction of nanoscale molecular motors with cytoskeletal filaments within cells). Such systems are often idealizable in terms of collections of individual units, referred to as active particles or self-propelled particles. These take energy from an internal replenishable energy depot or the ambient medium and transduce it into useful work performed on the environment, in addition to dissipating a fraction of this energy into heat. The individual units may interact both directly as well as through disturbances propagated via the medium in which they are immersed. Active particles can exhibit remarkable collective behavior as a consequence of these interactions, including non-equilibrium phase transitions between novel dynamical phases, large fluctuations violating expectations from the central limit theorem and substantial robustness against the disordering effects of thermal fluctuations.

Nanofluids are colloidal suspensions of nano-sized particles in a carrier fluid with wide range of potential applications. As material systems are made smaller approaching the nano-scale, changes occur which may affect properties. The number of atoms close to surfaces increases relative to the numbers that are truly in the bulk. At the same time, thermodynamics is no longer controlled by the laws of large numbers, so dynamical fluctuations often cannot be viewed as Gaussian. Liquids flowing through narrow tubes ("microfluidics/nanofluidics") exhibit laminar flow and do not mix in the same way as fluids in macroscopic containers. In many complex fluids the relative importance of various forces depends on system size so that in biological cells, for example, dissipative forces dominate inertial forces. These and other distinctions between the properties of truly macroscopic systems and those whose spatial dimensions are constrained will be explored in this Special Topics issue. There is special emphasis on effects which occur in soft matter, where thermal and cohesive forces are of similar magnitude, in many areas of nanotechnology and advanced materials.

The papers in this Special Topics issue reflect well the diversity of work in this area. This issue on "Cooperative particles: Patchy colloids, active matter and nanofluids" stems from a recent "Geilo School" (GS), the twenty-third GS in a series held every two years since 1971 [1]. The objective of this GS was to bring together researchers with various interests and background including molecular biologists, theoretical physicists and soft condensed matter experimentalists to identify and discuss areas where synergism between modern physics and biology may be most fruitfully applied to the study of various aspects of structure and dynamics of cooperative particles.

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Reference

1. Geilo, Norway, 16–26 March, 2015, A comprehensive list of previous Geilo schools, a list of lecturers, poster sessions and participants at the last GS can be found at `www.ife.no/departments/physics/projects/geilo`