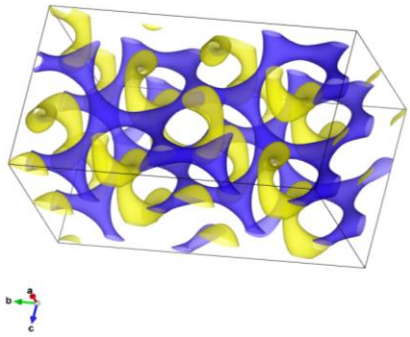
Soft matter physics

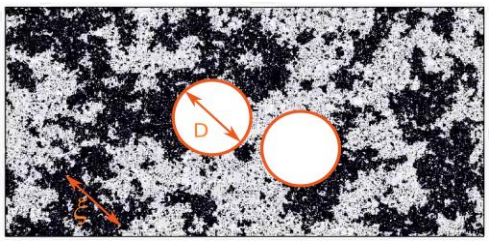
Complex fluids belong to the broad class of systems, known collectively as soft matter. They are solutions, typically water-based, of macromolecular entities (often called colloidal particles) with typical sizes ranging from 1 to 1000 nm: much larger than the atomic size but still small on a macroscopic scale. This class of systems permeates diverse fields of science, including physics, chemistry and biology, also playing a major role in the paint, food, cosmetic and pharmaceutical industry.
In physics, complex fluids are exploited both as magnified models of traditional atomic and molecular systems and as building blocks for genuinely novel materials. Nano-particle dispersions typically contain, in addition to the solvent, smaller components such as salt ions or free polymer chains and, possibly, other macromolecules. Due to the presence of these additional components (a phenomenon known as "macromolecular crowding") the colloidal particles often display physical properties quite different from those expected on the basis of their intrinsic structure: The external environment affects the behavior of the guest particles due to strong correlation effects. A physical understanding of the role of correlations in nano-particle suspensions is instrumental for a forthcoming exploitation of their peculiar properties. Our group, in collaboration with the experimental Soft Matter Laboratory of Polytechnic University of Milan, develops statistical models to describe the collective behaviour of these systems both at and out of equilibrium. Few illustrative examples, often leading to a surprising behavior are:

Pattern formation at the mesoscopic scale



D.Pini, A.Parola:
Pattern formation and self-assembly driven by competing interactions
Soft Matt. **13**, 9259 (2017)

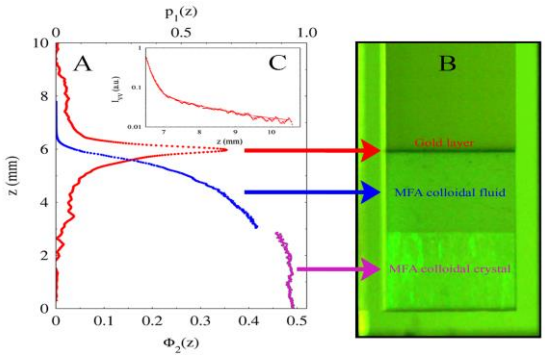
Fluctuation induced aggregation



S.Buzzaccaro, J.Colombo, A.Parola, R.Piazza
Critical depletion

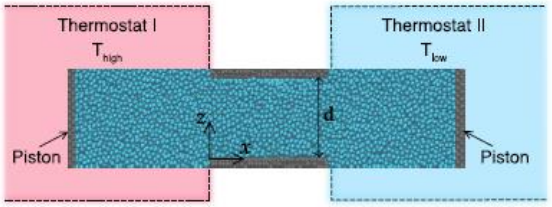
Phys. Rev. Lett. **105**, 198301 (2010)

Anomalous buoyancy



R.Piazza, S.Buzzaccaro, E.Secchi, A.Parola
What buoyancy really is.
A generalized Archimedes' principle for sedimentation and ultracentrifugation
Soft Matt. **8**, 7112 (2012)

Thermal Forces



R.Piazza, A.Parola
Thermophoresis in colloidal suspensions

J.Phys. Cond. Matt. **20**, 153102 (2008)

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