THEORETICAL STUDY OF COLLOID STABILIZATION IN POLYMER AND COPOLYMER SOLUTIONS

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Colloidal dispersions are indispensable for many technologically important applications. The main problem however is that colloidal particles tend to aggregate due to unavoidable van-der-Waals attractive forces. Usually stabilization is achieved by attaching or adsorbing polymers to the surfaces of colloidal particles (the so-called steric stabilization) [1]. Increasing concentration of unanchored (free) polymer in the semidilute regime may also enhance colloidal stability (this mechanism is often referred to as depletion stabilization). This effect is particularly important because of widespread presence of nonadsorbed polymers in colloidal systems including biological colloids such as liposomes, vesicles, and cells. The physical mechanisms of depletion stabilization are closely related to the recently discovered long-range end-induced [2] and fluctuation-induced [3, 4] repulsion forces. A theory of depletion stabilization developed along these lines [5] is open to further generalizations.

Experimental results suggest that copolymers and associating polymers can be very efficient for imparting colloid stability. The project is aimed at finding the optimal conditions for such polymer-induced colloidal stabilization. It should involve theoretical investigations of the polymer-mediated interaction between colloidal particles and its dependence on the solvent quality, concentration, polymer molecular weight and its polydispersity, macromolecular structure (homopolymer, copolymer, telechelic polymer, multi-sticker associating polymer) and architecture (linear, branched), interaction parameters (interactions of monomer units and associating groups with the colloid surface).

Required profile: A master degree in physics or equivalent from a EU university; a solid knowledge of the basic theoretical concepts in the statistical physics of macromolecules and an experience of theoretical research in this area.

[1] D. H. Napper, "Polymer Stabilization of Colloidal Dispersions", Academic, London, 1983.
[2] A.N.Semenov, J.Phys.II (Paris), 1996, v.6, No.12, pp.1759-1780.
[3] A N Semenov and S P Obukhov, 2005, v.17 (20) S1747-S1775.
[4] S. P. Obukhov and A. N. Semenov, 2005, v.95, art.no.038305.
[5] A. N. Semenov, Macromolecules 2008, 41, 2243-2249.