

Depletion interaction in colloidal systems: controlled attractions?

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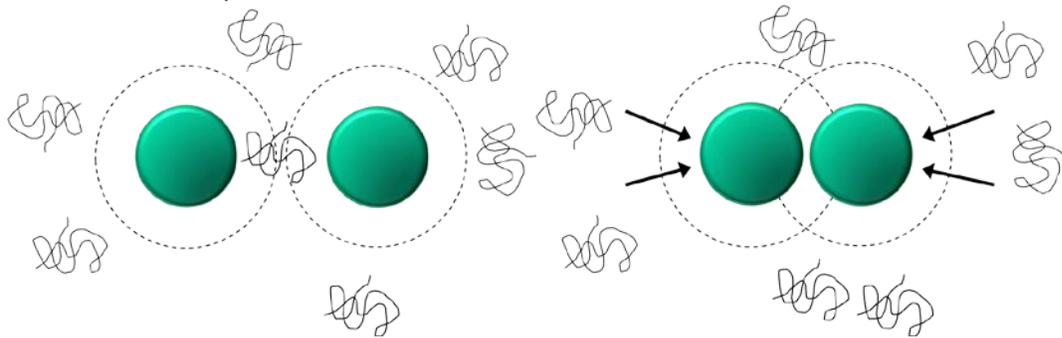
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Attempts to explain the physical properties of suspensions containing polymers and colloids go back to the beginning of the 20th century. In the last decades it has been observed that the stability of colloidal particles is strongly affected by non-adsorbing polymers in solution [1]. The origin of this interaction was first explained successfully about 60 years ago by S. Asakura and F. Oosawa using the concept that the free volume available to nonadsorbing polymers increases whenever two hard particles approach sufficiently close such that their depletion zones overlap and the total depletion zone decreases.



Since the 1990s the depletion-induced interaction has been declared by physicists as *the* tool to induce a controlled, tunable attraction between (spherical) particles. Here it is shown, however, that depletion effects should be treated with care and that it is not as controlled as often assumed. First, it is shown that the effective depletion interaction cannot be treated as pair-wise additive due to the multi-overlap of depletion zones [2]. As a result it violates the general law that the second virial coefficient at the critical point is -6 times the particle volume. Secondly, the standard assumption that the polymer segment is zero at the colloid surface may not always be true. It is shown that when the polymers are depleted but are weakly adhesive, a weaker depletion effect is operational [3]. Finally, the common assumption of hard core interactions often is an oversimplification. It is shown how additional direct attractions or double layer repulsion between the colloidal particles mediate the effective depletion interactions and phase behaviour.

References:

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- 4) A. González García, R. Tuinier, Tuning the phase diagram of colloid-polymer mixtures via Yukawa interactions. *Phys. Rev. E*, **94** (2016) 062607.