Long-range attraction among like-charged particles

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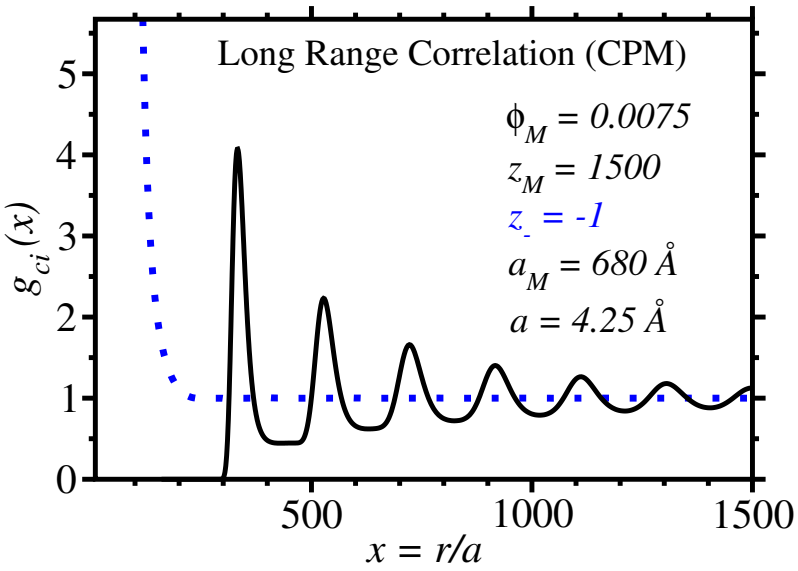
As early as in 1983 a coexistence of an ordered and disordered distribution of charged colloidal dispersions [1], as well as the formation of void structures [2] were reported. These phenomena imply that there are very long range repulsive and attractive potentials, of the order of thousands or even tens of thounsands of Angstroms. However, molecular interaction potentials are relativelly short range. Even for charged fluids, at low concentration, the particles correlation is at most a few hundreds of Angstroms. The existence of these long range correlation has been under discussion for some time [3]. In fact, the experimental results have been claimed not to be correct, argüing the reported attraction is due to confinement of the system [4], or not being in non-equilibrium conditions [5]. Here we present well-established statistical mechanics results of a model charged colloidal particles dispersion, at finite volume fraction, and show that, indeed, there is a long range colloidal correlation among like-charged particles: (a) without confinement, and (b) certainly for equilibrium conditions. We find good agreement of our theory with our MC and molecular dynamics studies, and existing experimental results.



Macroion−macroion (solid line) and macroion−counterion (dotted line) radial distribution functions for a macroions dispersion of diameter $a_M = 160a$, in the absence of salt, as a function of the distance of the central macroion, measured in little ions diameter size, a. ϕ_M is the colloidal volume fraction, Z_M and z_- are the macroion and counterion valences. Notice that $r = xa = 1500a \approx 6{,}400$ Å.

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[2] K. Ito, H. Yoshida, N. Ise, Void Structure in Colloidal Dispersions, Science **263**, 66 (1994).
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[4] J. C. Croker and D. G. Grier, Phys. Rev. Letts. 77, 1897 (1996).
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