Phase Separation in Charge-Stabilized Colloids: Influence of Nonlinear Screening

ALAN R. DENTON, North Dakota State University —
A range of experiments provide evidence that suspensions of like-charged colloids can separate into macroion-rich and -poor phases at low salt concentrations. An apparently related phenomenon is predicted by theories that map the mixture of macroions and microions (counterions and salt ions) onto an effective one-component system and include a one-body volume energy in the effective Hamiltonian. Theoretical studies of charged colloids commonly assume that electrostatic interactions between macroions are linearly screened by microions. However, as recently shown within the framework of response theory, nonlinear microion screening induces triplet attractions, weakens pair repulsions, and modifies the volume energy. Taking these nonlinear interactions as input to a thermodynamic perturbation theory, equilibrium phase diagrams for aqueous suspensions of highly charged colloids are computed. The main conclusion: nonlinear effects do not suppress, and can even promote, the predicted phase separation of deionized suspensions.

1Support from National Science Foundation grant DMR-0204020 is gratefully acknowledged.

Alan R. Denton
North Dakota State University

Date submitted: 29 Nov 2004