

Microstructure of Dense Colloid Suspensions and Gels

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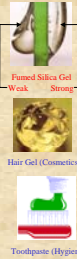
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Introduction

Colloid-Polymer mixtures are used in a number of industrial and scientific applications to achieve desired material properties. Understanding the effects of microscopic interactions provides tunable parameters to manipulate the macroscopic properties such as the flow behavior governed by the underlying phase transitions.

Suspensions can undergo both equilibrium and non-equilibrium phase transitions depending on the strength and range of these interactions. Strong short-ranged attractions often give rise to gelation whereas weaker longer ranged attractions result in equilibrium fluid-fluid or fluid-crystal transitions.

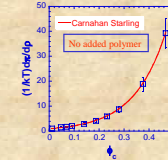
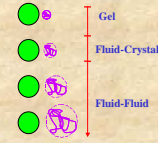
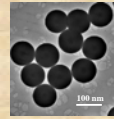
Here we present a comprehensive study of the microstructure of the gel phase of a well characterized colloidal suspension by Small Angle X-ray Scattering as the gel boundary is traversed. The location of the boundary is controlled by carefully tuning the strength and range of interparticle interactions by adding non-adsorbing polymer.



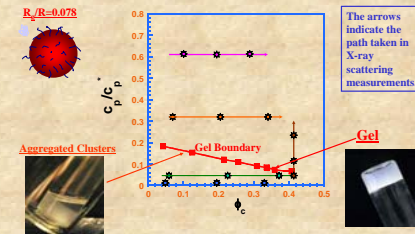
Experimental System

Colloid:
D = 100 ± 5 nm Sterically Stabilized Silica (Hard Spheres)

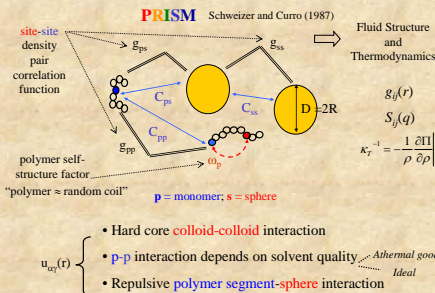
Polymer:
Polystyrene (near theta state) in decalin



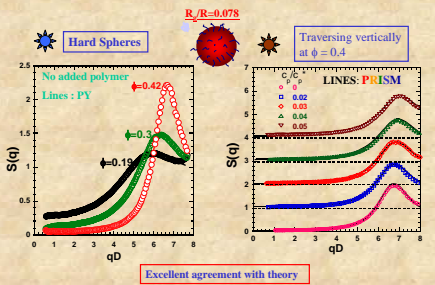
Phase Diagram



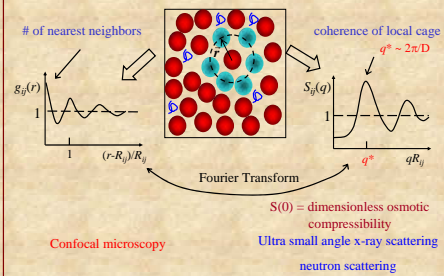
Liquid State Integral Equation Approach



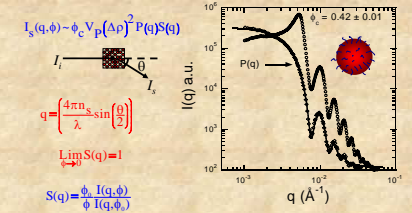
Comparisons of Equilibrium Structure with PRISM



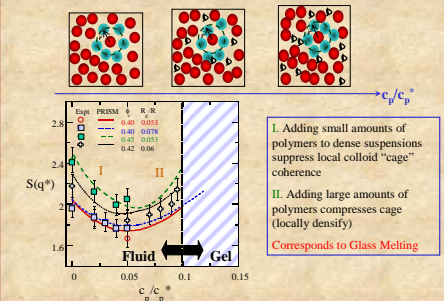
Fluid Structure



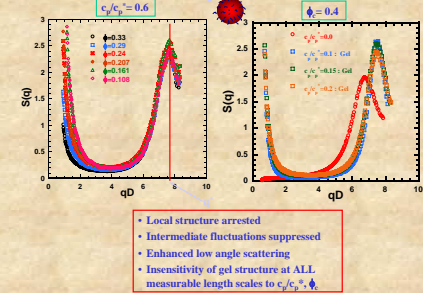
Scattering Theory



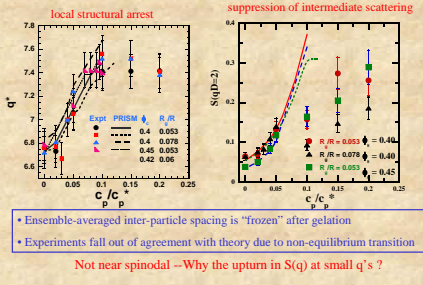
Alterations in Cage Structure with Addition of Polymer



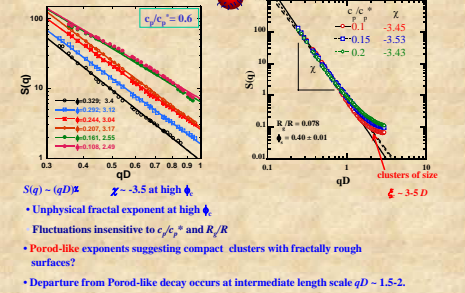
Microstructure of Gels



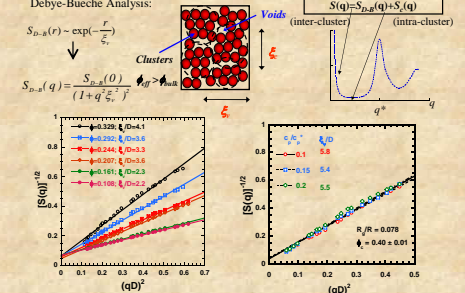
Signature of the Gel



Scattering At Small Angles



Clusters and Voids



Summary

Equilibrium

- Theory and experimental measurements of S(q) agree.
- Non monotonic variation of "cage" coherence with increasing polymer concentration.

Non-Equilibrium

- Scattering experiments suggest formation of heterogeneous regions as gel forms
- Ensemble-averaged structure is independent of strength and range of attraction after gelation.

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