



“Colloidal Gels: Non-equilibrium Solids with a Tendency to Collapse”

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Abstract

Colloidal dispersions assume a range of states of matter, i.e. the normal equilibrium phases (gases, liquids, and crystals) that are well understood as well as non-equilibrium phases (gels and glasses) that still hold some mysteries. For example, the simplest realization, hard spheres, form glasses at high concentrations but the nature of the transition is still debated. Colloidal gels form when very strong and short-range attractions frustrate thermal equilibration. These gels represent a non-equilibrium and non-ergodic state that has attracted considerable attention in the field over the past 5-10 years. Examples range from monodisperse polymer colloids through polymeric vesicles to inorganic colloids. While equilibrium phases and glasses persist indefinitely, colloidal gels are susceptible to dramatic collapse after some time. This delayed collapse seems to be controlled by thermally activated creep, which produces a time scale that increases roughly exponentially with the strength of attraction. The driving force must be a combination of the gravitational load and thermodynamic forces seeking a gas-liquid or gas-crystal phase separation. The collapses take several interesting forms ranging from a sudden homogenous disintegration of the gel to opening of fissures that are quickly widened by fluid flow. While a correlation of some collapse times has been constructed, no theory or model exists capable of anticipating the phenomena.

Bio

William B. Russel has been the Dean of Princeton University's Graduate School since 2002. Dr. Russel received his B.A. and M.Ch.E. degrees from Rice University and a Ph.D. from Stanford University. He held a NATO Postdoctoral Fellowship in the Department of Applied Mathematics and Theoretical Physics at Cambridge University. He is a member of the National Academy of Engineering and the American Academy of Arts and Sciences, and serves on the Board of Directors of the Association of American Universities (AAU), Association of Graduate Schools. He also served as Chair of the Council of Graduate Schools. Dr. Russel is the author of *The Dynamics of Colloidal Systems* and co-author of *Colloidal Dispersion*. He earned the American Chemical Association's "2007 Award in Colloid and Surface Chemistry."