

Role of fluctuations in formulating organizing principles in meso-scale systems

Opportunity

Understanding the mean behavior of meso objects, and their fluctuations in behavior
Many mesoscale materials are metastable.
Metastability arises from kinetic arrest
Self assembly/organization of large systems

Statistical issues in meso-scale science

Meso Challenge

Systems of high complexity, composed of a large number of atoms (100 nm object $>10^7$ atoms).
They have many degrees of freedom with a rugged energy landscape.
Their evolution over time, (spanning time scales) .
Why are they metastable.
What determines the evolution between the possible structural motifs.

Approach

Develop exp. & theo tools for complex systems and microstates or fluctuations
Tools to study populations of meso systems and their evolution over time
Time resolved structural/chemical probes
Time dependent studies of fluctuation
Coarse graining approaches
Accurate descriptions of dynamics in coarse grains models
Statistical studies of molecular populations

Impact

Fundamental understanding will lead to rational design of new materials with tailored functionality
Understanding fluctuations will enable improved materials with lower degradation and longer lifetimes.

