

## Dr. James Swan

Assistant Professor, Dept. of Chemical Engineering  
**Massachusetts Institute of Technology**



Dr. James W. Swan is an assistant professor in the Department of Chemical Engineering at MIT. He focuses on how microstructured, in particular nano-particle, materials can be manipulated for the benefit of society. His research on soft matter is broad and has included accurate measurement of biophysical forces and the self-assembly nano-particles in microgravity. Dr. Swan aims to combine theory and simulation to model the fluid mechanics and out-of-equilibrium statistical physics that are fundamental to complex fluids and other soft matter.

James Swan received a BS in Chemical Engineering in 2004 from the University of Arizona where he worked with Drs. James Baygents and Raymond Goldstein on issues related to spatio-temporal pattern formation in diffusing and reacting systems. He earned a Masters degree in 2007 and a Ph. D. in 2010 in Chemical Engineering from the California Institute of Technology. His thesis work, under the supervision of Dr. John Brady, focused on low Reynolds number fluid mechanics and the role of macroscopic boundaries in hindering the dynamics of suspended micro-scale objects. This work led to important conclusions about the flow of complex fluids in confinement. Following this, he worked in the laboratory of Dr. Eric Furst at the Department of Chemical and Biomolecular Engineering at the University of Delaware directing experimental investigations of nano-particle self-assembly performed on the International Space Station by astronauts Sunita Williams, Kevin Ford and Chris Hadfield.

## “The Hydrodynamics of Colloidal Gelation”

Colloidal gels are formed during arrested phase separation. Sub-micron, mutually attractive particles aggregate to form a system spanning network with high interfacial area, far from equilibrium. Models for microstructural evolution during colloidal gelation have often struggled to match experimental results with long standing questions regarding the role of hydrodynamic interactions. In the present work, we demonstrate simulations of gelation with and without hydrodynamic interactions between the suspended particles. The disparities between these simulations are striking and mirror the experimental-theoretical mismatch in the literature. The hydrodynamic simulations agree with experimental observations, however. We explore a simple model of the competing transport processes in gelation that anticipates these disparities, and conclude that hydrodynamic forces are essential. Near the gel boundary, there exists a competition between compaction of individual aggregates which suppresses gelation and coagulation of aggregates which enhances it. The time scale for compaction is mildly slowed by hydrodynamic interactions, while the time scale for coagulation is greatly accelerated. This enhancement to coagulation leads to a shift in the gel boundary to lower strengths of attraction and lower particle concentrations when compared to models that neglect hydrodynamic interactions. Away from the gel boundary, differences in nearest neighbor distribution persist. This result necessitates a fundamental rethinking of how both microscopic and macroscopic models for gelation kinetics in colloids are developed.

**DATE:**

**June 2, 2015**

**TIME:**

**10:00 am**

**LOCATION:**

**366 CLB**