Schedule for the 12th Mid-Atlantic Soft Matter workshop, January 17, 2014

The University of Pennsylvania, Department of Physics and Astronomy and MRSEC.

8:15 am
Registration and Breakfast (LSRM)

8:35 am
Opening Remarks

8:40 am
Paulo Arratia (UPenn):
Yielding, Plasticity, and Microstructure in a 2D Jammed Material

9:20 am
Remi Dreyfus (Rhodia):
Fluid Flow & Transport in Granular Media for Soil-Water Retention

10:00 am
Sound-bite Session I

10:50 am
Coffee Break

11:05 am
Michael Falk (Hopkins):
Cavitation in amorphous solids

11:45 am
Sound-bite Session II

12:15 pm
Lunch

1:20 pm
Alison Sweeney (UPenn):
Graded refractive index materials from patchy colloids: Inspiration from squid lens

2:00 pm
Sound-bite Session III

2:50 pm
Break

3:10 pm
Sound-bite Session IV

4:00 pm
Break

4:20 pm
Wolfgang Losert (UMDCP):
Dynamics of Living Systems: From Actin Waves to Cell Migration

5:00 pm
Peter Olmsted (Georgetown):
What is the current understanding of entangled polymers in strong flows?

5:40 pm
End of Workshop

Paulo Arratia, University of Pennsylvania

Yielding, Plasticity, and Microstructure in a 2D Jammed Material under Shear Deformation

In this talk, I will discuss an experimental investigation on the yielding and plastic deformation of disordered solids. Experiments are performed on colloidal particles that are adsorbed at an oil-water interface and form a dense disordered monolayer. The rheological properties (G', G") of this dense monolayer are obtained in a custom-built interfacial stress rheometer that uses a magnetic needle within the material. This configuration allows for the simultaneous characterization of both microstructure (tracking $\sim$ 105 particles) and bulk rheology. Results show that for oscillatory shear below a certain strain amplitude, the microstructure becomes reversible after a transient. Above this strain amplitude, the microstructure continues to evolve through many irreversible events. We argue that this boundary between a reversible and irreversible steady state is a yielding transition, and that our experiments measure a meaningful yield stress. Further, we find that reversible plastic deformation is possible. That is, the material can reorganize itself so that the link between plasticity and irreversibility is broken: the material flows slightly, and yet at the end of each deformation cycle, it is exactly unchanged.

Remi Dreyfus, Rhodia

Fluid Flow & Transport in Granular Media for Soil-Water Retention

In the context of water retention, we investigate fluid flow in porous media and how physico-chemical parameters affect fluid transport. In order to develop a better understanding of the various fluxes (e.g. evaporation, drainage) in soil and the coupling between these fluxes and the surrounding biological environment, we elaborate studies that permit to reduce water loss and improve the absorption of water by the roots.

We will especially focus on the phenomena of evaporation out of a soil with and without roots growing. We will show that evaporation from porous media exhibits an abrupt transition from capillary-supported regime 1 to diffusion controlled regime 2. Varying the wettability or packing of the model soil permits to control the extent of the hydraulic continuity responsible for fast evaporate rates during regime 1 due to networks linking bulk and the surface.

Finally, we will focus on experimental investigations on evaporation when roots grow in the model soil and how root growth can be driven in order to optimize water uptake.

Michael Falk, Johns Hopkins University

Cavitation in amorphous solids

Molecular dynamics simulations of cavitation in a Zr50Cu50 metallic glass exhibit a waiting time dependent cavitation rate. On short time scales nucleation rates and critical cavity sizes are commensurate with a classical theory of nucleation that accounts for both the plastic dissipation during cavitation and the cavity size dependence of the surface energy. All but one parameter, the Tolman length, can be extracted directly from independent calculations or estimated from physical principles. Direct comparisons are made between the theoretically predicted strain dependent cavitation activation energies and critical radii and those observed in simulation. On longer time scales aging in the form of shear relaxations due to shear transformation zone activity results in a decrease of cavitation rate. The high cavitation rates that arise due to the suppression of the surface energy in small cavities provide a possible explanation for the quasi-brittle fracture observed in metallic glasses. We hypothesize that other disordered systems with cohesive forces may undergo similar nucleation and relaxation processes under hydrostatic tensile loads.

Alison Sweeney, University of Pennsylvania

Graded refractive index materials from patchy colloids: Inspiration from squid lens

"Patchy colloids" are systems in which constituent particles exhibit rich phase and assembly behavior due to the anisotropic distribution of discrete attractive and repulsive "patches" on the particle surface. These systems show great promise in both theory and experiment for generating sophisticated new, self-assembled material properties, but the particles used in current experimental systems are typically micron-scale or larger, limiting the range of material properties that can be explored. Proteins are an intuitive choice for patchy, complex particles several orders of magnitude smaller than currently tractable experimental systems. However, naturally evolved proteins are typically strongly selected to avoid the kind of semi-disordered assembly or aggregation like that observed in patchy colloidal systems, to avoid poisoning the cells which make them. This talk will explore experimental and modeling evidence for patchy-colloid-like behavior in the living optical systems found in cephalopods – proteins evolved for optical function may escape some of the constraints on assembly experienced by more typical enzyme or structural proteins. Our evidence suggests that the optical properties of both the graded-index lenses in the eyes, and the sophisticated reflectors in the skin evolved for camouflage may arise from proteins following patchy-colloid-like assembly rules. The assembly principles observed in cephalopods may suggest extrapolation to possible rules for engineering patchy proteins for self-assembly more generally.

Wolfgang Losert, University of Maryland

Dynamics of Living Systems: From Actin Waves to Cell Migration

Living systems are very dynamic. From the directed motion of individual immune cells chasing an invader to the intricate collective motion of cells in a developing embryo cellular motion is critical to life. The control of cell dynamics is of significant practical importance in tackling complex diseases such as cancer, where cell migration is central to cancer metastasis. But for systems of such complexity, how can the dynamics even be characterized, much less steered? While genomics has given us unprecedented quantitative insight into the inner workings of the cell, genetic and proteomic properties are highly variable from cell to cell and from patient to patient. On the other hand, the physical characteristics of cells have proven to be more universal indicators of health and disease. Such characteristics include shape and stiffness, which have both been used for diagnosis for more than a century. With this in mind, we have developed novel approaches that quantitatively characterize the dynamics of shapes of migrating cells, ultimately connecting shape dynamics with the cellular biochemistry. Specifically we have discovered that rapidly migrating cells move via persistent shape waves. These mechanical waves of polymerizing actin are part of the dynamic, biochemically controlled cellular scaffolding. We found that cells utilize such mechanical waves to sense and follow surface nanotopography. The wave-like character of the sensing allows us to use our physics toolbox to thoroughly characterize these motions, as well as develop novel strategies to guide the migration of cells.

Peter Olmsted, Georgetown University

What is the current understanding of entangled polymers in strong flows?

Entangled polymers have been thoroughly studied since the 1940s at least....or so we thought. In the last decade particle velocimetry and other imaging methods, combined with rheology, have shown that some dramatic instabilities can occur in strongly sheared well-entangled polymer melts. I will discuss how some of these new observations (such as various shear banding phenomena and 'fracture') can be understood in terms of the 'Standard Model' for entangled polymers, and highlight some of the current controversies in the area.

Soundbite Talks: *MASM 12*

Session I

1. Marcus T Cicerone (NIST)
   Heterogeneous Dynamics of Liquids - Roles of Energy and Structure Fluctuations
2. Woo-Sik Jang (University of Pennsylvania)
   Fabrication of Giant Polymersome using Microfluidic Device
3. Martin Iwanicki (Saint Joseph's University)
   Dynamical Heterogeneity in Dense Colloidal Suspensions with Short-Range Attraction
4. Charles Thomas (University of Pennsylvania)
   Velocity fluctuations in hopper flow near the clogging transition
5. Anthony Chieco (University of Pennsylvania)
   Testing for Hyperuniformity in Two Dimensional Foam
6. Ye Xu (University of Pennsylvania)
   Rheology of Soft Colloids across the Onset of Rigidity
7. Jennifer Rieser (University of Pennsylvania)
   Structure and deformation in compressed disordered packings
8. Tevis Jacobs (University of Pennsylvannia)
   Visualizing deformation in disordered systems
9. Rana Ashkar (NIST/UMD)
   Segmental polymer dynamics in PMMA/SWNT composites
10. Pasha Tabatabai (Georgetown University)
    Silk Electrogel Rheology
11. Michael J. A. Hore (NIST)
    Small-angle Neutron Scattering from Polymer-grafted Nanoparticles
12. Stephanie Majkut (University of Pennsylvania)
    Mechanics optimizes striation and contraction of cardiomyocytes in tissue and in culture during early development
13. Xinran Zhang (Georgetown University)
    Microstructural Origin of High Field-Effect Mobility in Weakly Diffracting Polymer Semiconductors
14. Teresa Duncan (Georgetown University)
    Rheological properties of poly(vinyl acetate)-borax networks with glycol ethers
15. Jerome Irianto (School of Engineering and Applied Science, University of Pennsylvania)
    Nuclear Damage in Constrained Migration

16. Matthew Gratale (University of Pennsylvania)
Transitions of a hard-sphere colloidal crystal to a colloidal crystals with attractive interactions

Session II

1. Matthew Lohr (University of Pennsylvania)
Vibrational Modes and Structure in Disordered Attractive Colloidal Packings
2. Tim Still (University of Pennsylvania, LRSM)
Phonons in Soft Colloidal Glasses with Frictional Interactions
3. Nathan Keim (University of Pennsylvania)
Microscopic and mechanical properties of reversible plastic deformation
4. Joel Lefever (University of Pennsylvania)
Searching for soft spots in amorphous nanoparticle packings using atomic force microscopy
5. David A. Gagnon (University of Pennsylvania)
Undulatory swimming in fluids with polymer networks
6. John Royer (NIST)
Dynamics of Cubic Colloids
7. Doug Godfrin (University of Delaware)
What a cluster! Their formation and effect on viscosity
8. Jie Chen (NIST Center for Neutron Research)
From depletion attraction to bridge attraction: the effect of solvent molecules to the effective colloidal interaction
9. Lilian Lam Josephson (University of Delaware)
Microviscosity of therapeutic protein solutions using particle tracking microrheology
10. Paul Salipante (NIST)
Interfacial kinetics of colloids at solid interfaces

Session III

1. James T McGinley (University of Pennsylvania)
Assembling Colloidal Clusters using Crystalline Templates and Reprogrammable DNA Interactions
2. Jonathan Bauer (University of Delaware)
Self-assembly in toggled magnetic fields
3. Teresa Brugarolas (University of Pennsylvania)
Ultrastrong bubbles for lightweight materials

4. Jillian Emerson (University of Delaware)
   Phase separation in poly(3-hexylthiophene)/polystyrene thin films
5. Liana Vaccari (University of Pennsylvania)
   Mechanical Evolution of Biofilms at Oil-Water Interfaces
6. Matt Harrington (University of Maryland)
   Local rotational dynamics in sheared 3D granular materials
7. Ningwei Li (University of Pennsylvania)
   Colloidal particle diffusion on confined lipid bilayers
8. Yun-Ru Huang (University of Pennsylvania)
   Multifunctional All-TiO2 Bragg Stacks Based on Blocking Layer-Assisted Spin Coating
9. Yifan Wang (University of Pennsylvania)
   Preparation of Novel Crystal Structures from Dimpled Oil Droplets through Depletion Interaction
10. Justin Stimatze (Georgetown University)
    Simulating fiber motion in shear flow using Dissipative Particle Dynamics
11. Katie Weigandt (NIST)
    Extensional Flow Cell for SANS Experiments
12. Douglas Jerolmack (UPenn)
    Controls on tracer trapping and dispersion in fluid-driven sediment transport.
13. Carlos Ortiz (University of Pennsylvania)
    Observing Granular Dynamics Driven By Fluid Couette Flow – I
14. Morgane Houssais (University of Pennsylvannia)
    Observing Granular Dynamics Driven By Fluid Couette Flow – II

Session IV

1. Abhishek Ravva (University of Pennsylvania)
   Fundamental investigation of spray assisted layer-by-layer assembly of polyelectrolyte multilayers.
2. Pramukta Kumar (Georgetown University)
   Inferring Structural Properties of SU8 Microrod Aggregates.
3. Christopher Bertrand (NIST Center for Neutron Research)
   Direct measurements of critical adsorption on a highly curved surface
4. Michelle Calabrese (University of Delaware)
   Effect of micellar topology (branching) on rheology and SANS

5. Kathryn Whitaker (University of Delaware)
   Direct measurement of interparticle forces in a depletion gel
6. Rohini Gupta (University of Pennsylvania)
   Wetting of cryogenic fluids: van der Waals interactions and film thickness
7. Alison Koser (University of Pennsylvania)
   Measuring material relaxation and creep recovery in a microfluidic device
8. Richard Remsing (University of Pennsylvania)
   The Role of Density Fluctuations in Hydrophobic Hydration and Assembly
9. Klebert Feitosa (Dept. of Physics and Astronomy - JMU)
   Plastic and Elastic Deformations of Foam Bubbles Under Oscillatory Compression
10. Debra Audus (NIST)
    Protein Aggregation and Viscosity
11. Polimyr Caesar Dave Dingal (University of Pennsylvania)
    'Scar on a dish': a model for mesenchymal cell mechanopathology
12. Francesco Elio Angile' (University of Pennsylvania)
    Microfluidic Microbubbles for Antivascular Ultrasound Theranostics
13. Ryan Murphy (University of Delaware)
    Chain exchange in highly amphiphilic block copolymer micelles
14. Steve Hudson (NIST)
    Microcapillary viscometry
15. Iris Liu (University of Pennsylvania)
    Behavior of anisotropic particles at an air/nematic interface

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