Experimental Soft-Matter Research at UMass

Candela
Dinsmore
Menon

Individual research projects, highly connected with collaborators.
Fundamental Science ↔ Applications
Candela-group research: Granular/soft matter

Granular and other soft matter: Probe experimentally using NMR/MRI

In NMR/MRI, the sample is placed in a strong magnetic field, and then radio-frequency and field gradient pulses are used to probe the motion of hydrogen nuclei.

To date and in progress:
- Vibrofluidized granular bed
- Gas-fluidized granular bed
- Granular flow through vertical channel

Planned and future:
- Foams
- Emulsions?
- Gels?
- Bio matter?

In granular fluids, heat can flow from cold to hot.
Candela-group research: in quantum fluids and solids

(Helium at extremely low T and high magnetic field)

(to be described in a separate presentation)
Dinsmore Group - Soft Condensed Matter Physics

Statistical mechanics of colloids, vesicles, emulsions, suspended nanoparticles, …

Freezing/melting of crystals
(Liquan Pei, Derek Wood)
Surfactant/polymers

Self-assembly of novel materials:
- Electronics,
- Photonics,
- Photovoltaics (solar cells)
(Yipeng Yang, Ryan Horton, Austin Barnes)

Curvature & forces in membranes & liquid interfaces
(Chuan Zeng, Jaime Hutchison, Nesrin Senbil)

Supported by NSF, DOE, Xerox, Petroleum Research Fund.

Stress & structure in granular materials
(Isaac Vega)
Packing Spheres for Crystallization and New Materials

- Nucleation by passing through metastable states (“Ostwald’s Rule of Stages”)
- Metastable states have a huge influence on nucleation rate.
  (protein crystallization, materials science)
- Changing the interactions…

Assembling Semiconducting, polymer Nanoparticles:
(w/ Profs. Venkataraman, Barnes)
- Goal: controlled packing of organic semiconducting particles for photovoltaics.
- A novel structure raises fundamental questions.

5 μm
I. Fluid-Fluid Interfaces with surface tension (e.g., oil-water)

- *Curved* interfaces: what are the capillary forces?  
  *(w/ Benny Davidovitch)*

- Materials applications…

- New projects:
  1. Particle-based “dispersants” for oil-spill recovery.
  2. Electrostatics at liquid interfaces.

II. Lipid Bilayer Membranes with bending modulus & tension:  

  *(w/ Bob Weis, Adrian Parsegian)*

- *Curved* membranes: what are the elastic forces on proteins?

- How does tension affect protein organization & function?

*Blood & Voth, PNAS (‘06)*

“BAR” protein

membrane
Menon group: Experiments on nonequilibrium systems

• We work on classical, disordered, out-of-equilibrium systems
• Experimental systems: *granular media, thin sheets, molecular glasses*
• Typically 3-5 grad students, 1-2 undergrads
Projects

• Ongoing
  Pattern formation in thin sheets King, Toga
  Geometry and mechanics of the crumpled state Cambou
  Structure and response of disordered packings Farrell

• Possible future projects
  Fibre Mechanics
  Dense granular flows
  Self-propelled matter
  Particle rafts

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Experimental Soft-Matter Research:

• Relatively new areas, many open questions
• Wide range of techniques and systems
• Intellectual motivations are physics questions, but systems & experimental methods technologically important
• Projects are single-person experiments, but connected to other work in group
• Learn from colleagues around us

Recent Graduates (Ph.D. students)

• Kan Du – Postdoc at NIST
• Kevin Facto – Training for financial industry
• Klebert Feitosa – Faculty at James Madison U.
• Chao Huan – Postdoc at Georgia Tech.
• Jiangshui Huang – Postdoc Harvard U.
• Vijay Narayan – Postdoc Cambridge U. (a visiting student)
• Xiaotao Peng – R&D at AFOP Fiber Optics
• John Savage – Research Scientist at Liquidia Technologies
• Hongqiang Wang – Blumberg Analysis Group
• KZ Win – Postdoc at Texas Tech
• Chuan Zeng – Postdoc at Mass. Gen’l Hospital
• Jing Zhou – Research Scientist at Xerox, Inc.