Soft/granular matter

This field studies large systems of interacting entities

- sand
- grain
- bubbles
- cells
- living beings
- ...

Oil droplets in water + glycerol
E.R. Weeks, 2007

Pachinko balls
Otaku Lounge, 2016

Pilgrims on Hajj
NY Times, 2015
“Jammed” means that entities have undergone a phase transition to a disordered, yet rigid, state which can withstand pressure and shear forces without yielding.

Siemens and van Hecke, 2010
Relevant physics: Mechanics and (non-equilibrium) Statistical Mechanics

The jammed state is one of stable mechanical equilibrium

-Tang and Behringer, 2011
Jamming is theoretically interesting and has real-world importance

1/density

(a) Jamming phase diagram b) soft robotic gripper, Gouad, 2012
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*The physics of cancer cells, work of M.L. Manning reported in Quanta Mag. 2016*
Our research goal: tailoring jammed structure and dynamics via array of obstacles or "pins"

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Simulations of jamming in the presence of "pins"

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cooling down soft discs and asking how pin density and geometry affect

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- Network of contact forces
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- Elastic constants
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- Point J
- Network of contact forces
- Orientational order
- Elastic constants
- **positional order**
New platform and simulation environment:
• Supercomputers: NSF XSEDE
• LAMMPS (Sandia Labs)
New simulations:

- Molecular Dynamics (MD)
  Grains evolve in time under Newton's laws.

- Study structure of stress fields and dynamics of "soft spots" where rearrangements are likely to occur.

- **future**: Machine learning
- **future**: Active matter

Karimi and Maloney, 2015

Manning and Liu, 2010
New collaboration:

• Funded by NSF DMR-1905474 (2019-2022)

• Work with Swat Prof. Cacey Bester (experiment) and her students

• Work with Bucknell Profs. Brian Utter (experiment) and Katharina Vollmayr-Lee (computation)
Research with Amy Graves
Summer 2020

Do you want to put research with me on your preference form? 😊

For Summer 2020 I ask that students have:

• Taken at least one CS course
• Taken Phys. 7 and Phys. 13

I might give preference to students who are able to do a few hours per week (paid!) of preparation in Spring, 2020.

Ditto for students who are able to continue their research (again, a few hours a week is enough) in Fall, 2020.
I am on leave this year ...

If you want to work with me, you don't have to come see me individually. Just put me on your preference form. 🎉

If you however are interested in talking to me individually, you are welcome to email me for an appointment!