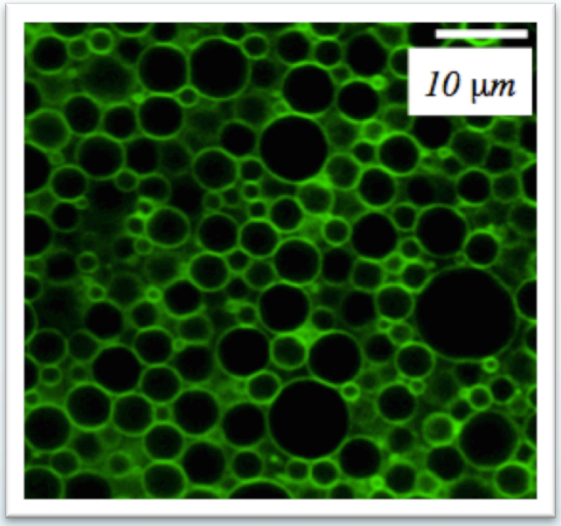
Research with Amy Graves
Summer 2020

Soft/granular matter

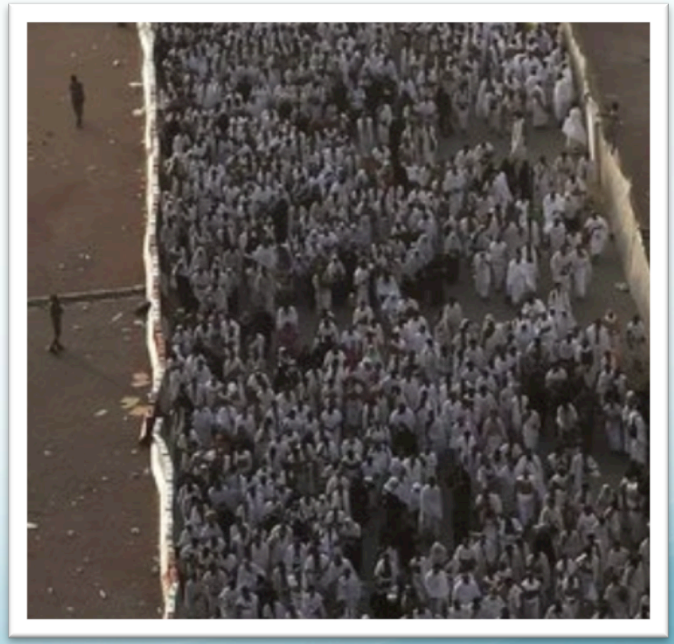
This field studies large systems of interacting entities

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

Pachinko balls
Otaku Lounge, 2016



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



Pilgrims on Hajj
NY Times, 2015

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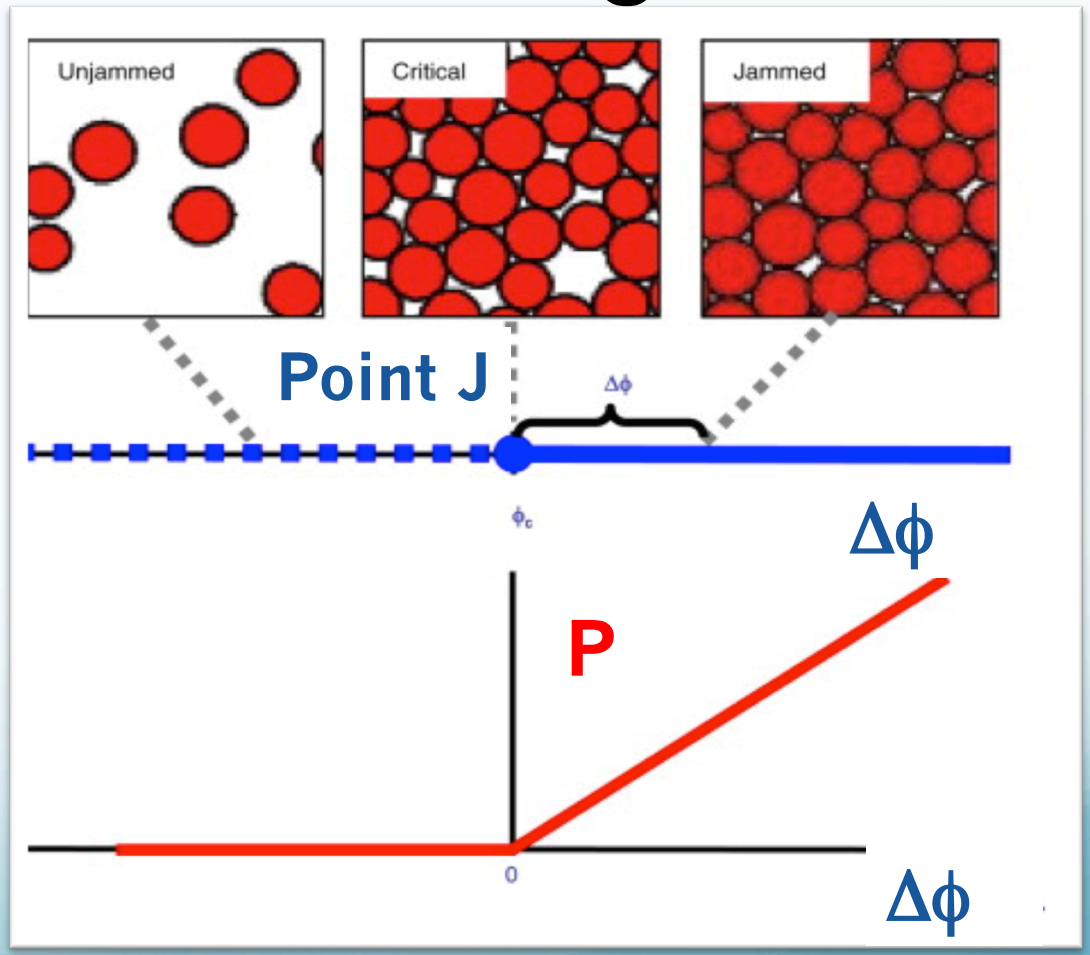
Soft/granular matter: **Jamming**

"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

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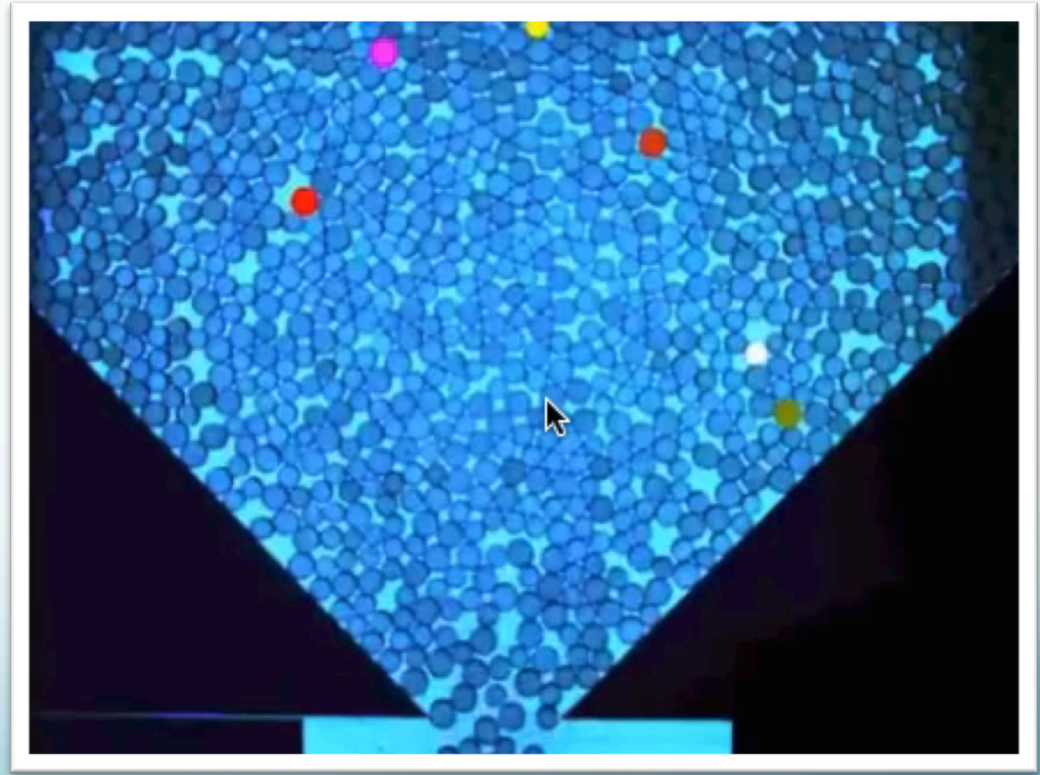
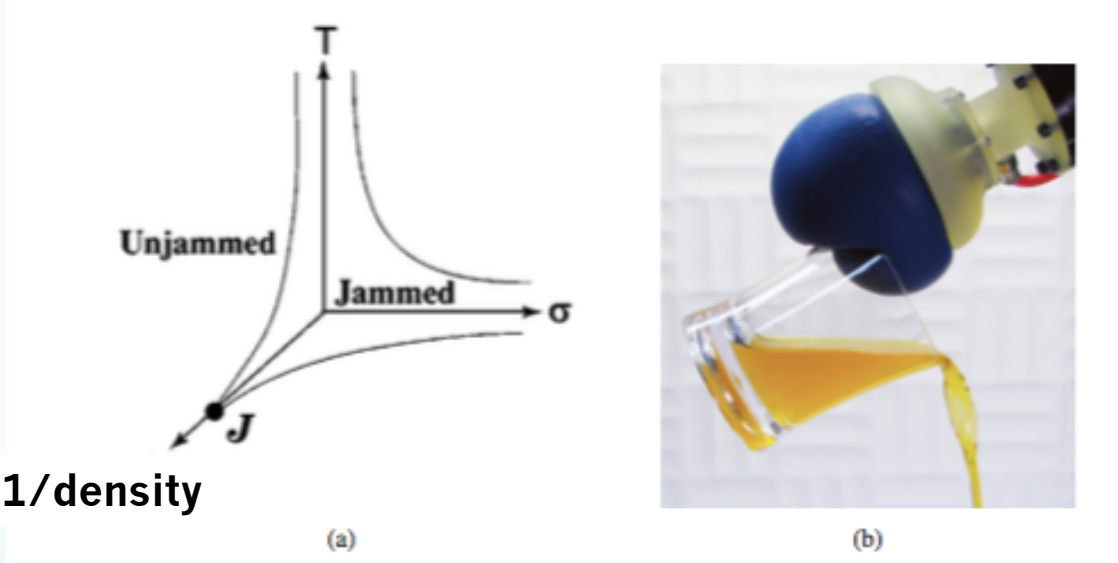
Relevant physics: Mechanics and (non-equilibrium) **Statistical Mechanics**

The jammed state is one of stable mechanical equilibrium



-Tang and Behringer, 2011

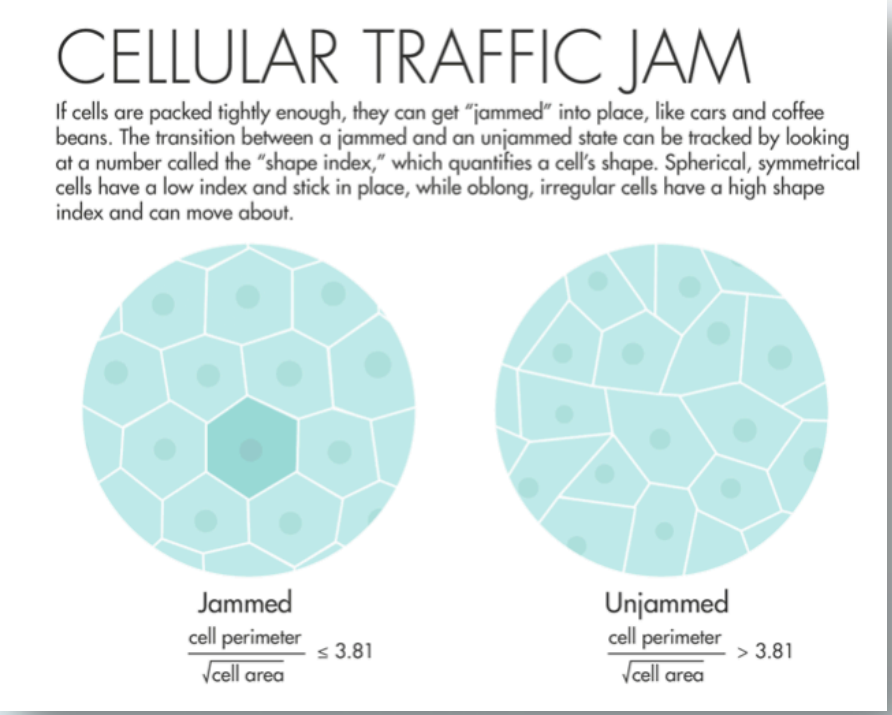
Jamming is theoretically interesting and has real-world importance



a) Jamming phase diagram b) soft robotic gripper, Gouad, 2012

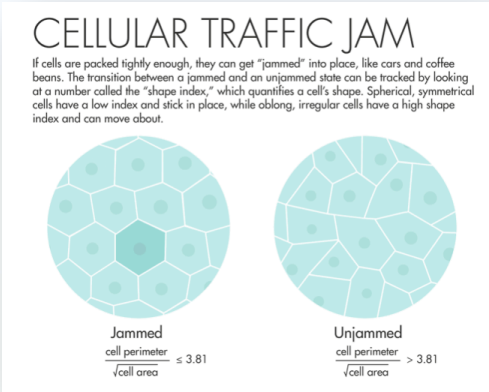
Jamming is theoretically interesting and has real-world importance

The physics of cancer cells, work of M.L. Manning reported in Quanta Mag. 2016

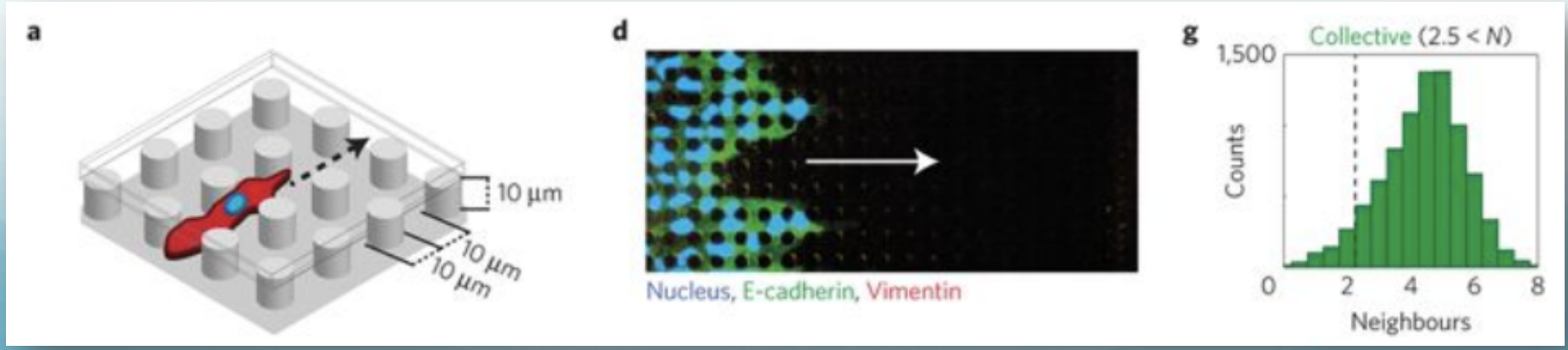


Our research goal: tailoring jammed structure and dynamics via array of obstacles or "pins"

The physics of cancer cells, work of M.L. Manning reported in Quanta Mag. 2016

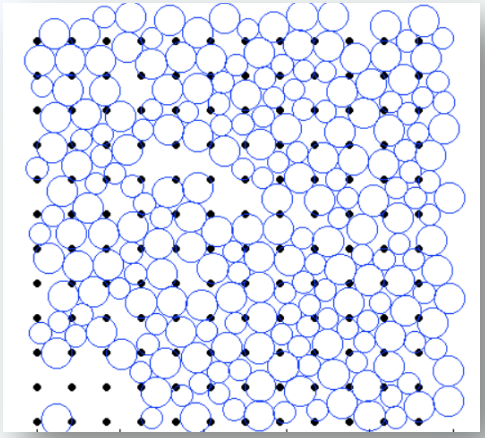


Wang et al, Nature Materials, 2014



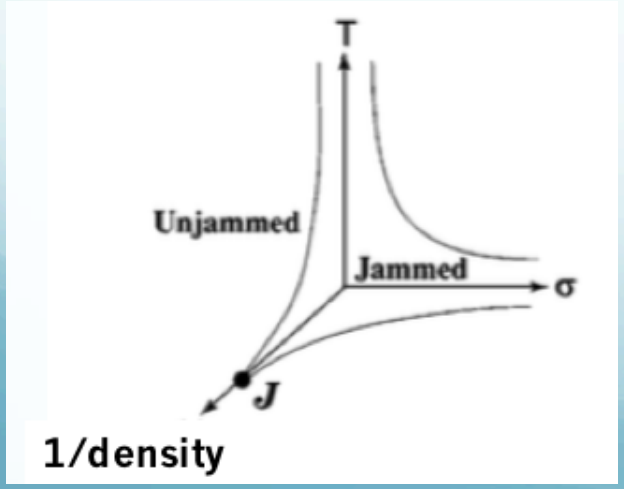
Prior results from Graves Lab

Simulations of jamming in the presence of "pins"

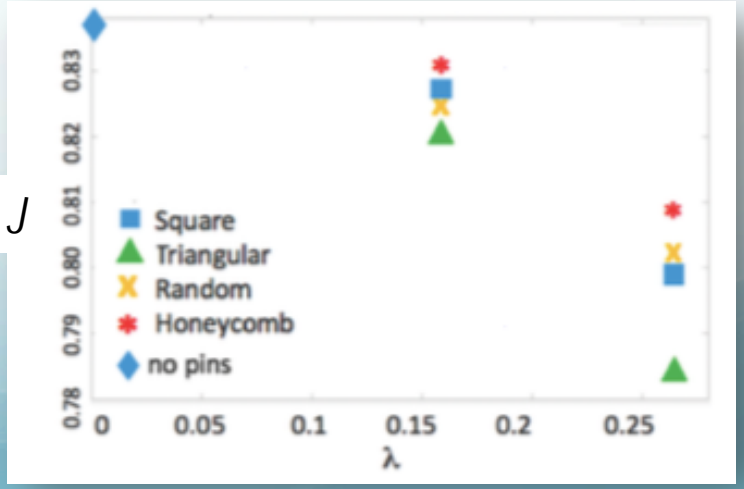


We have many theory-rich and real-world applicable results from our **simulations**: cooling down soft discs and asking how pin density and geometry affect

- **Point J**



Point *J*



Prior results from Graves Lab

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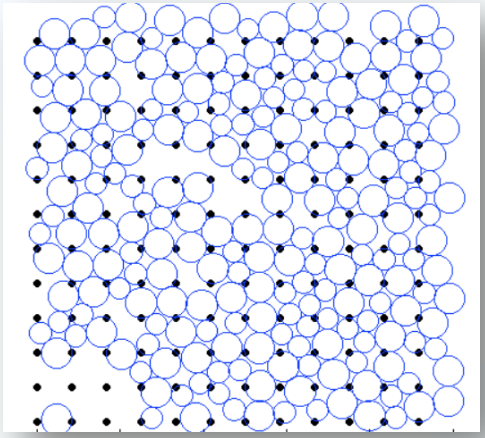

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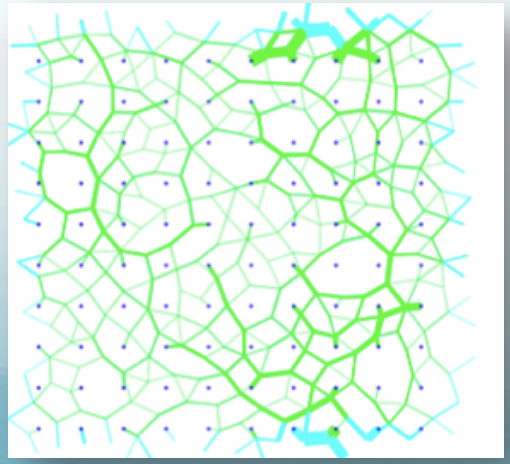
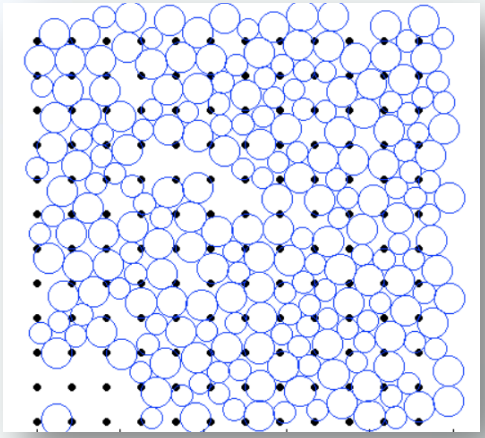
- Point J •**Network of contact forces**



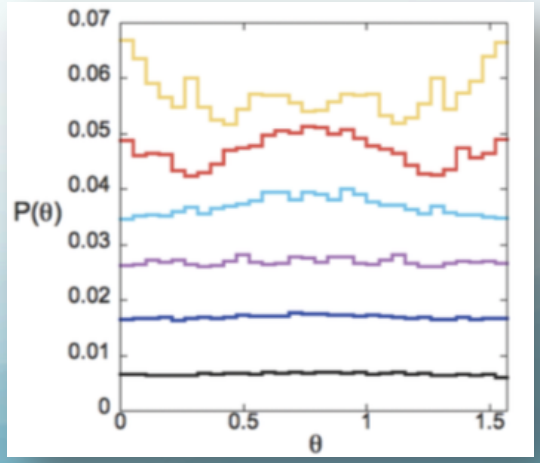
Prior results from Graves Lab

Simulations of jamming in the presence of "pins"



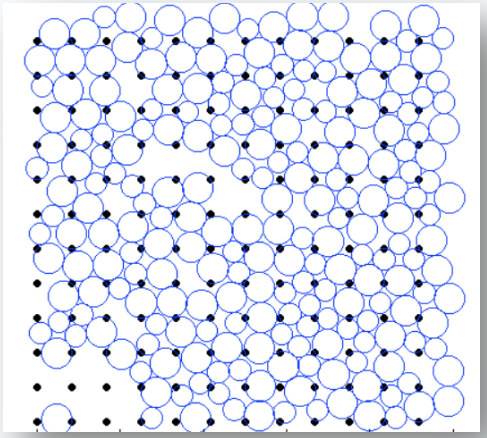
We have many theory-rich and real-world applicable results from our **simulations**: cooling down soft discs and asking how pin density and geometry affect

• Point J •Network of contact forces • **Orientational order**



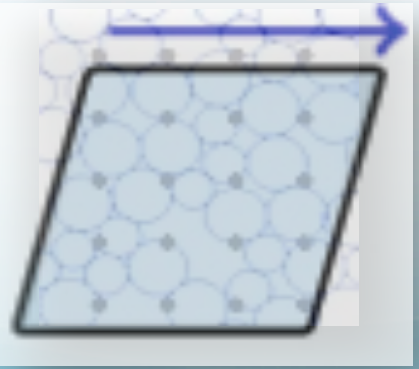
Prior results from Graves Lab

Simulations of jamming in the presence of "pins"



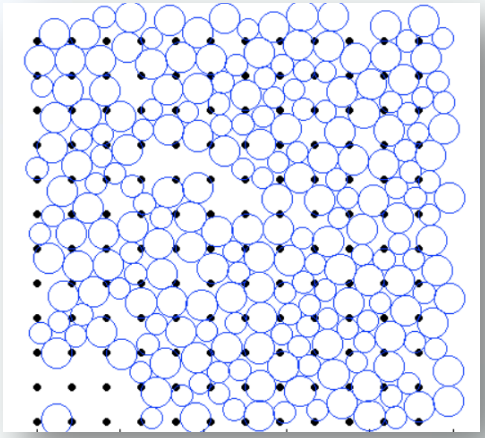
We have many theory-rich and real-world applicable results from our **simulations**: cooling down soft discs and asking how pin density and geometry affect

• Point J •Network of contact forces • Orientational order
•**Elastic constants**



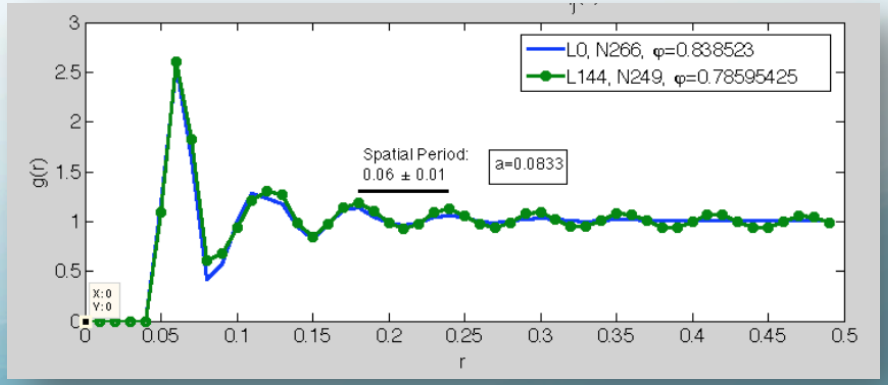
Prior results from Graves Lab

Simulations of jamming in the presence of "pins"



We have many theory-rich and real-world applicable results from our **simulations**: cooling down soft discs and asking how pin density and geometry affect

• Point J •Network of contact forces • Orientational order
•Elastic constants • **positional order**



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New platform and simulation environment:

- Supercomputers: NSF XSEDE

Swat's XSEDE "campus champion" Andy Ruether

- LAMMPS (Sandia Labs)

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Summer 2020

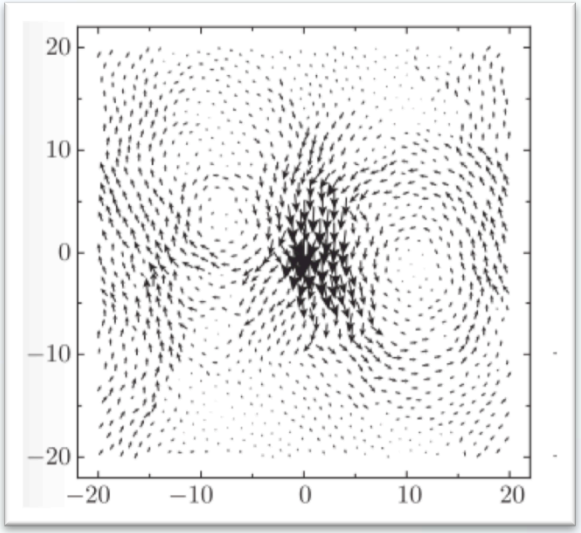
New simulations:

- Molecular Dynamics (MD)

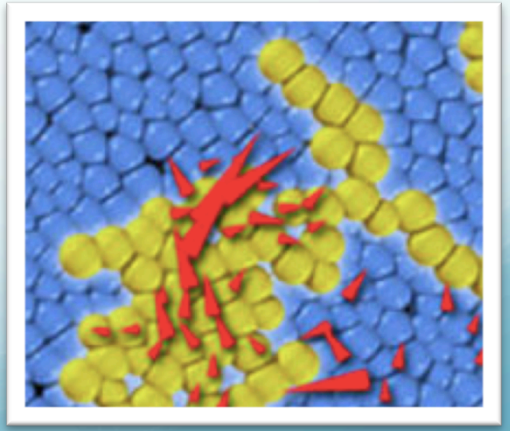
Grains evolve in time under Newton's laws.

- 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

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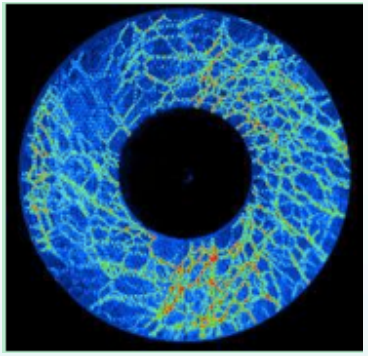
New collaboration:

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

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



Couette cell will show displacements and network of stresses for grains in presence of pins

- Work with Bucknell Profs. Brian Utter (experiment) and Katharina Vollmayr-Lee (computation)

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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.

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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!