Jamming of Ice Mélange: Using Particle Rafts to Model Ice Mélange
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Introduction
Ice mélange represents a fascinating granular system, as it is a collection of interacting particles on the surface of water that is partially confined between two walls and being driven by a moving glacier into an open reservoir. This represents a fundamentally new system in which to study the jamming of granular matter. Jamming refers to a condition in granular matter in which a critical force is required to generate flow. Under conditions of constant driving, a signature of jamming is sudden increases in the force required to maintain the constant driving velocity, followed by sudden releases in the force. Traditional studies of jamming focus on closed geometries or ones with spatial constrictions.

Two questions
1) Are there new jamming behaviors in the open channel flow of floating, granular particles? ANSWER: YES.
2) If there are, are they relevant to the dynamics of ice mélange in fjord? ANSWER: subject of future work.

Experimental Details
We use plastic walls with sandpaper to model the fjord walls. Plastic particles of various shapes are used to model the ice mélange. A pair of plastic bars separated by spring are used to model the glacier driving the flow and measure forces in the system.

Acknowledgments
We acknowledge NSF-DMR-007212, Research Corporation, and Institute for Complex Adaptive matter for funding.

Images of the different Particle systems

Performance measurements illustrating jamming events

Force Results
The main experimental signature of jamming is the observation of sudden increases in the applied force. The existence of jamming is dependent on the shape of the particle at the wall of the channel. We find that when rectangular shaped particles form the boundary layer with the wall, then jamming is observed. If disks form the boundary layer, there is slip at the wall and no jamming occurs. If we place a single layer of rectangular particles at the wall, then buckling of the particles is observed, but no increase in force is measured.

Conclusion
We observe a new class of jamming: boundary driven jamming. The jamming requires two steps:
1) Buckling of particles at the wall.
2) The buckling induces density variations in the interior of the system that produces the measured increase in force.

Future Work
1) Measure particle dynamics
2) Quantify density variations
3) Develop relevant scaling
4) Connect experiments with glacier data