הטכניון מכון טכנולוגי לישראל
TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Thursday, December 01, 2022 at 13:30, D. Dan and Betty Kahn Building, Auditorium 1.
Online: http://technion.zoom.us/OfekPeretz

Fluids & Elastic Multi-Stability

Ofek Peretz

Adviser: Prof. Amir D. Gat

The focus of my doctoral studies was understanding the fundamental physics that governs the interaction between fluids and multi-stable elastic structures and using this interaction for various applications. My presentation will cover three topics within this context, based on three publications emanating from my doctoral work.

In the first part, we address the challenge of underactuated pattern generation in continuous multistable structures. The examined configuration is a slender membrane that can concurrently sustain two different equilibria states, separated by transition regions, and is actuated by a viscous fluid. We first demonstrate the formation and motion of a single transition region and then sequencing of several such moving transition regions to achieve arbitrary patterns by controlling the inlet pressure. Finally, we show that nonuniform membrane properties, along with transient dynamics of the fluid enable to directly snap through any segment of the membrane. Resulting in a multi-degree-of-freedom system that could be shaped to any desired pattern using only one actuator, thereby significantly simplifying the control of soft robots.

In the second part, I aimed to utilize the same fundamental physics (elastic multistability and viscous flow) to demonstrate and characterize new kinds of artificial fluids, named *metafluid*. Such fluids are composed of a suspension of a multitude of multistable capsules containing compressible gas. In this study, a theoretical model for the suspension's internal energy and pressure-density relations is obtained. The elastic multistability of the capsules is shown to endow the fluid with multistable thermodynamic properties, including the ability of capturing and storing energy at standard atmospheric conditions, not found in naturally available fluids.

In the third part, the *metafluid* transient dynamics are examined for a configuration of calorically-perfect compressible gas contained within multistable elastic capsules flowing in a fluid-filled tube. We study both analytically and experimentally the velocity-, pressure- and temperature-fields of multistable compressible metafluids, focusing on transitions between different equilibria. We initially examine the dynamics of a single capsule, which may move or change equilibrium state, due to fluidic forces. We then study the interaction and motion of multiple capsules in a 1D lattice configuration. We show that such a system can be used to harvest energy from external temperature variations in either time or space. Thus, fluidic multistability allows specific quanta of energy to be captured and stored indefinitely as well as transported via tubes at standard atmospheric conditions without the need for thermal isolation.

Seminars Coordinator: Assoc. Prof. Matthew Suss.