

LMS internal discussion

Multi-physical coupling in mechanics

Moderator: Laurent Guin

Speakers: Kostas Danas, Laurent Guin, Vignesh Kannan

Date and Time: September 25, 2025 (2 – 3 pm)

Venue: Amphi 104 (Pole Meca)

Abstract

In this internal seminar on multi-physical coupling in mechanics, Kostas Danas, Laurent Guin and Vignesh Kannan will cover different current topics such as magneto-mechanical couplings in magnetorheological elastomers (MREs), chemo-mechanical couplings in batteries and electro-mechanical couplings in ferroelectrics and magnetic shape-memory alloys.

Magnetorheological elastomers are composite materials that comprise ferromagnetic nano- and micro-particles embedded in a soft polymeric matrix. This gives rise to a coupled magneto-mechanical response at the macroscopic (order of millimeters and larger) scale when they are subjected to magneto-mechanical external stimuli. They find potential application in controlled pattern formation, soft sensor-actuators, haptic sensing devices.

From the lead-acid batteries of the early 1920s to today's lithium-ion batteries, the specific energy of rechargeable batteries has increased by a factor of seven, a game-changer for the electrification of numerous technologies. Fortuitously, mechanics happens to play an important role in some of the current battery research directions. We will cover two examples: the coupling between lithium diffusion and stress in silicon used as an electrode material and the problem of lithium dendrite growth associated with electrolyte fracture in solid-state batteries.

Exploring materials at short time scales and large stresses pose exciting new questions related to multi-physical coupling in mechanics. Under such conditions, engineering applications range from vibration damping to shock absorption and pulsed-power generation. We will discuss two problems: (1) the interplay between polarization switching and viscoelastic behavior of ferroelectric crystals, (2) open questions on the thermo-(magneto)-mechanical coupling in shape memory alloys at large loading rates.

Format

Each speaker will have 10 minutes for a presentation, followed by 5 minutes for questions. The last 10 - 15 minutes will be allocated for the lab to engage in a larger discussion about exciting new open questions in the field.