MECHANICAL ENGINEERING SEMINAR

Monday, November 30 2026 at 14:30, D. Dan & Betty Kahn Building, Auditorium 1

Predicting Crack Paths through the Geometry of Elastic Charges

Oran Szachter, Ph.D.
Postdoctoral Researcher, Racah Institute
The Hebrew University of Jerusalem
Email: oran.szachter@mail.huji.ac.il

Hosted by: Prof. Gal Shmuel

Predicting crack trajectories is a central challenge in fracture mechanics. Crack propagation is non-local and history-dependent: each increment of growth changes the body's boundary, so the elastic problem must be solved anew as the crack advances. We address this challenge using elastic charges, a geometric description of stress sources in solids.

In many solids, stresses may arise from geometric incompatibility: a material's intrinsic geometry cannot be realized in Euclidean space without strain. In incompatible elasticity, this incompatibility is represented by elastic charges, which act as sources of stress and admit a multipole expansion, analogous to electric charges in electrostatics.

We show that a crack can be represented as a distribution of elastic charges. Its leading interaction with a background stress field is captured by effective monopole and dipole charges at the crack tip. Crack growth then reduces to the motion of point-like charges in a pre-existing stress field, much like a charged particle moving in an external field. This allows us to predict the entire crack path without recalculating the stress field.

We test the theory in quasi-static fracture experiments on residually stressed elastomeric sheets prepared by flattening sheets containing a dislocation, showing quantitative agreement with the theoretical predictions. More broadly, the elastic-charge formulation offers an analytical framework for fracture in residually stressed and geometrically frustrated materials.

[1] **SO**, Siéfert, E., Adda-Bedia, M., Sharon, E. and Moshe, M., 2025. Curved crack paths are predicted by elastic-charges. *Communications Materials*, *6*(1), p.229.

Seminars Coordinator: Prof. Sefi Givli



Dr. Oran Szachter is a postdoctoral researcher at the Hebrew University of Jerusalem, where he completed his PhD in physics in 2026. He also holds a BSc in Physics and Linguistics and an MSc in Physics from the Hebrew University. His doctoral work focused on geometric approaches to fracture mechanics. His current work, in collaboration with Prof. Yinon Ashkenazy and Prof. Michael Moshe, combines theory and simulations to study the mechanics and geometry of disordered solids. He is currently extending these tools to the mechanics of living systems. He was awarded a Milner Foundation doctoral scholarship and the Rakavy Prize for research in computational physics.