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Ernst Melan-Lectures

In October 2016, the Institute for Mechanics of Materials and Structures (IMWS), the Department of Civil and Environmental Engineering, and the Center for Geometry and Computational Design at Vienna University of Technology have established a new Distinguished Lecture Series in the Engineering Sciences, named Ernst Melan-Lectures.

Ernst Melan (* 1890, in Brünn/Brno, † 1963, in Vienna) was a pioneer of engineering mechanics in the 1st half of the 20th century. As professor of elasticity theory, structural mechanics, and building construction at TU Wien from 1925 to 1962, he has sustainably shaped the culture of teaching and research at this university, where he has also held the positions of department head („Dekan“) and president („Rektor“). Among his numerous contributions to the engineering sciences, his shake-down theorem, as of 1936, and his general treatise of elastoplasticity, as of 1938, both anticipating many ideas which were hardly discussed before the 1950s, are true landmarks in the history of theoretical and applied mechanics.

We are pleased to announce that the Fifth Ernst Melan Lecture at TU Wien

will be given

by

Professor Huajian GAO
Tsinghua University, Beijing, China

Prof. Gao will talk about

Towards Proactive Design of Fracture Resistance in Mechanical Metamaterials

on

September 5th, 2025; 2:00 p.m.
Technische Universität Wien, Karlsplatz 13, 1040 Vienna
Sem AA03-1 (1st Staircase, 3rd Floor)

Towards Proactive Design of Fracture Resistance in Mechanical Metamaterials

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Abstract

Fracture is a classical topic in solid mechanics, while mechanical metamaterials represent an emerging field enabling innovative applications. The intersection of these areas presents both significant challenges and unique opportunities. In this study, we demonstrate that the fracture toughness of lattice metamaterials is profoundly influenced by their topology, with shell-based lattice metamaterials exhibiting superior fracture resistance compared to their truss-based counterparts. We reveal a topology-induced intrinsic toughening mechanism in shell-based lattices and identify a distinct fracture dissipation mechanism, termed structural plasticity. Additionally, we show that fracture behaviors in mechanical metamaterials can be proactively controlled. By harnessing elastic instability, we regulate the plastic zone size in pseudoplastic metamaterials, thereby amplifying structural plasticity. Through a combination of experimental and computational approaches, we realize distinct fracture behaviors, including the intrinsic-to-extrinsic transition in fracture toughness. This work demonstrates a framework for transitioning from passive understanding to proactive control of fracture behavior through mechanical metamaterials, deepening the understanding of the interplay between fracture and mechanical metamaterials and opening avenues for advanced material design.

Short Bio

Huajian Gao, PhD (Harvard, 1988), is a Xinghua Distinguished University Professor (兴华卓越讲席教授) at Tsinghua University and Walter H. Annenberg Professor Emeritus at Brown University. His research focuses on the understanding of basic principles that control mechanical properties and behaviors of materials in both engineering and biological systems. His honors include the Rodney Hill Medal, Timoshenko Medal, and ASME Medal—the three highest international awards in his field—and elections to the Chinese Academy of Sciences, U.S. National Academy of Sciences, U.S. National Academy of Engineering, American Academy of Arts and Sciences, U.K. Royal Society, German National Academy of Sciences Leopoldina, and Academia Europaea.