DANISH CENTER FOR APPLIED MATHEMATICS AND MECHANICS

The 2018 DCAMM Annual Seminar Speaker

Ken Kamrin

Professor
Massachusetts Institute of Technology (MIT)
Cambridge, USA

gives the following lecture at

Aarhus University
Auditorium 00.117, Dept. of Engineering,
Inge Lehmanns Gade 10, Aarhus

Continuum modeling of flowing grains

Thursday, December 13, 14:00

There will be an open discussion after the lecture.
At 15:00 refreshments are served

This lecture aims at popularizing mechanical science to a broad audience of interested students and staff as well as engineers working in industry

The Danish Centre for Applied Mathematics and Mechanics, DCAMM, is a framework for internationally oriented scientific collaboration between staff members at a number of departments at the Technical University of Denmark, Aalborg University, Aarhus University and University of Southern Denmark. The "DCAMM Annual Seminar Speaker" is an initiative created to disseminate mechanics to a broader audience. *For further information on DCAMM, see www.dcamm.dk*

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Abstract

Granular materials are common in everyday life but are historically difficult to model. This has direct ramifications owing to the prominent role granular media play in multiple industries and terrain dynamics. One can attempt to track every grain with discrete particle methods, but realistic systems are often too large for this approach and a continuum model is desired. However, granular media display unusual behaviors that complicate the continuum treatment: they can behave like solid, flow like liquid, or separate into a "gas", and the rheology of the flowing state displays remarkable subtleties that have been historically difficult to model. To address these challenges, in this talk we develop a family of continuum models and solvers, permitting quantitative modeling capabilities for a variety of applications, ranging from general problems to specific techniques for problems of intrusion, impact, driving, and locomotion in grains.

To calculate flows in general cases, a rather significant nonlocal effect is evident, which is well-described with our recent nonlocal model accounting for grain cooperativity within the flow rule. On the other hand, to model only intrusion forces on submerged objects, we will show, and explain why, many of the experimentally observed results can be captured from a much simpler tension-free frictional plasticity model. This approach gives way to some surprisingly simple general tools, including the granular Resistive Force Theory, and a broad set of scaling laws inherent to the problem of granular locomotion. These scalings are validated experimentally and in discrete particle simulations suggesting a new down-scaled paradigm for granular locomotive design, on earth and beyond, to be used much like scaling laws in fluid mechanics.

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