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Serija predavanja za istraživače pripravnike i doktorante iz oblasti Kinetike, Elastodinamike, Analitičke mehanike, Primene tenzorskog računa u mehanici, Teorije oscilacija i Nelinearne dinamike

42-vi blok predavanja
(od 14h do 16 h)

Odabrana poglavlja mehanike
Topics in multiscale modeling

Predavač

Prof. dr Sinisa Dj. Mesarovic,
Associate Professor School of Mechanical & Materials Engineering
Washington State University.

Sreda, 16 maj 2012 u 14 časova

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Predavanja se održavaju svake srede od 11 do 17 časova u Biblioteci (ili u velikoj sala na prvom spratu) Matematičkog instiuta SANU, ul. Knez Muhalova 36, treći sprat
Prijava potencijalnog slušaoca se dostavlja Upravniku Odeljenja za mehaniku na adrsu khedrih@eunet.rs *sa naznakom oblasti interesovanja.*

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Topics in multiscale modeling

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Two fundamental problems of multiscale modeling are:

- the theoretical problem: Mathematically consistent definition of the coarse-scale model, on the basis of the fine-scale model, and,
- the computational problem: Boundary/Interface conditions between domains.

In this lecture, three examples are considered: two addressing the theoretical problem, and one addressing the computational problem.

1. *From particles to continuum*

Numerical simulations are used to uncover the micromechanism of dilatancy and critical state.

Dense granular materials exhibit a peculiar behaviour – *dilatancy* – volume increase when sheared under constant pressure. . The *critical state* is the boundary between dilating and compacting states when material shears at constant volume. The key to this distinct granular behaviour is the presence of *intrinsic stress*, the existence of which has been postulated earlier, but its physical nature has remained conjectural. Graph theory representation of particles assemblies, provides the micromechanical definition of the intrinsic stress. Numerical simulations are used to uncover the micromechanism of dilatancy and critical state.

Persistent shear bands in granular materials occur at later stages of deformation. Typically, widths of shear bands are about 10-20 particle diameters. What determines this length? Numerical simulations, specifically designed for this problem, indicate that the transmission of rotations depends on direction. Specifically, it depends on the strength of the force chain branch in that direction. The maximum propagation distance is comparable to observed widths of shear bands.

2. *Dislocations to continuum crystal plasticity*

Plasticity in heterogeneous materials with small domains (e.g., polycrystals) is governed by the interactions/reactions of dislocations at interfaces. These include reactions of existing dislocations, as well as the nucleation of dislocations at an interface. The rational for interface dominated plasticity is simple: dislocations glide through the single crystal domain with relative ease, but pile up at interfaces, so that interface reactions become a critical step in continuing plastic deformation.

Recently developed size-dependent crystal plasticity theory employs the representation of the singular part of dislocation pile-up boundary layers as superdislocation boundary layers, or equivalently, as jumps in slip at the boundary, but internal to the crystal. These boundary superdislocations exist on two sides of an interface and react or combine to lower the total energy under certain conditions.

The problem of single and double-slip shear of a thin film is analyzed and the results compared to dislocation dynamics simulations.

3. Minimal kinematic boundary conditions are developed for representative volume elements of continua and particles