Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad - 500107

Students' Annual Seminar

Farewell to a Power Law

Paswa Nath

Despite much effort, no theory, consistent with all rigorous thermodynamic constraints, has been derived that can predict the yield point of a real solid. An exact result states that the free energy of any material, made up of entities interacting with short ranged forces, cannot depend on the shape of the boundary. This implies that crystalline solids are guaranteed to yield at infinitesimal stresses when deformed at vanishing rates. I'll present our work on yielding of an ideal FCC solid in the strictly zero strain rate limit. In this limit, the yield point vanishes for infinitely large systems. Earlier, we showed, for an ideal 2d triangular crystal that the yielding phenomena is a dynamic consequence of a hidden first order phase transition [1]. Our calculations of the free energy of such solids also show that the solid phase is always metastable at any finite temperature and infinitesimal deformation. Our prediction for the dynamical yield points agree with MD simulations for a wide range of deformation rates. Recently, we have shown that a closed-form solution to the dynamical yield point as a function of strain-rate can be obtained from our theory which seems to agree with real-world experimental data performed on single crystalline materials spanning over *14 orders of magnitudes* in strain-rate! [2].Also, I'll describe our extension of this previous work to the initially defect-free FCC crystal.

References:

1. On the existence of thermodynamically stable rigid solids PNAS, 2018
Parswa Nath, Saswati Ganguly, Jürgen Horbach, Peter Sollich, Smarajit Karmakar, Surajit Sengupta
2. A nucleation theory for yielding of nearly defect-free crystals: understanding rate dependent yield points, Physical Review Letters, 2019 V.S. Reddy, Parswa Nath, Jürgen Horbach, Peter Sollich, Surajit Sengupta

Friday, Feb 14th 2020

10:30 AM (Tea/Coffee at 10:15 AM)

Seminar Hall, TIFR-H