

# NOMATEN SEMINAR

Tuesday OCT 26 2021 at 1PM CET (13:00)

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## On the nature of plastic fluctuations in crystalline materials

Jérôme Weiss PhD, Institut des Sciences de la Terre (ISTerre) of CNRS and University of Grenoble

### ABSTRACT:

In classical plasticity theory, plastic *flow* is assumed to be smooth and homogeneous, as illustrated by the Orowan's relation linking the strain-rate to an average mobile dislocation density. However, it has been long recognized that in HCP materials plastic deformation can occur through bursts of activity involving the coordinated motion of numerous dislocations, i.e. dislocation avalanches. More recently, acoustic emission (AE) measurements showed that these avalanches are associated with scale-free properties such as intermittency, power-law statistics and fractal patterns. In the words of Mandelbrot, these plastic fluctuations are wild, thus making tricky the definition of a representative volume element for plasticity. On the other hand, in multi-slip systems such as FCC materials, short-range interactions between dislocations lead to the emergence of dislocation patterns characterized by a well-defined internal length scale, which can be related with the dislocation density and strain-hardening from the similitude principle and Taylor's relation. This patterning frustrate the development of dislocation avalanches. Consequently, plastic deformation occurs essentially through small and uncorrelated, i.e. mild, fluctuations, coexisting however with few larger and intermittent events leading to fundamental rearrangements of the dislocation substructure. When the system size becomes comparable or smaller than the internal length scale mentioned above, dislocation patterning can no longer emerge, leading to a dominance of wild (scale-free) fluctuations even for FCC or BCC materials, and a change in the mechanisms of hardening. In other words, there is a size effect on the nature of plastic fluctuations. Such wild fluctuations might be unwelcomed in the context of nanotechnology. Recent works showed that the introduction of disorder (alloying) allows controlling (decreasing) the internal length scale, hence mitigating wild plastic fluctuations at small scales. These different aspects of plastic fluctuations will be discussed.

### BIO:

Jérôme Weiss PhD is a Senior Research Scientist (Directeur de Recherche) at the Institut des Sciences de la Terre (ISTerre) of CNRS and University of Grenoble. He graduated with a MEng

as well as a MSc in geophysics at the Institut National Polytechnique de Lorraine in France, and then completed his PhD in Materials Science at the Ecole des Mines de Paris in 1992. He is working on fracture, friction and plasticity, from material science to geophysics. He published about 120 peer-reviewed papers, one book on sea ice mechanics, and received the CNRS Silver Medal in 2021.