

Dynamics of dislocation densities in a deterministic and stochastic framework

The purpose of this mentoring internship is to approach from several points of view the modeling of the dynamics of dislocation densities [HL], where dislocations are microscopic defects corresponding to a discontinuity in the atomic organization, which is present in most metal alloys. On the one hand, it is requested to revisit the Groma-Balogh (GB) model proposed in [GB] by showing an entropy estimate [CEMR] and by proposing a discretization scheme encompassing a more general elasticity setting. On the other hand, we propose to develop and analyze numerically a stochastic PDE model associated with the GB model, by perturbing the deterministic model by a random term in order to model phenomena that occur at small scales as in [H]. The main goal is to validate laws of macroscopic behavior, known in the study of visco-plasticity, from microscopic and stochastic models deriving the dynamics of dislocations, considering random effects.

[CEMR] M. Cannone, A. El Hajj, R. Monneau, R. Ribaud, Global existence for a system of non-linear and non-local transport equations describing the dynamics of dislocation densities, Arch. Ration. Mech. Anal., 196, pages 71 (2010).

[GB] Groma and P. Balogh, Investigation of dislocation pattern formation in a two-dimensional self-consistent field approximation, Acta Mater., 47 (1999), pp. 3647-3654.

[HL] J. P. Hirth and J. Lothe, Theory of Dislocations, 2nd ed., Krieger, Malabar, FL, 1992.

[H] Martin Hairer, An Introduction to Stochastic PDEs (<https://arxiv.org/pdf/0907.4178.pdf>).

Subjects

Modeling the dynamics of dislocations

Stochastic model for the study of material deformations

Understanding of visco-plasticity and the link with the dynamics of dislocations

Validation of macroscopic behavior laws

Mentor

Pr. Ahmad EL HAJJ is a professor at the LMAC laboratory of UTC. He holds an HDR from UTC in 2016 and a PhD in applied mathematics from the École Nationale des Ponts et Chaussées (ENPC), delivered in 2007. His research themes are mainly: the analysis of the dynamics of dislocations and the study of some inverse problems. For more details about this you can visit : [🏠](#)

Student Profile

Master or final undergraduate in mechanical engineering with a strong background in applied mathematics.

