Kolloquium Mechanik

UNIVERSITÄT DORTMUND

RUHR-UNIVERSITÄT BOCHUM

Vortragsankündigung

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Thema: **SPATIAL CORRELATIONS AND HIGHER-ORDER GRADIENT TERMS IN A CONTINUUM DESCRIPTION OF DISLOCATION DYNAMICS**

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Inhalt:

A main goal in the theory of crystal plasticity is the derivation of continuum constitutive relations from the underlying dynamics of systems of discrete dislocations. One approach to achieve this goal is to perform the discrete-to continuum transition on the dislocation dynamics level, adopting a formulation of dislocation dynamics in terms of appropriately defined dislocation densities. Several attempts have been made towards a continuum description of dislocation dynamics which account for the collective behaviour of the dislocations. In the models of Holt and Ricman & Vifials, an irreversible thermodynamics analogy was used, Walgraef and Aifantis elaborated an approach where different dislocation populations evolve according to reaction-diffusion equations, Kratochvil et al1. developed the idea of nonlocal hardening based on particular mechanisms such as dislocation sweeping and Hähner and Zaiser proposed a stochastic description of dislocation dynamics in terms of nonlinear stochastic processes. Most of these models are based on analogies with other physical problems like spinodal decomposition, oscillating chemical reactions and chemical patterning, etc. As a consequence of this, the properties of individual dislocations are taken into account only in a very indirect way. In most of these models the collective nature of dislocation motion is described by diffusion-like gradient terms. Since the balance equations are quite heuristic, the actual values of diffusion coefficients are difficult to estimate, the meaning of the associated internal length scales is often unclear, and one may even ask whether it is possible at all to describe dislocation interactions in gradient terms. Hence, the question arises whether it is possible to devise more rigorous procedures to obtain a continuum description of dislocation dynamics from the dynamics of discrete dislocations. It has been shown by Groma and co-workers that for a system of straight parallel dislocations a continuum description can be rigorously derived from the equations of motion of individual dislocations. Using a different approach, a continuum description of the dynamics of a system of curved dislocations in three dimensions was formulated by El-Azab. However, a major drawback of these earlier investigations is that in order to get a closed set of equations short range dislocation-dislocation correlations have been neglected and dislocation-dislocation interactions were described only by the long-range term which is the self-consistent stress field.
In the current work, the problem of the collective behavior of straight parallel edge dislocations is investigated. Starting from the equation of motion of individual dislocations a continuum description is derived. It is shown that the influence of the short range dislocation-dislocation interactions on the dislocation dynamics can be well described by a local back stress which scales like the square root of dislocation density plus a non-local diffusion-like term. The value of the corresponding diffusion coefficient is determined numerically, and implications for size effects in plasticity are discussed.

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