THERMODYNAMICAL MODEL OF FRICTION

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Property of rock friction have been investigated mainly by laboratory experiments, and empirical equations have been proposed [1]. Many researches were looking for the mechanism described by the equations, and most of the proposed models assume a special shape of the frictional contact surface [2]. The real contact surfaces, however, do not have any special shape but have small particles of the medium between them. Thus their assumption is not sufficient and we aim at understanding the mechanism of the friction in a thermodynamic framework. As a first of step, we focused the change in dynamic friction depending on the shear loading rate [1]. First, we summarized the qualitative properties in experimental data of rock friction. They are 1) frictional coefficient in a stable sliding condition with a constant loading rate depends on the logarithm of the loading rate 2) instantaneous jump of the frictional coefficient is caused by the loading rate change, 3) the following relaxation of frictional coefficients to a stable stationary value, and 4) oscillation occurs in some cases (e.g., large loading rate, polished surfaces, thin sand interface layer between the samples) [3]. Second, we construct a model based on thermodynamical constitutive equations. In the presentation, the mentioned properties are compared with model predictions. The advantege of the presented framework is the uniform background with dissipative continuum theories. Therefore the different parameters can be calculated and compared with the continuum equivalents and the role of weakly nonlocal extensions can be analysed.

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NEGATIVE GROUP VELOCITY MAY APPEAR IN MICROSTRUCTURED SOLIDS

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The phenomenon of negative group velocity (NGV) is discovered by Sommerfeld and Brillouin in 1914 in optics. First it was considered as a theoretical possibility but later such a phenomenon was shown to exist by many experiments. In optical materials the NGV is a direct consequence of interference between different frequency components due to the changes in the refractive index. In solids the NGV is found for Lamb waves in layered materials, in composite circular shells, in crystal lattices etc. The interest to such materials is now increased in the context of metamaterials which are engineered with a purpose to create effective macroscopic behaviour like in phononic crystals.

We report on NGV in microstructured materials which are widely used in contemporary technology. The materials under consideration are of two types: hierarchical Mindlin-type materials ("a scale within a scale") [1] and wool felt [2]. In both cases basic mathematical models are presented together with the corresponding dispersion relations. The analysis shows that there are certain ranges of physical parameters which allow the NGV [3] in both materials. We stress that although NGV characterizes the "backward propagation", it has been shown [4] that the causality principle is not violated.

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CONCEPTS AND METHODS OF WEAKLY NONLOCAL CONTINUUM THEORIES

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Weakly nonlocal continuum theories are developed with different methods and concepts.

- Phase field,
- GENERIC,
- Diffusive internal variables,
- Weakly nonlocal irreversible thermodynamics,

are conceptual frameworks where weak nonlocality, the extension existing evolution equations and creation of new ones, can be formulated and tested.
Why only space derivatives, that is nonlocality? What about time derivatives? How can we decide between the different frameworks? Improved prediction and/or rigorous formulation?
The presentation survey the mentioned theories and formulate some comparative statements. It is argued that second law, objectivity and effciency of weakly non- local theories cannot be separated. Some benchmark open problems of continuum physics are collected.

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