Institute of Thermomechanics Seminar
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Lecture No. 104

Czech Society for Mechanics
and Institute of Thermomechanics, CAS

invite you to a lecture and discussion within
the lecture series **Institute of Thermomechanics Seminar**

Heat conduction in microstructured solids

given by

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The Fourier law is the cornerstone of heat transfer theory and practice. Being well applicable for homogeneous continua, the Fourier law is not sufficient for the description of heat conduction in inhomogeneous solids. Moreover, inner microstructure in a solid can be the source of a hyperbolic character of heat conduction. A variety of phenomenological hyperbolic heat conduction models has been proposed as discussed in [1, 2]. The common feature of the hyperbolic heat conduction models is the extension of the thermodynamic state space by heat flux and/or entropy flux. The most developed approach to the generalization of heat equation is provided by extended irreversible thermodynamics [3]. However, the hyperbolic heat conduction equation is obtained in this framework only under assumption of the independence of internal energy of heat flux. Such an assumption is inconsistent with the main constitutive postulate of the dependence of entropy (and, therefore, internal energy) on temperature and heat flux [3].

The thermodynamically consistent method of the extension of the state space is provided by the internal variable theory [4, 5]. Internal variables are used for accounting for the influence of inner microstructure on heat conduction. Two variants of the internal variable treatment are compared by means of the numerical simulation of two-dimensional heat conduction in a plate under a localised thermal pulse loading. Computations of the same problem by the different internal variable descriptions produce qualitatively dissimilar results. The single internal variable approach [5] leads to a diffusional type of the internal variable evolution. In contrast, the dual internal variable technique provides a wave-like evolution of the internal variables, and, as the consequence, the corresponding wave-like heat transfer. The results are obtained in the dimensionless form, and parameters of models are chosen to emphasize the features of each model.

[1] D. D. Joseph and L. Preziosi, Heat waves, Reviews of Modern Physics, vol. 61, pp. 41–73, 1989.
[2] B. Straughan, Heat Waves, Springer, New York, 2011.
[3] D. Jou, J. Casas-Vazquez, G. Lebon, ´ Extended Irreversible Thermodynamics, Springer, New York, 2010.
[4] B. D. Coleman, M. E. Gurtin, Thermodynamics with internal state variables, The Journal of Chemical Physics, vol. 47, pp. 597–613, 1967.
[5] G. A. Maugin, W. Muschik, Thermodynamics with internal variables. Part I. General concepts, Journal of Non Equilibrium Thermodynamics, vol. 19, pp. 217–249, 1994.

The lecture will be held on Wednesday, September 29, 2021 at 11:00
in the building of the Institute of Thermomechanics (new large lecture room),
Dolejškova 5, 182 00 Prague 8

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