Finding Non-Fourier Heat Conduction in Room Temperature Experiments

Robert Kovacs^{C, S}, Gyula Grof, Peter Van, Tamas Fulop and Adam Lovas Department of Energy Engineering, Budapest University of Technology and Economics, Budapest, Hungary kovacs.robert@wigner.mta.hu

The first experimental evidences of non-Fourier heat conduction show wave-like propagation called second sound and measured in superfluid He. Later on it was measured in solids, too, e.g., in NaF crystals at 10-20 K. However, the deviation from Fourier's law exists in common materials at room temperature as well. Here, the deviation is called over-diffusive propagation and it is detected in several unhomogeneous materials. First, we present the applied nonequilibrium thermodynamic theory which extends the Fourier's equation and it is applied to evaluate and understand the measurement results [1]. Here, we used two internal variables to generalize the Fourier equation. This framework is tested first on the so-called NaF experiments [2]. In our experiments, we applied the heat pulse measurement method [3]. We investigated several different types of material such as metal foams and rock samples, and we analysed biological measurements found in the literature [4]. Our evaluation shows clearly the influence of material inhomogeneity on the heat conduction process.

References:

[1] R. Kovács and P. Ván. Generalized heat conduction in heat pulse experiments. International Journal of Heat and Mass Transfer, vol. 83. pp. 613–620, 2015.

[1] R. Kovács and P. Ván. Second sound and ballistic heat conduction: NaF experiments revisited International Journal of Heat and Mass Transfer 117: pp. 682-690. (2018)

[3] S. Both et al.: Deviation from Fourier law at room temperature heterogeneous materials. Journal of Non-Equilibrium Thermodynamics, 41(1), 2016. arXiv:1506.05764.

[4] P. Ván, A. Berezovski, T. Fülöp, Gy. Gróf, R. Kovács, Á. Lovas, J. Verhás, Guyer-Krumhansl–type heat conduction at room temperature. Europhysics Letters 118:(5) Paper 50005. 4 p. (2017)