

Analysis of laser flash experiments and generalized heat conduction

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The minimal weakly nonlocal thermodynamics extension of classical Fourier heat conduction leads to the following general equation of heat conduction [1, 2]:

$$\tau \dot{q}^i + q^i = \lambda_1 \partial^i \frac{1}{T} + \lambda_2 \frac{\partial}{\partial t} \left(\partial^i \frac{1}{T} \right) + a_1 \partial^{ij} q^j + a_2 \partial^{jj} q^i + b_1 \frac{\partial}{\partial t} (\partial^{ij} q^j) + b_2 \frac{\partial}{\partial t} (\partial^{jj} q^i).$$

Here τ , λ , a , b are material parameters. The above general equation reduces to the well-known Maxwell-Cattaneo-Vernotte (MCV), Guyer-Krumhansl and Green-Naghdi cases. Explicit finite difference schemes are elaborated and appropriate stability criteria are calculated by Jury's conditions. The algorithm is applied to analyze certain initial value problems, first of all those that belong to flash experiments. According to the calculations the additional terms may suppress the characteristic qualitative MCV indicators, like the temperature jump. Experimental data is analyzed in the light of the predicted solutions.

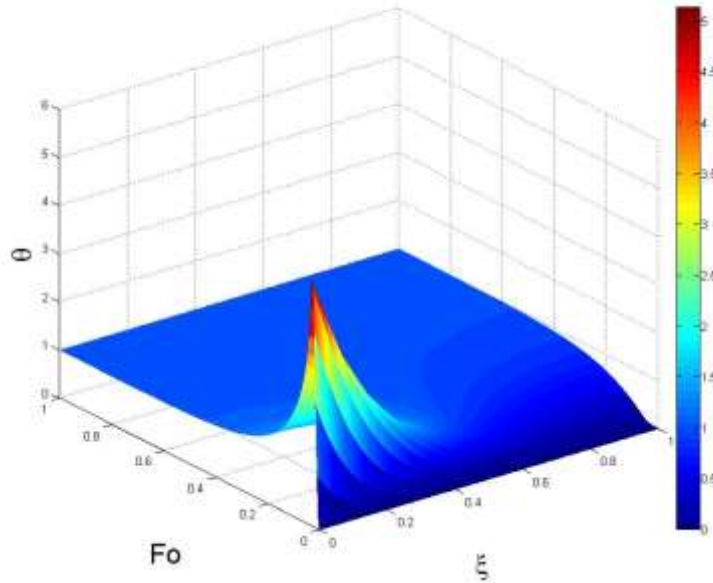


Figure 1: Simulation of the laser flash experiment with Guyer-Krumhansl equation. Fo is the Fourier number, ξ and θ are the dimensionless length and temperature.

References

- [1] P.Ván; T. Fülöp; *Universality in Heat Conduction Theory – Weakly Nonlocal Thermodynamics*; **2012**, Annalen der Physik (Berlin), 524/8, 470-478.
- [2] P.Ván; B. Czél; T. Fülöp, Gy. Gróf, Á. Gyenis, J. Verhás; *Experimental Aspects of Heat Conduction Beyond Fourier*; Proceedings of the 12th Joint European Thermodynamics Conference, Brescia, **2013**, 519-524.