NONLINEARITY IN THE HEAT TRANSPORT MODELS

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ABSTRACT

The growing possibilities of heat transfer control in solids, and in particular in nanosystems, has stimulated the research of thermal transfer modeling. In those systems where the relaxation time of the heat flux is not neglegible, the Fourier law has been generalized by the so-called Maxwell-Cattaneo (MC) equation. Additionally, in those systems with size comparable to the mean free path of heat carriers, nonlocal contributions are required to be considered, and the heat flux satisfies the so-called Guyer–Krumhansl (GK) equation (also related to phonon hydrodynamics) [1].

These models are linear differential equations for the heat flux field, and they have led to some interesting results in the propagation of thermal waves and in the hydrodynamics of heat transport. There is a recent interest to investigate the nonlinear contribution to these models, in order to analyzed similarities and differences with other well-known physical systems.

In this talk I will introduce some recent results we have found by considering the nonlinear contributions to the MC equation [2] and to the GK equation [3; 4]. In the former we have shown a parallelism with optical communications which has led to solitons. The other two papers instead are related to phonon hydrodynamics and they take into account a possible non-Newtonian generalization of the GK and the contribution (linear or nonlinear) of the walls.

Keyword: heat transport; Maxwell-Cattaneo equation; Guyer–Krumhansl equation; phonon hydrodynamics; solitons; thermal waves.

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