Ann. Acad. Rom. Sci.
Ser. Math. Appl.
ISSN 2066-5997 Vol. 14, No. 1-2/2022

GENERALIZED HEAT TRANSPORT EQUATIONS IN THREE-DIMENSIONAL ANISOTROPIC RIGID HEAT CONDUCTORS*

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Abstract

In this paper we derive generalized heat transport laws for an anisotropic rigid heat conductor. We use a model formulated in a previous paper in the framework of non-equilibrium thermodynamics with internal variables. In the thermodynamic state vector beside the internal energy and the heat flux a second order tensor is introduced as internal variable, influencing the thermal phenomena. In the three-dimensional case the phenomenological equations are presented, the entropy production is worked out and anisotropic transport equations for the heat flux are carried out, as Maxwell-Cattaneo and Guyer-Krumhansl equations, describing heat waves and the ballistic propagation of the phonons, respectively. The conductivity matrix is given in the Appendix. The obtained results have applications in several technological sectors, as in nanotechnology, where there are situations of high-frequency waves propagation and Knudsen number is comparable or larger than unity.

MSC: 74A15, 74A20, 74E10.

*Accepted for publication in revised form on January 9-th, 2022

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