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Acoustic and Seismic Dispersion in Complex Fluids and Solids

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The first part of the present paper is the continuation of a previous work [3] on the effects of higher spatial gradients and temporal relaxation on stress and heat flux in complex fluids. In particular, the general linear theory is applied to acoustic dispersion, extending a simpler model proposed by Davis and Brenner [2].

The theory is applied to a linearized version of the Chapman-Enskog fluid [1] valid to terms of Burnett order and including Maxwell-Cataneo relaxation of stress and heat flux on relaxation time scales τ. For this model, the dispersion relation $k(\omega)$ giving spatial wave number k as function of temporal frequency ω is a cubic in k^2, in contrast to the quadratic in k^2 given by the classical model and the recently proposed modification [2]. The cubic terms are shown to be important only for $\omega\tau = O(1)$ where Maxwell-Cataneo relaxation is also important.

As a second part of the present work, it is shown how the above model can also be applied to isotropic solids, where both shear and pressure waves are important. Finally, consideration is given to hyperstress in micro- polar continua, including both graded and micro-morphic varieties.

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[3] J.D. Goddard. On material velocities and non-locality in the thermo-mechanics of continua. Int. J. Eng. Sci., 48(11):1279–88, 2010.