

GLOBAL WELL-POSEDNESS OF THE CAUCHY PROBLEM FOR THE 3D JORDAN-MOORE-GIBSON-THOMPSON EQUATION

REINHARD RACKE¹ & BELKACEM SAID-HOUARI²

ABSTRACT. We consider the Cauchy problem of a third-order in time nonlinear equation known as the Jordan–Moore–Gibson–Thompson (JMGT) equation arising in acoustics as an alternative model to the well-known Kuznetsov equation. We show a local existence result in appropriate function spaces, and, using the energy method together with a bootstrap argument, we prove a global existence result for small data, without using the linear decay. Finally, polynomial decay rates in time for a norm related to the solution will be obtained.

1. INTRODUCTION

In this paper, we consider the nonlinear Jordan–Moore–Gibson–Thompson equation:

$$(1.1a) \quad \tau u_{ttt} + u_{tt} - c^2 \Delta u - \beta \Delta u_t = \frac{\partial}{\partial t} \left(\frac{1}{c^2} \frac{B}{2A} (u_t)^2 + |\nabla u|^2 \right),$$

where $x \in \mathbb{R}^3$ (Cauchy problem in 3D), and $t > 0$, and where $\tau > 0$ is a time relaxation parameter, the unknown $u = u(x, t)$ is the acoustic velocity potential, c is the speed of sound, β is the parameter of diffusivity and A and B are the constants of nonlinearity. We consider the initial conditions

$$(1.1b) \quad u(t = 0) = u_0, \quad u_t(t = 0) = u_1, \quad u_{tt}(t = 0) = u_2.$$

Equation (1.1a) appears as a generalization of the Kuznetsov equation (see equation (1.3) below). Both equations are used as models in what is called nonlinear acoustics that deals with finite-amplitude wave propagation in fluids and solids and related phenomena, see the books of Beyer [1] or Rudenko and Soluyan [31]. In particular, the JMGT equation arises from modeling high-frequency ultra sound waves, see [24] for more details.

The derivation of equation (1.1a) (see [14] and [33]) can be obtained from the general equations of fluid mechanics by means of some asymptotic expansions in powers of small parameters, cf. Appendix B for the derivation.

In the derivation of (1.1a), the Cattaneo (or Maxwell–Cattaneo) law was used which accounts for finite speed of propagation of the heat transfer and eliminates the paradox

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