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# ON AN IMPORTANT OBSERVATION REGARDING SOME HYDROMAGNETIC MOTIONS OF MAXWELL FLUIDS AND ITS APPLICATIONS*

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Dedicated to Dr. Dan Tiba on the occasion of his $70^{th}$ anniversary

**Abstract**

The problem of exact solutions for isothermal motions of non-Newtonian fluids is of interest yet and a new way to get them is welcome. In this work an important observation regarding the governing equations corresponding to some isothermal hydromagnetic unidirectional motions of incompressible Maxwell fluids is brought to light. It allows us to easily determine exact solutions for motions with shear stress or velocity on the boundary when similar solutions for motions with velocity, respectively shear stress on the boundary are know. To exemplify, the solutions of some hydromagnetic motion problems of Maxwell fluids with velocity on the boundary are used to generate exact steady state solutions for similar motions of same fluids with shear stress on the boundary. These solutions are very important for the experimental researchers who want to know the required time to reach the steady state.

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## 1 Introduction

The motion of a fluid over an oscillating flat plate, as well as the motion between parallel plates, is not only of fundamental theoretical interest but it also appears in many applied problems [1]. It is called Stokes second problem by Schlichting [2]. The same motion is also termed as Stokes or Rayleigh problem in the existing literature. The fluid motion between parallel plates is also termed as the modified Stokes second problem by Rajagopal et al. [3] if one of plates oscillates. They are some of the most important motion problems near moving bodies having multiple applications in engineering and science in general. Both motions have been extensively studied in the literature and the obtained solutions are important both for theoreticians and experimental researchers. Although the numerical integration of governing equations can be realized by computers, the accuracy of results can be established by a comparison with an exact solution.

The first exact starting solutions of the second problem of Stokes for incompressible Newtonian fluids seem to be those of Erdogan [1]. New equivalent exact solutions for the same problem and their extension to incompressible Maxwell fluids have been established by Corina Fetecau et al. [4], respectively [5]. On the other hand, the interaction between an electrical conducting fluid and the magnetic field produces important effects with many applications in physics, chemistry, engineering, horticulture and hydrology. In addition, the hydromagnetic motions of fluids have multiple applications in polymer technology, petroleum industry, nuclear reactors and so on. More recent results regarding hydromagnetic motions of incompressible Newtonian fluids have been obtained by Kiema et al. [6], Onyango et al. [7] and Dash and Ojha [8]. However, the first general solutions for such motions of same fluids over an infinite plate or between infinite parallel plates have been obtained by Fetecau et al. [9], respectively Fetecau and Narahary [10] using an important remark concerning the governing equations of velocity and shear stress.

The main purpose of this work is to show that the respective remark is also valid for the same isothermal hydromagnetic unidirectional motions of the incompressible Maxwell fluids. This observation, with direct applications in obtaining new exact solutions for fluid motions, says that the governing equations of the velocity and shear stress fields corresponding to some