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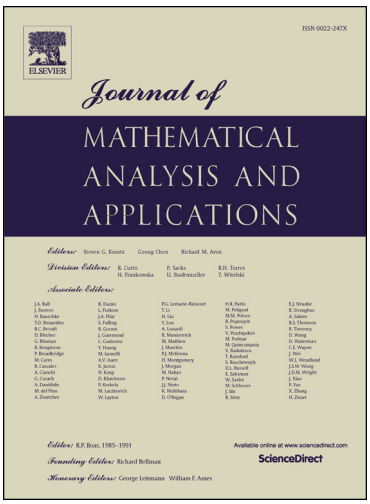

Nonlinear convective instability in the compressible magnetic convection problem without heat conductivity

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Nonlinear convective instability in the compressible magnetic convection problem without heat conductivity

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Abstract

We investigate the convective instability problem for a full compressible viscous magnetohydrodynamic (MHD) fluid with zero resistivity and zero heat conductivity in the presence of a uniform gravitational force in a bounded domain $\Omega \in \mathbb{R}^3$. First, we establish an instability criterion for the magnetic convection problem, and construct unstable solutions of linearized magnetic convection problem that grow in time in the Sobolev space H^3. Then, based on the linearly unstable solutions, we further modify the initial data of the linearly unstable solutions to be ones of the original magnetic convection problem. Finally, using the local well-posedness of classical solutions to the original magnetic convection problem, and a modified bootstrap instability method, we can construct unstable solutions for the original magnetic convection problem in the sense of Hadamard under the instability criterion.

Keywords: Thermal instability; Magnetohydrodynamics fluids; Compressible viscous fluid.

1. Introduction

Convective (or thermal) instability often arises when a fluid is heated from below. The classic example of the instability is a horizontal layer of fluid with its lower side hotter than its upper. The basic state is then one of rests with light and hot fluid below heavy and cool fluid. When the temperature difference across the layer is great enough, the stabilizing effects of viscosity and thermal conductivity are overcome by the destabilizing buoyancy, and an overturning instability ensues as thermal convection: hotter part of fluid is lighter and tends to rise as colder part tends to sink according to the action of the gravity force [29]. The phenomenon of thermal convection itself had been recognized by Rumford [34] and Thompson [37]. However, the first quantitative experiments on thermal instability and the recognition of the role of viscosity in the phenomenon are due to Benard [27], so the convection in a horizontal layer of a fluid heated from below is called Bénard convection. In this article, we further investigate the convective instability problem for a full compressible viscous magnetohydrodynamic (MHD) fluid with zero resistivity and zero heat conductivity in the presence of a uniform gravitational force in a bounded domain $\Omega \in \mathbb{R}^3$. Next we introduce the magnetic convection problem.

We consider the following three-dimensional full compressible and viscous MHD equations with zero resistivity and zero heat conductivity in the presence of a uniform gravitational field

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