Investigating Salt Finger Convection under Time-Dependent Gravity Modulation in Micropolar Liquids

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1. INTRODUCTION & OBJECTIVE

Double diffusive convection, also known as thermohaline convection or salt-fingering convection, occurs in fluids where there are gradients in both temperature and concentration of dissolved substances, such as salt or chemicals. Two types of double diffusive convection are salt finger convection and diffusive convection.Here in this paper a layer of Boussinesquian micropolar liquid is considered between two horizontal plates of infinite length. When hot salty water overlies the cool fresh water, the water molecules coming down are surrounded by the colder water molecules and it loses both heat and salt to the surrounding water molecules. As temperature diffuses faster than the salt, those water molecules continue to move downwards in the form of fingers. Understanding double-diffusive convection is crucial for various applications, including climate modeling, ocean circulation studies, and the design of desalination processes. Traditional studies have focused on single-component convection, but the interaction between heat and solute gradients in double-diffusive systems introduces additional layers of complexity.

In the paper by Arun Kumar N and Nisha Mary Daniel on discusses about different non-uniform concentration profiles of infinite extent separated by thin layer, heated and solutes from above. The paper studies on the effect of different micropolar parameters which is studied through linear stability analysis on the onset of stationary convection. In the paper by S.Pranesh and Arun Kumar N, discusses on the effect of gravity modulation on the onset of thermal convection between the plates containing micropolar liquid. The paper studies both linear and non-linear stability theory due to gravity modulation on Rayleigh-Benard Convection.

This study aims to explore the influence of gravity modulation on salt finger convection within a micropolar fluid layer confined between two parallel, infinitely long plates. By utilizing linear stability analysis and normal mode analysis, we seek to determine the critical Rayleigh number and solutal Rayleigh number, which are essential for understanding the onset of convection. The research also examines how varying micropolar fluid parameters—such as the coupling parameter, micropolar heat conduction parameter, couple stress parameter, and inertia parameter—affect convection stability under different gravity modulation frequencies and to understand how gravity modulation and micropolar parameters influence the onset and control of convection, thereby stabilizing or destabilizing the system and affecting heat and mass transfer rates.

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2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

The linear theory is used to study the effect of gravity modulation and micropolar parameters on the onset of convection. The problems studied in this paper throw light on the effect of gravity modulation on salt finger convection and how this phenomenon is affected by the presence of micropolar liquid parameters. The following conclusions are drawn from the present study and also plotted the results as shown in Figure A to Figure D.

- Frequency of gravity modulation plays an important role in stabilizing and destabilizing the system.
- When gravity modulation frequency tends to infinity the effect of modulation becomes very small.
- The coupling parameter N1, inertia parameter N2 and micropolar heat conduction parameter N5 destabilizes the system and in general increase the rate of heat and mass transfer.
- The couple stress parameter N3, stabilizes the system and in general, decreases the rate of heat and mass transfer.

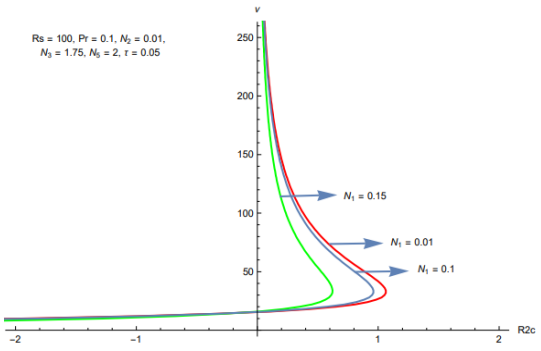

Figure A

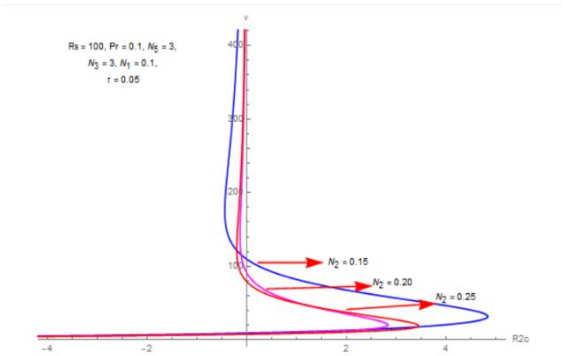

Figure B

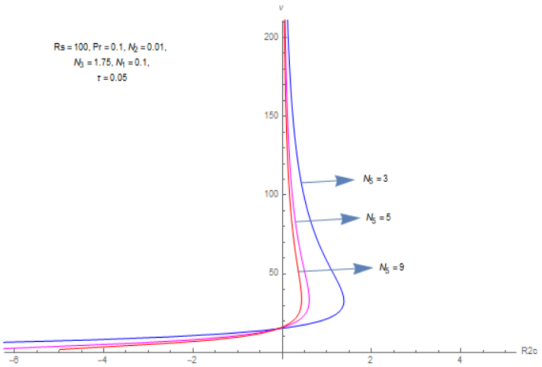

Figure C

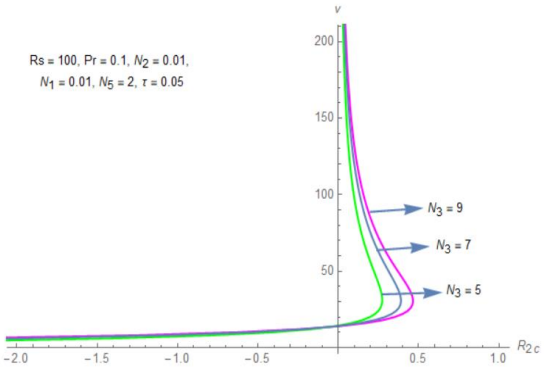

Figure D

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