Linear analysis of thermomagnetic convection in a ferrofluid under radial buoyancies.

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Linear stability analysis (LSA) was conducted on a aqueous based ferrofluid confined in the gap of an axially infinite cylindrical annulus, with differential radial heating between the inner cylinder at R_1 maintained at temperature T_1 and the outer cylinder at R_2 at temperature T_2, where $T_1 > T_2$. A stack of magnets is placed inside the inner cylinder [1]. In addition, the cylinders can rotate rigidly with an angular frequency Ω. The forced acting on the ferrofluid in our system are, magnetic buoyancy due to magnetic gravity g_m, and centrifugal buoyancy g_c due to a centrifugal acceleration.

The study was made on microgravity condition. The flow equations in the nondimensional format is given as,

$$\vec{\vec{\nabla}}.\boldsymbol{v} = 0 \tag{1}$$

$$\frac{d\boldsymbol{v}}{dt} + (\boldsymbol{v}.\vec{\vec{\nabla}})\boldsymbol{v} = -\vec{\vec{\nabla}}\pi + \Delta\boldsymbol{v} - \frac{Ra_m}{Pr}\theta\boldsymbol{e_r} - \gamma_a\frac{v^2}{r}\theta\boldsymbol{e_r} \tag{2}$$

$$\frac{d\theta}{dt} + (\boldsymbol{v}.\vec{\vec{\nabla}})\theta = \frac{1}{Pr}\Delta\theta \tag{3}$$

The equations Eqn.(1)-Eqn.(3) are linearized by adding small perturbations and the eigen values are calculated. The complex growth rate of our system is a function of control parameters $s = f(\eta, Pr, Ra_m, Ta, k, n)$, where $\eta = R_1/R_2$ is the radius ratio, $Pr = \nu/\kappa$ is the Prandtl number, $Ra_m = \alpha\Delta T g_m d^3/\nu^2\kappa$ is magnetic Rayleigh number, Ta is Taylor number, k is the axial wave number and n is the azimuthal number of modes.The growth rate is also defined as $s = \sigma + i\omega$, where σ is the growth rate of our perturbations and ω is the frequency of the perturbations.

For marginal states we try to investigate the states were $\sigma = 0$. These marginal modes can be stationary $\omega = 0$ or osciallatory in nature $\omega \neq 0$.

Références

1. R. Tagg & P.D. Weidman, Linear stability of radially-heated circular Couette flow with simulated radial gravity, *Z. angew. Math. Phys.*, **58**, 431–456 (2007).