A Nonlinear Stability Analysis of a Double-Diffusive Magnetized Ferrofluid

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A nonlinear (energy) stability analysis is performed for a magnetized ferrofluid layer, heated and soluted from below, with stress-free boundaries. A rigorous nonlinear stability result is derived by introducing a suitable generalized energy functional. The mathematical emphasis is on how to control the nonlinear terms caused by magnetic body and inertia forces. For ferrofluids we find that the existence of subcritical instabilities is possible, however, it is noted that, in case of a nonferrofluid, the global nonlinear stability Rayleigh number is exactly the same as that for linear instability. For lower values of the magnetic parameters, this coincidence is immediately lost. The effects of the magnetic parameter, M_3, and the solute gradient, S_1, on the subcritical instability region have also been analyzed. It is shown that with the increase of the magnetic parameter the subcritical instability region between the two theories decreases quickly, while with the increase of the solute gradient the subcritical region expands. We also demonstrate the coupling between the buoyancy and magnetic forces in the nonlinear energy stability analysis.

Key words: Magnetized Ferrofluid; Nonlinear Stability; Double-Diffusive Convection; Magnetization.