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内部発熱対流のセルパターン形成に与える回転場の影響
Influence of rotating field on the cell pattern formation of internal heating convection

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Influence of a background rotation on the transition of flows is one of the interesting topics in fluid mechanics. The influence in thermal convections also has great importance not only for fluid mechanics but also for geophysics to understand large scale phenomena in the planets. Many studies about influence of rotation on Rayleigh-Benard convection have been carried out. For example, formation of the spiral flow in convection cells is theoretically predicted by Chandrasekhar(1961). On the other hand, only a few research of the effect of rotation on the internally heating convection has investigated. In generally, convection cells occurring in the internally heating convection expand as increasing Rayleigh number. Conversely, convection cells shrunk as the effect of background rotation. As described above, the increasing rotation speed and increasing Rayleigh number provide the opposite effect on the size of convection cells. The aim of this study is to clarify how the convection pattern changes with changing balance of these opposite effect.

This experimental study deals in the response of thin horizontal fluid layer with background rotation. The bottom boundary of the layer is composed by an insulating glass plate. And the top boundary is contact with copper plate where the temperature is kept constant by circulating water from a thermo-static bath. Internally heat generation is induced by Joule heating due to passing electric current in the ionic fluid. After electrifying to fluid layer, rotation immediately is begun.

Four characteristic flow patterns were observed with modifying the rotation speed and power of the heat generation. First one is that there are stable, polygonal convection cells. Second, flow pattern is irregular without forming any cell structure. Third is the unsteady cell pattern formation: roll or polygonal cells form but immediately change into different form with combining and dividing. The fourth one is conduction state without convection.

We have organized the results by Rossby number showing the relationship between the Rayleigh number and Taylor number. The convection cell is stable when Rossby number is greater than 3 or less than 0.7. But the cell pattern formation becomes unstable and repeats split and join when the Rossby number is around zero. In addition, when Taylor number is greater than 1000, convection does not form cell structure even if Rossby number is greater than 3.

When we focus on the parameter region of stable convectional cell, flow structure and cell size differ between Rossby number is less than 0.7 and greater than 3. The shape of convectional cell is regular hexagon and the flow inside the cell takes large distortion due to Coriolis force when Rossby number is less than 0.7, in other word the effect of rotation is relatively stronger than the effect of convection. On the other hand, when Rossby number is greater than 3, the shape of cell is irregular polygon and the flow inside the cell has little distortion as the effect of rotation.

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