Cell formation of thermal convection induced by internal heating

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Internal heating is ubiquitous in the interior of stars. The Earth's mantle also has a strong internal heat source from decay of radioactive materials, and convection is induced not only by the temperature difference between core and surface but also by internal heating. We treat the thermal convection between two horizontal plates induced by internal heating.

In this framework, well-controlled experiments are very difficult, and there are few experimental studies. The experimental investigation was done using Joule heating in a fluid layer (Triton and Zarraga, 1967). They observed the hexagonal convection patterns with fluid falling at the cell centers. They also observed that cell sizes increase when heating is increased. Schwiderski and Schwab (1971) proposed that the increased cell size was caused by non-uniform heating due to the dependence of electrical resistivity of the working fluid on its temperature. In a recent experimental study in which the nonuniformity of heating was small (Yonekura, 2003, master's thesis), enlargement of the cell size was also observed. Statistical survey is not enough, and we don't have satisfactory explanation for this cell configuration.

In this study, first, we simulate this setting in a three-dimensional thin flat box and confirm whether enlargement of the cell size is inherent or not in convection induced by internal heating. Second, we attempt to address the stability of flow patterns.