Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MIS24-16 Room:313 Time:April 28 17:30-17:45

Flow reversals in liquid metal convection by the skewed-varicose instability

YANAGISAWA, Takatoshi[1*] ; SAKURABA, Ataru[2] ; HAMANO, Yozo[1]

[1]IFREE, JAMSTEC, [2]School of Science, Univ. Tokyo

The natures of turbulence and large-scale flow pattern in the outer core are controlled by the magnetic field. It is important to know the basic behavior of flow in relation to the magnetic field, for understanding the flow patterns observed in real Earth and core dynamo simulations. By recent laboratory experiments of Rayleigh-Benard convection with liquid gallium, a regime diagram of convection patterns was established under various intensities of a uniform horizontal magnetic field for a wide square geometry (Yanagisawa et al. 2013, PRE). Five flow regimes are recognized; (I) fluctuating large-scale pattern without roll, (II) weakly constrained roll with fluctuations, (III) continuous oscillation of roll, (IV) repetition of roll number transitions with random reversals of the flow direction, and (V) steady 2-D rolls. In these, regime (IV) with flow reversals is the most interesting behavior. Flow reversals have been observed so far in narrow vessels with small aspect ratio, and the proposed processes for reversals are reorientation and cessation. Experiments with liquid metal under horizontal magnetic field suggest the existence of new type of reversal, via the skewed-varicose instability.

We performed numerical simulations of magnetoconvection in a same setting as the experiment with no-slip velocity boundary conditions. Both the Prandlt number and magnetic Prandtl number of the working fluid are set small to simulate liquid metals. Our numerical result successfully reproduced all regimes that observed in the experiments. The process of flow reversal is illuminated by the simulation. Axis of roll is skewed with a roll shrinking, and the number of rolls is reduced. In case the reduced roll number structure is not fit the vessel, new small circulation grows to a roll again, and then reversed flow state is established. The process repeats with irregular time interval. It works in 3-dimensional geometry, and should play important role in various flow systems.

Keywords: thermal convection, liquid metal, flow reversal