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水平磁場下の液体金属対流におけるロール状対流について
Roll convection in a liquid metal layer subject to a horizontal magnetic field

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Recent investigations using ultrasonic velocity profiling (UVP) on Rayleigh-Benard convection in a liquid metal layer under horizontal magnetic field gave good understanding for typical temperature fluctuations shown in previous studies (Yanagisawa, et al., 2013). For example, regime transition against variations of Rayleigh number (Ra) and Chandrasekhar number (Q), variation of the roll number and spontaneous, random flow reversal that consists of spontaneous transition between two modes having different number of rolls, mainly N = 4 and 5. This flow reversal may be due to non-integer number of stable wave number in corresponding conditions of Ra and Q. The rolls can take only integer number even though the stable wave number determined by flow instability is, for example, N = 4.3. In this case the dominant condition is N = 4, and it is sometime modified into N = 5 due to external noise. However, N = 5 is not stable, and thus Skewed varicose instability occurs to restore N into 4. Time average of instantaneous N may correspond to stable wave number for the corresponding conditions.

This study aims to widen the flow regimes into larger Ra and larger Q by one order to clarify the influence of strong magnetic field: Past studies predict that the strong magnetic field greatly modifies the critical Rayleigh number at the onset of the convection. Experiments were done in Helmholtz center at Dresden-Rossendorf (HZDR) to utilize strong magnetic field generator that can provide quasi uniform magnetic field with 30 mT in the intensity. The test fluid layer is almost same with our previous study (Yanagisawa, et al., 2013) and its main aspects are, 5 in aspect ratio, 40 mm in height and sandwiched between copper plates for cooling at top and heating at bottom. The obtained regime diagram shows that the fraction rule on Ra/Q determining the regimes is still almost valid in the widen region of Ra and Q. But the number of rolls is slightly modified from expectations by the rule. Also we observed "regular" flow reversals instead of random one. This may be due to stable number of rolls larger than N = 4.5 and aspect ratio of the vessel, 5. The dominant roll number also depends on the side boundary of the vessel. Velocity profiles parallel to the roll axes clarified three dimensional motion during the regular flow reversals.

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