Axial flow characteristics of a liquid metal roll convection under a horizontal magnetic field

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Magneto-convection is one of important flow systems for describing behavior of the earth’ s outer core. It is well known that applying sufficiently strong horizontal magnetic field to thermal convection in a liquid metal layer stabilizes the convections into quasi-two-dimensional rolls aligned parallel to the magnetic field. The corresponding phenomena of convection rolls are, however, not so simple because of existence of side boundaries; pressure gradient nearby the wide wall perpendicular to the magnetic field causes axial flow due to Ekman pumping in Bödewadt layer. And, the flow provides complexity on the convection. We examined axial flow and advection structures on quasi-two-dimensional convection rolls by laboratory experiment using liquid metal layer imposed by horizontal magnetic field. Ultrasonic velocity profiler visualized and quantified roll structures and axial flows by multiple measurement lines set in the fluid layer. The measurements were performed for different Rayleigh and Chandrasekhar numbers and variations of the axial flow velocity were investigated. Visualized flow pattern suggested influence of Lorenz force on the axial flow and scaling law with considering the Lorenz force effect was discussed.

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