WAVES IN FERROFLUID CONVECTION INDUCED BY INCLINED MAGNETIC FIELD

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Ferrofluids are modern strongly magneto-polarisable nanofluids flows of which can be non-intrusively controlled by applying an external magnetic field. One of their prospective applications is as a heat carrier in thermal management systems operating in zero-gravity conditions. The purpose of the research that we will present in this talk was the estimation of parametric boundaries of magneto-convection regimes anticipated to occur in an arbitrarily inclined magnetic field in the lead to the corresponding experiments planned onboard Autonomous space module "OKA-T" (Russian Space Corporation) and International Space Station.

The influence of the field inclination angle on ferrofluid convection was the main purpose of the investigation. It was found that when a field is strictly perpendicular to a ferrofluid layer stationary thermomagnetic patterns develop, but an unexpected form of convection, waves propagating in the direction of concavity of magnetic field lines have been discovered for non-orthogonally applied fields. Therefore on the one hand a symmetry breaking associated with a nonlinear refraction of magnetic field lines results in the appearance of thermo-magnetic waves that propagate in the direction of concavity of field lines so that in contrast to the classical Rayleigh-Benard problem stationary convection patterns exist for sufficiently large values of magnetic Grashof number only when magnetic field is strictly perpendicular to a ferrofluid layer. One the other hand the deviation of the applied field lines from the direction normal to a ferrofluid layer in the absence of gravity leads to the stabilization of a motionless state.

The preliminary ground-based experiments were performed with chamber containing a magnetic fluid layer of the thickness 6.0 mm, length 375 mm and the width 180 mm. The maximal intensity of a magnetic field creating by Helmholtz coils was 35 kA/m. The flows were visualized using an infrared camera with an accuracy of 0.1 C.