Colloquium

Department of Physics, Temple University

Magnetically Localizing Heat by Inducing Anti-Equilibration Flow in a Quasi 1D Magnetic Fluid

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Heat flow from high temperature to low temperature to reduce the thermal imbalance and bring the system closer to thermal equilibrium is the thermal phenomena in nature as well as in our daily life. In this talk I report a counter example, namely, the heat does not flow from high to low temperature. Rather, heat energies at both high and low temperatures were held “localized” in place, halting the approaching to equilibrium in the system by magnetic body force originated from both temperature and field gradients in a magnetic fluid. Using two different configurations of temperature and magnetic field gradients, we observed magnetic field-induced flow that either enhances the gravito-thermal convection when the gradients of temperature and field are parallel to each other (PL), or suppress it when the two gradients are antiparallel (AP) to each other, where the convection roll in zero field was replaced by two localized flows at the two ends of the sample cell. This flow structure stops the heat flow of approaching to thermal equilibrium in the system, causing the temperature difference across the sample to increase with applied fields. The drastically different effects of the field on the equilibration processes resulted from two totally different topological flow-structures for the two experimental configurations imply a profound bifurcation of the solutions for the underlying physics. These observations qualitatively confirmed the prediction that the differential magneto-thermal force designed for this experiment can drive a new type of apparatus to transfer heat energy with higher efficiency than the convention ones, such as heat engine.

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