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On the possibility of CMB thermoelectric dynamics

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Thermoelectric (TE) properties at the CMB and TE-induced core flow dynamics remain poorly understood. Although TE currents have long been proposed to drive dynamos in the interior of planets (e.g. [1][2]), the implication of TE-induced dynamics in the vicinity of CMB has yet been discussed in depth. Thus, we have developed a two-metal laboratory experimental model to simulate core-mantle interface.

We conducted a series of surveys in a turbulent Rayleigh-B\'enard convection system with a vertical imposed magnetic field. Two sets of boundaries, one electrically conducting and one electrically insulating, are used to investigate the TE effects on the system. We performed thermal measurements at a fixed buoyancy forcing and varying magnetic forces in a cylindrical cell filled with liquid gallium. A tank-scale overturning circulation develops in most of the experiments. This large-scale circulation slowly precesses in azimuth in the subcases which have electrically conducting boundaries, as magnetic Lorentz forces become comparable to buoyant inertial forces. This novel magnetoprecessional mode reverses its orientation when the magnetic field reverses its polarity. We develop a simple analytical model that predicts the TE magnetoprecession frequency.

Extrapolating our results to the Earth's core, we provide estimates of the material properties based on up-to-date thermal and electric conductivity of the CMB that needed to generate TE dynamics. In particular, we postulate mega-ULVZs are well-suited to drive TE core dynamics. Further, should thermoelectric processes drive core flows in the vicinity of the CMB (or ICB), such TE-drive flows should reverse their direction when the geomagnetic field reverses, providing a natural symmetry breaker between normal and reversed geomagnetic field orientations. A better understanding of **Seebeck coefficient**, **lateral thermal gradients**, **electric and thermal conductivity** at the CMB will help better characterize the TE dynamics in future studies [3].

References:

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