MAR15-2014-000448

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Convection, Stability, and Turbulence[1]

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Many natural flows are driven by buoyancy forces, perhaps the most familiar being those resulting from density variations due to temperature or compositional differences in the presence of a gravitational field. Buoyancy-driven flows of this sort play a major role in geophysical fluid mechanical processes and their transport properties and are central to climate dynamics. The simplest setting to study this phenomena is so-called Rayleigh-Bénard convection, the buoyancy driven flow in a horizontal layer of fluid heated from below and cooled from above. This seminal problem has received tremendous attention over the last century but many riddles remain, especially regarding strongly nonlinear turbulent convection. In this presentation, following an introduction to the phenomena and its applications along with a review of the current state of theory and experiments on high Rayleigh number convection, I will describe some recent results that mathematical analysis has contributed to our understanding of turbulent heat transport.

[1]Supported in part by NSF Mathematical Physics Award PHY-1205219

[2]2014 Simons Fellow in Theoretical Physics