Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Tailoring boundary geometry to optimize heat transport in turbulent convection SRIKANTH TOPPALADODDI, Yale University, University of Oxford, SAURO SUCCI, Istituto per le Applicazioni del Calcolo "Mauro Picone" (C.N.R.), Rome, JOHN WETTLAUFER, Yale University, University of Oxford, Nordita — Turbulent Rayleigh-Bénard convection between planar horizontal boundaries is a classical example of the challenge posed by multiple interacting scales in fluid dynamics. The detailed description by which hot fluid rises and cold fluid descends focuses on the nature of the interaction between the boundary layers and the turbulent interior of the flow. Here, by tailoring the geometry of the upper boundary we manipulate this boundary layer – interior flow interaction, and study the turbulent transport of heat in two-dimensional Rayleigh-Bénard convection with numerical simulations using the Lattice Boltzmann method. By fixing the roughness amplitude of the upper boundary and varying the wavelength λ, we find that the exponent β in the Nusselt-Rayleigh scaling relation, $Nu - 1 \propto Ra^{\beta}$, is maximized at $\lambda \equiv \lambda_{\max} \approx (2\pi)^{-1}$, but decays to the planar value in both the large ($\lambda \gg \lambda_{\max}$) and small ($\lambda \ll \lambda_{\max}$) wavelength limits. The changes in the exponent originate in the nature of the coupling between the boundary layer and the interior flow. We present a simple scaling argument embodying this coupling, which describes the maximal convective heat flux.

Srikanth Toppaladoddi
Yale University, University of Oxford

Date submitted: 27 Jun 2015 Electronic form version 1.4