Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Thermal convection over a fractal surface[1] SRIKANTH TOPPALADODDI, ANDREW WELLS, University of Oxford, CHARLES DOERING, University of Michigan, JOHN WETTLAUFER, Yale University & Nordita — We use well resolved numerical simulations to study Rayleigh-Bénard convection in cells with a fractal boundary in two dimensions for $Pr = 1$ and $Ra \in [10^7, 2.15 \times 10^9]$. The fractal boundaries are functions characterized by power spectral densities $S(k)$ that decay with wavenumber as $S(k) \sim k^p$ $(p < 0)$. The degree of roughness is quantified by the exponent p with $p < -3$ for smooth (differentiable) surfaces and $-3 \leq p < -1$ for rough surfaces with Hausdorff dimension $D_f = \frac{1}{2}(p + 5)$. By computing the exponent β in power law fits $Nu \sim Ra^{\beta}$, where Nu and Ra are the Nusselt and the Rayleigh numbers, we observe that heat transport increases with roughness. For $p = -3.0$, -2.0 and -1.5 we find, respectively, $\beta = 0.256, 0.281$ and 0.306. For a given value of p we observe that the mean heat flux is insensitive to the details of the roughness.

[1]Work supported by a Research Fellowship from All Souls College Oxford, US National Science Foundation award DMS-1813003, and Vetenskapsrdet No. 638-2013-9243.

Srikanth Toppaladoddi
University of Oxford

Date submitted: 02 Aug 2019

Electronic form version 1.4