

Title: High Rayleigh Number Convection in a Fluid Saturated Porous Layer

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The Darcy-Boussinesq equations at infinite Darcy-Prandtl number are used to study convection and heat transport in a basic model of porous medium convection over a broad range of Rayleigh number Ra . High resolution direct numerical simulations are performed to explore the modes of convection and measure the heat transport, i.e., the Nusselt number Nu , from onset at $Ra = 4\pi^2$ up to $Ra = 10^4$. Over an intermediate range of increasing Rayleigh numbers, the simulations display the 'classical' heat transport $Nu \sim Ra$ scaling. As the Rayleigh number is increased beyond $Ra = 1255$ we observe a sharp crossover to a form fit by $Nu \approx .0174 \times Ra^{.9}$ over nearly a decade up to the highest Ra . New rigorous upper bounds on the high Rayleigh number heat transport are derived, quantitatively improving the most recent available results. The upper bounds are of the classical scaling form with an explicit prefactor: $Nu \leq .0297 \times Ra$. The bounds are compared directly to the results of the simulations. We also report various dynamical transitions for intermediate values of Ra , including hysteresis and multistability observed in the simulations as the Rayleigh number is decreased from 1255 back down to onset. This is joint work with Jesse Otero, Lubomira A. Dontcheva, Hans Johnston, Rodney A. Worthing, Alexander Kurganov and Guergana Petrova, and is the content of a paper published in Journal of Fluid Mechanics (2004).