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Nonlinear subcritical and supercritical thermal convection in a sphere

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Fluids that are subject to temperature gradients (or internal heating) and a gravity force will begin convecting when the thermal forcing, conventionally measured by the nondimensional *Rayleigh number* Ra exceeds a critical value. The critical value R_L for the transition from a static, purely conductive state to an advective state can be determined by linearising the equations of motion and formulating an associated characteristic value problem. We discuss two aspects of fluid behaviour away from this point:

(i) Highly supercritical behaviour, and the asymptotic behaviour of heat transport in the highly nonlinear regime. (ii) Subcritical behaviour for $Ra<R_L$, which may be possible for finite amplitude fluid motions. We work in both full sphere and shell geometries, with various forms of heating and gravitational profiles. We report on both theoretical developments and direct numerical simulations using highly accurate fully spectral methods for solving the relevant equations of motion and of heat transfer.