Subcritical convection in a rapidly rotating sphere at low Prandtl numbers

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We study nonlinear convection for low Prandtl number fluids ($Pr = 10^{-1} - 10^{-2}$) in a rapidly rotating sphere with internal thermal heating. Our model assumes that the velocity is invariant along the axis of rotation due to the rapid rotation of the system, while the temperature is computed in 3D. We identify two separate branches of convection near the onset of convection: a well-known weak branch that is continuous at the linear onset of convection, and a novel strong branch at low Ekman numbers with large values of the convective and zonal velocities. For small Ekman numbers ($E < 10^{-7}$), the strong branch is subcritical.