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Tides and turbulent convection: a new frequency dependence[1]

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The interaction of tidal flows and convection within a star or giant planet plays an important role in the spin and orbital evolution of close binary systems. It is thought to act as an effective (turbulent) viscosity (ν_E) in dampening the large-scale tidal flow. However, there exists a debate in the efficiency of this mechanism when the tidal frequency (ω) exceeds the relevant convective frequency (ω_c). Zahn (1966) proposed that $\nu_E \sim \omega^{-1}$ while Goldreich and Nicholson (1977) proposed $\nu_E \sim \omega^{-2}$. We use hydrodynamical simulations in a local Cartesian domain to investigate the dissipation of the large-scale tidal flow as a result of its interaction with convection. We use the well-studied Rayleigh-Bnard equations for convection along with an oscillatory background shear flow which represents our tidal-like flow. We will present results of an extensive parameter survey which explores the frequency dependence of the effective viscosity. The key result is a new scaling law which has not been predicted or observed previously. This result will then be related to the inherent nature of the turbulent convection in the absence of shear and as such gives a hint as to the physical mechanism responsible for this scaling.

[1]CDT Fluid Dynamics

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