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Three-dimensional Global Modes in Spatially Varying Rayleigh–Bénard–Poiseuille Convection

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Above their critical threshold, the thermo-convective instabilities rising in a laminar Poiseuille flow heated from below by a two-dimensional bump of temperature may self-tune to precise temporal frequencies despite the spatially varying base flow. In cases where these variations are slow, such instabilities are analytically sought as travelling rolls with slowly spatially varying amplitudes and wavevectors. Furthermore, the existence of turning points where the group velocity of an unstable mode vanishes yields an analytical selection criterion for these instabilities and their respective frequencies. The most unstable linear modes and their critical conditions obtained by this method are compared with the results of direct numerical simulations of the Navier–Stokes equation under the Boussinesq approximation. The issue of the nonlinear behaviour of these instabilities is then addressed.

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