INTERACTING INERTIAL MODES AND THEIR INSTABILITY IN A DIFFERENTIALLY ROTATING SPHERICAL GAP FLOW

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Inertial modes are Coriolis-restored linear wave modes, often arise in rapidly-rotating fluids (e.g. in the Earth's liquid outer core [1]). Recent experimental works showed that inertial modes exist in differentially rotating spherical shells. A set of particular inertial modes, characterized by $(l, m, \hat{\omega})$, where l, m is the polar and azimuthal wavenumber and $\hat{\omega} = \omega/\Omega_{out}$ the dimensionless frequency [2], has been found [4, 6]. It is an open issue why only a few modes develop and how they get enhanced.

We present an experimental study of inertial modes, based on Particle-Image-Velocimetry (PIV) data, in a spherical gap flow ($\eta = r_i/r_o = 1/3$) where the inner sphere is subrotating/ counter-rotating at Ω_{in} with respect to the outer shell at Ω_{out}, characterized by the Rossby number $Ro = (\Omega_{in} - \Omega_{out}/\Omega_{out})$. Based on a frequency-Rossby number spectrogram (figure 1), we can partly confirm previous considerations with respect to the onset of inertial modes [4, 6]. In contrast, the behavior of the modes in the counter-rotation regime is different. We found a triad interaction between three dominant inertial modes, where one is a slow axisymmetric Rossby mode [3]. We show that the amplitude of the most dominant mode ($l = 3, m = 2$) is increasing with increasing $|Ro|$ until a critical Rossby number Ro_{crit} (left red line). At the particular Ro_{crit}, the flow breaks down into small-scale disorder [5], together with a strong increase of the zonal mean flow which significantly expands outside the tangent cylinder at η. We found that the critical Rossby number scales approximately with $E^{1/5}$.

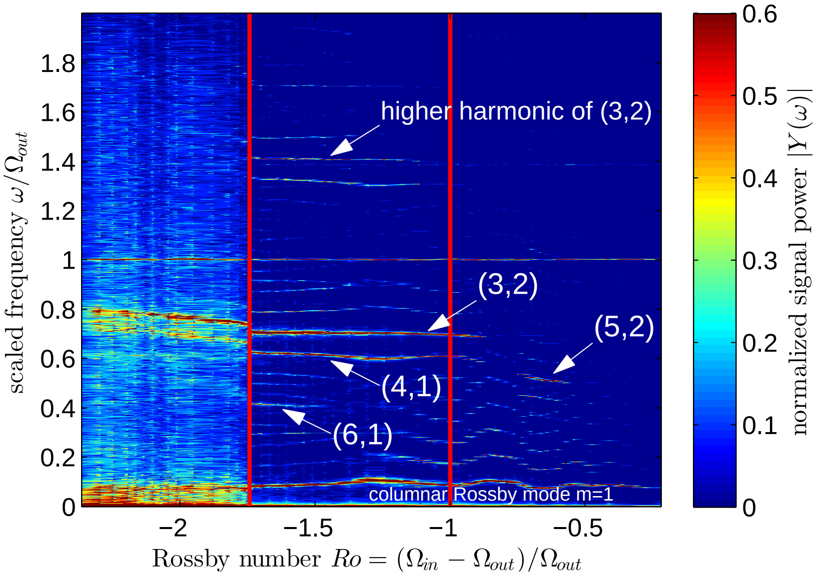

Figure 1. Azimthal velocity spectrogram for $\Omega_o \approx 64$rpm ($E \approx 1.35 \times 10^{-5}$). The inner sphere rotation Ω_i was variable.

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