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Experimental study of inertial waves in a spherical shell induced by librations of the inner sphere

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Many planetary bodies do not rotate with a constant velocity but undergo rotations with superposed oscillations called longitudinal librations. This is the case e.g. for the Earth's moon, Mars' moon, Mercury and many other moons of Jupiter and Saturn and some of them have a solid inner core and a molten outer core. It is worth to know the interaction between the libration of the core and the interior of the fluid to understand tidal heating, fluid mixing, and the generation of magnetic fields. Here we present an experimental investigation of inertial waves in a spherical shell. The shell rotates with a mean angular velocity Ω around its vertical axis overlaid by a time periodic oscillation of the inner sphere in the range $0 < \omega < 2\Omega$, in order to excite inertial waves with a known frequency. We want to show the influence of the libration amplitude ϵ on different libration frequencies ω and how efficient libration is, to excite inertial waves in the given frequency range. For low ω and high ϵ instability starts to grow and, beside the excited inertial waves, several low frequency structures can be found. Quantitative PIV analyses of the horizontal plane in the co-rotation frame show clear spiral structures with different wave numbers for high libration amplitudes due to strong shear, similar to differential rotation. Another question, we like to address, is whether high libration amplitudes can also excite very low frequency Rossby wave structures? If the frequency increases, it can be seen from Poincaré plots that large attractor windows for inertial waves appear. We want to show PIV analyses for such flows dominated by wave attractors. It is known that for large excitation frequencies subharmonic parametric instability starts to grow and triads will be excited. Our experimental data show hints for the existence of triads and preliminary results will be discussed.