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Shallow Flow Past a Cavity: Self-Excited Oscillations due to Resonant Coupling MAXWELL WOLFINGER, DONALD ROCKWELL, CEM OZEN, Lehigh University — A fully turbulent shallow flow past a cavity can give rise to highly coherent oscillations. Coupling between the instability of the separated shear layer along the cavity and a gravity standing wave mode within the cavity results in: sharp spectral peaks of fluctuating pressure along the cavity wall; and substantial modification of the flow patterns along and within the cavity. Onset of the fully coupled, highly coherent oscillation of the shear layer-cavity system occurs as follows. As the inflow velocity along the cavity increases, the instability frequency of the separated shear layer approaches the frequency of the gravity standing wave mode. When these frequencies are coincident, the instability frequency locks-on to (remains the same as) the standing wave frequency, and highly ordered, time-dependent deflections of the free-surface occur. The peak amplitude of the unsteady pressure fluctuation occurs during this locked-on state. Moreover, quantitative imaging in the form of particle image velocimetry reveals large-scale vortex formation in the separated shear layer, which is associated with substantial changes of time- and phase-averaged flow patterns within the cavity. In turn, these features of the flow are associated with large increases of Reynolds stresses in the separated layer along the cavity.

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