On Centrifugal Instabilities and Wake Mode in the Flow over
an Open Cavity

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of Technology — Three-dimensional Direct Numerical Simulations of the full com-
pressible Navier-Stokes equations are performed for open cavities that are homoge-
neous in the spanwise direction. The formation of oscillating spanwise structures
is observed inside the cavity. This 3D instability arises from a generic centrifugal
instability mechanism associated with the mean recirculating vortical flow in the
downstream part of the cavity. In general, the three-dimensional mode has a span-
wise wavelength of approximately the cavity depth and oscillates with a frequency
an order-of-magnitude lower than 2D Rossiter (flow/acoustics) instabilities. The 3D
mode properties are in excellent agreement with predictions from our previous linear
stability analysis. When present, the shear-layer (Rossiter) oscillations experience
a low-frequency modulation that arises from nonlinear interactions with the three-
dimensional mode. We connect these results with the observation of low-frequency
modulations and spanwise structures in previous experimental and numerical stud-
ies on open cavity flows. Preliminary results on the connections between the 3D
centrifugal instabilities and the presence/suppression of the wake mode are also
presented.

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