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# Shape effects of single axisymmetric cavity in a circular duct on flow induced acoustic oscillations

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## Abstract

The acoustic oscillations excited by flow past an axisymmetric cavity in a circular duct are experimentally investigated. The focus of the work is on the effects of different dimensions and shapes of the cavity, namely, rectangular, V, and U shapes. A large number of transducers are used to simultaneously record the variation of acoustic pressure axially and azimuthally in the duct. The trapped acoustic modes excited in the duct are confirmed by the observation of axial decay of the acoustic pressure amplitude away from the cavity. Shifts are observed between tangential natural acoustic modes of the duct, corresponding to which the amplitudes rise and fall. The subdominant mode amplitude increases simultaneously as the dominant mode decreases during a mode shift. The experimentally observed azimuthal variation of amplitude and phase indicate the prevalence of mixed standing and spinning wave modes, which are separated so as to evaluate the spin ratio, defined as the ratio of the amplitude of the spinning part to the total amplitude comprising both the spinning and standing modes. It is found that the spin ratio reaches low values corresponding to when the mode shifts occur. Accordingly, the ratio of the dominant to subdominant amplitudes registers a spike. The results suggest that, when a dominant mode prevails over a velocity range, the acoustic energy is substantially contributed towards the spinning mode, whereas during conditions of mode shifts, the amplitudes of the competing modes decrease, leaving only their standing wave patterns to prevail mostly. The depth of the cavity affects the natural frequency excited, whereas the length influences the amplitude. The U- and V-shaped cavities offer lesser effective geometric depths to the acoustic modes. The shape of the cavity influences the amplitude excited, with the U-shaped cavity registering the lowest levels. It is expected that the dynamics in the shear layers between the central large-scale vortex and the corner vortices accommodated by the cavity shape contributes to the acoustic oscillations excited.

**Keywords:** Duct acoustics; axisymmetric cavity; trapped azimuthal modes; cavity shapes; spin ratio.