SUPPLEMENTARY MATERIAL

Resonant frequencies of cantilevered sheets under various clamping configurations immersed in fluid

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S1. MODE SHAPE AND PRESSURE DISTRIBUTION FOR OTHER CLAMPS

The normalized deflection functions (mode shapes) for a zero aspect ratio cantilevered sheet clamped into a horizontal plate and a vertical wall are given in Fig. S1; results for the normalised pressure distributions are in Fig. S2. The added mass parameter, Λ, for the surrounding fluid [see Eq. (20)] is varied to encompass fluid loading strengths ranging from small to large. These results are qualitatively similar to those for a rigid line clamp; see Fig. 5.

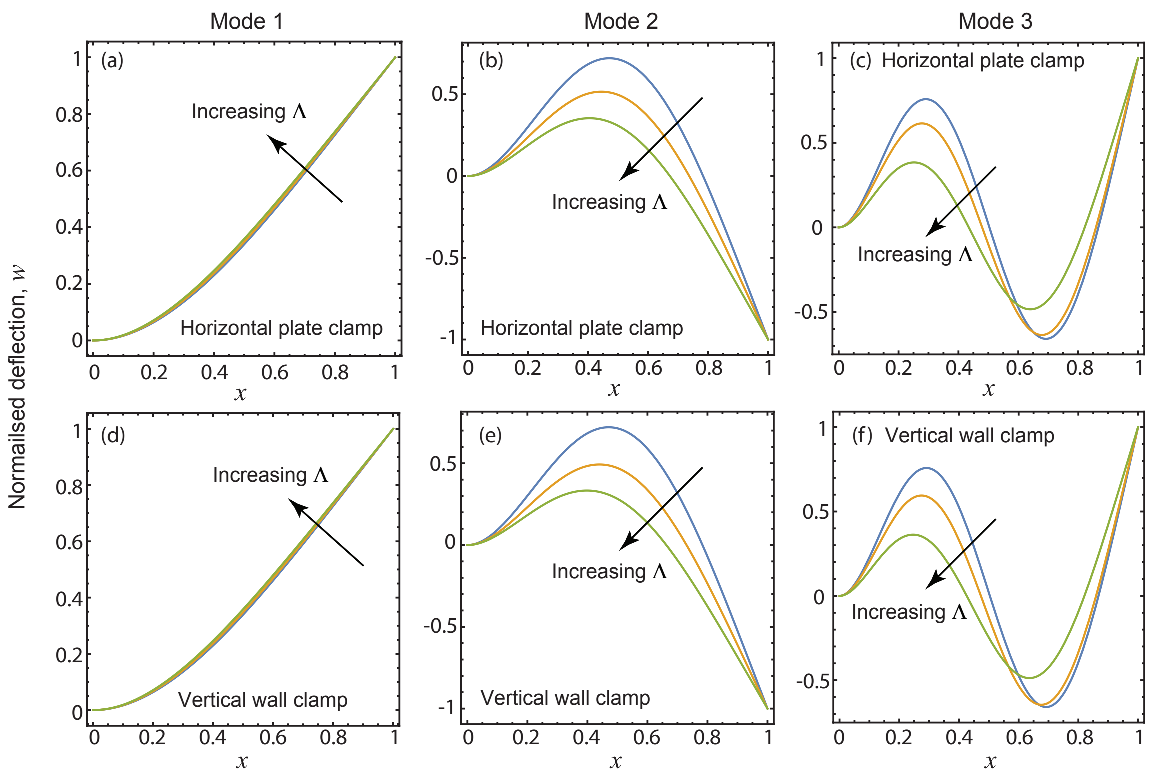

FIG. S1: Normalized deflection functions for a cantilevered sheet with a horizontal plate clamp: (a), (b), (c) for mode 1, 2 and 3; and a vertical wall clamp: (d), (e), (f) for mode 1, 2 and 3. Results given for $\Lambda = 0, 1, 100$, corresponding to vacuum, light and heavy fluid loading, respectively.

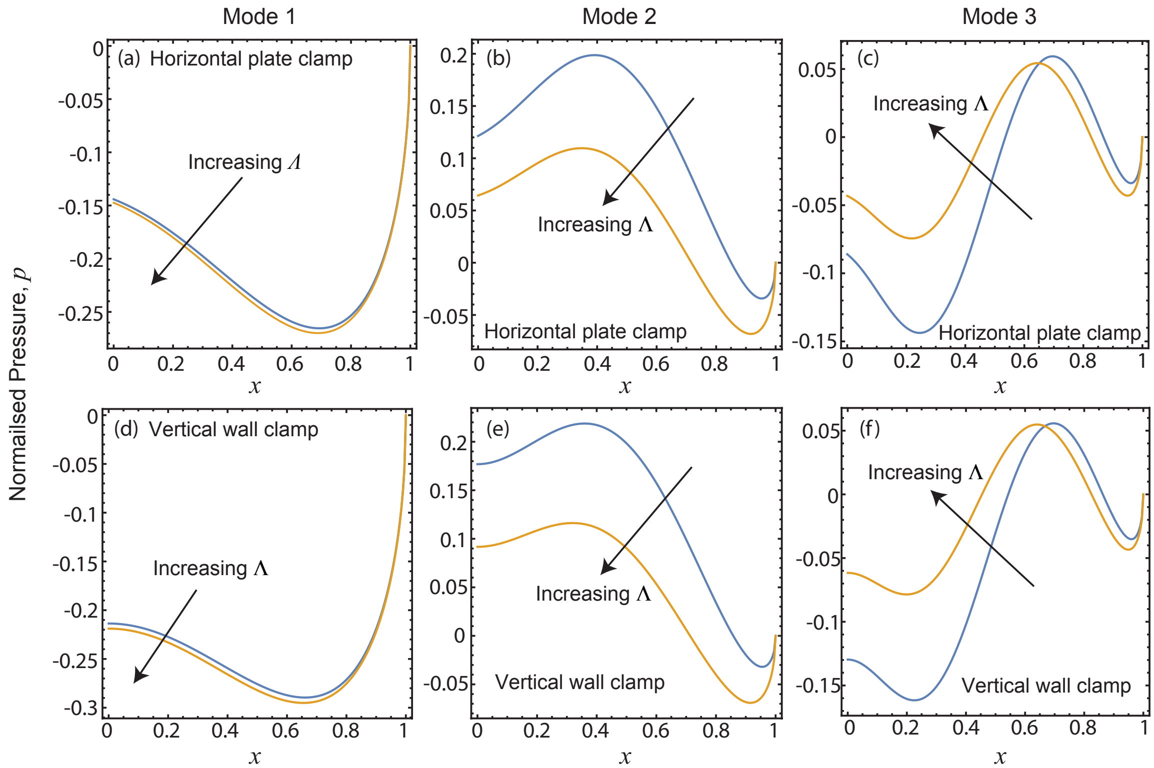

FIG. S2: Normalized pressure distributions for a cantilevered sheet with a horizontal plate clamp: (a), (b), (c) for mode 1, 2 and 3; and a vertical wall clamp: (d), (e), (f) for mode 1, 2 and 3. Results given for moderate and heavy fluid loading: $\Lambda = 1$ and 100.

S2. LARGE MODE NUMBER LIMIT FOR OTHER CLAMPS

Here, we illustrate the large mode number ($n \gg 1$) behavior of the rescaled hydrodynamic function, α_{small}, for a zero aspect ratio cantilevered sheet clamped into (i) a horizontal plate, and (ii) a vertical wall. Convergence to the asymptotic limit ($n \to \infty$) is observed for large mode number, n; see Fig. S3. These two clamps exert a stronger fluid effect on the resonant frequency relative to the line clamp; see Fig. 3. As such, larger n-values are required to ensure the pressure distribution depends locally on position, compared to the line clamp results (in Fig. 6).

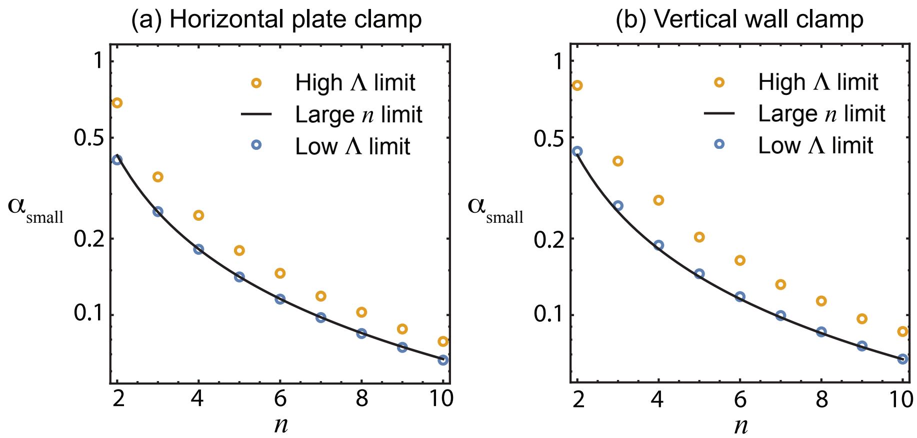

FIG. S3: Rescaled hydrodynamic function, α_{small}, for a zero aspect ratio cantilevered sheet with horizontal plate and vertical wall clamps, as a function of mode number, n. The range that α_{small} varies in response to increasing fluid load, Λ, is indicated by the vertical distance between the two open circles for each n. The large mode number asymptotic solution ($n \to \infty$) is the solid curve.

S3. EFFECT OF CANTILEVER THICKNESS

Finite element (FE) results are given in Fig. S4 for the rescaled hydrodynamic function, α_{small}, for a series of zero aspect ratio cantilevered sheets with increasing length-to-thickness ratio, L/h. The cantilevers are clamped into a vertical wall and results are given for the fundamental mode ($n = 1$) as a function of the added mass parameter, Λ. As the length-to-thickness ratio increases, FE results for finite thickness converge to the analytical solution for an infinitely thin sheet; derived in Section II. Finite thickness enhances the hydrodynamic load experienced by the cantilever. This increase in α_{small} with increasing thickness explains the slight overestimates of the hydrodynamic functions provided by FE analysis; see Fig. 7.

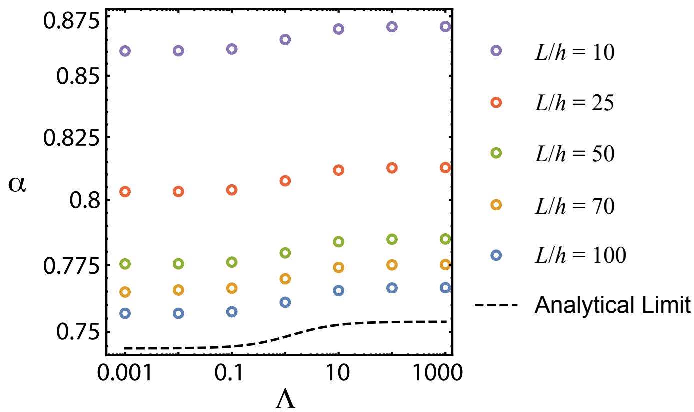

FIG. S4: Scaled hydrodynamic function of mode 1 as a function of the length-to-thickness ratio; a vertical wall clamped is used. FE results are open circles; dashed curve is the infinitely thin result of Section II.