Dynamics of cylinders, plates and shells in contact with axial flow: a review and some new developments

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Some of the principal applications of these systems in engineering applications or in nature are mentioned first, to motivate this talk, ranging from nuclear engineering to snoring and aircraft engines, from oil exploration to swimming fish and ocean mining.

The linear dynamics of pipes conveying fluid with various end conditions is then recalled, as a paradigm in the dynamics of all such systems, followed by a review of the similarities in both mathematical and physical terms with the dynamics of cylindrical shells, cylinders and plates subjected to axial flow.

The post-critical dynamical behaviour of pipes conveying fluid and differences in nonlinear behaviour of pipes, shells, cylinders and plates are discussed next, focusing on some new work. A characteristic of this new work is the close synergy between theory and experiment. As a result, a number of paradoxes have been resolved, and new insights gained into the nonlinear dynamics of these systems. E.g., in one case (shell with supported ends conveying fluid) the system had been observed to lose stability by flutter, whereas theory and energy considerations suggested it should do so via static divergence; in other cases discrepancies in dynamical behaviour as predicted by linear and nonlinear theory have been clarified, more specifically with regard to post-divergence flutter of shells conveying fluid and cylinders in axial flow. Some interesting dynamical behaviour is illustrated along the way, involving strongly subcritical loss of stability, and quasiperiodic and chaotic oscillations.