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Wave propagation in stratified fluid flows: application of the Stroh formalism to Lagrangian acoustic perturbations

Olivier Poncelet[a] and Mélanie Ottenio[b]
[a]LMP, UMR CNRS 5469, Université Bordeaux I, 351, cours de la Libération, 33405 Talence, France
[b]INRETS - Univ. Claude Bernard Lyon 1, UMR-T 9406, Laboratoire de Biomecanique et Mecanique des Chocs, 25, Avenue Francois Mitterand, 69675 Bron, France

We consider the problem of harmonic waves propagating in non uniform fluid flows in presence of either solid interfaces (elastic walls), or jumps of mechanical properties or jumps of fluid convection-speed. The acoustic field is described by taking into account Lagrangian perturbations referred to an Eulerian frame related to the moving fluid. In contrast to the case of eulerian perturbations, the lagrangian description enables us to introduce the acoustical displacement in the problem and therefore to write the continuity conditions in a simple and unambiguous way: normal acoustical displacement is always continuous through an interface between either solids or (moving) fluids; the normal acoustical stress is also continuous in most of the practical cases (boundary layers, vibrating walls). We express the wave equation as an ordinary differential system by making use of the Stroh formalism from which analytical and semi-analytical results can be obtained for any arbitrary profile of the flow properties. This formalism, coupled with Peano-Neumann series expansion and Frobenius power series, enable us to compute modes dispersion in elastic ducts, and reflective properties of a mixing layer in between two fluids in relative motion. Some analytics on those problems is provided.