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Normal modes with Boundary Dynamics HOUSSAM YASSIN, Princeton University — Consider infinitesimal wave perturbations to a resting stable fluid equilibrium and suppose that there are restoring forces at the boundary as well as in the interior. Examples include a stratified Boussinesq fluid with a free-surface or a quasigeostrophic fluid with bottom topography. In such problems, the resulting eigenvalue problem for the normal modes will include the eigenvalue parameter in the boundary conditions. This leads to normal modes with fundamentally new properties: 1) The modes form a basis in a larger function space than L^2 and may be discontinuous at the boundaries. Any function with a finite-jump discontinuity at an active boundary may be represented by the modes. 2) The modes are orthonormal with respect to an indefinite inner product that contains contributions from Dirac delta "functions". Some modes may have a negative square norm. 3) Distinct modes may have an identical number of internal zeros. Assuming the eigenfunctions are ordered by their eigenvalues, the number of internal zeros for the eigenfunctions may take forms such as $1, 0, 0, 1, 2, 3, \ldots$ 4) Such problems include a δ-sheet formulation analogous to the Bretherton (1966) interpretation of boundary buoyancy gradients as infinitely thin sheets of potential vorticity.

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