HAMILTONIAN DISCONTINUOUS GALERKIN FEM FOR LINEAR INCOMPRESSIBLE FLUID

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ABSTRACT

Several discrete Hamiltonian structures for three dimensional linear incompressible fluid flow with a free surface are determined. The first approach uses the Hamiltonian structure for incompressible fluid flow in a direct discretization. Whereas, the second uses the compressible Hamiltonian structure for discretization with a Lagrange multiplier technique to enforce the incompressibility constraint. Differences and similarities of these discretizations are discussed and as an interim result the compressible Hamiltonian structure is discretized. Discretization of the Hamiltonian structures with bilinear Poisson bracket will provide a starting point for a conservative numerical model. Conserving energy, mass and phase space structure the Poisson bracket is discretized using discontinuous Galerkin FEM (DGFEM) method with the introduction of proper numerical fluxes. This discretization ensures the skew-symmetry property conservation, which automatically results in mass and energy conservation on a discrete level. Rotational fluid flow models allow us the investigation of currents and wave-current interactions and also it makes it possible to model inertial waves. Two applications are discussed based on our numerical implementation. The first application discusses the inertial waves in rectangular domain with rigid walls everywhere [1], Fig 1. Next application involves the inertial waves in rectangular domain with sloping wall on one side. Experimental data of this phenomena is also available [2], Fig 2.

REFERENCES

[1] Maas, L.R.M., On the amphidromic structure of inertial waves in a rectangular parallelepiped, *Fluid Dynamics Research,* **33**, 373-401pp (2003).

[2] Manders, A.M.M., Maas, L.R.M, Observations of inertial waves in a rectangular basin with one sloping boundary, *J. Fluid Mechanics,* **493**, 59-88pp (2003).

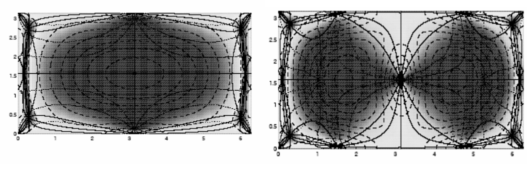

Figure 1: 2D velocity field of horizontal currents for different rotation speeds.

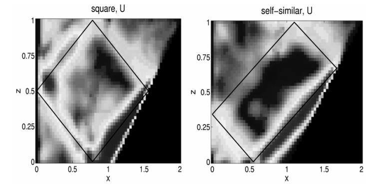

Figure 2: Wave attractor in vertical cross sections for sloping wall domain.