Water Bags and Contour Dynamics

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Abstract

The water bag model and contour dynamics are examples of reductions of the Vlasov-Poisson and two-dimensional Euler fluid-like equations, respectively. Both are based on initial conditions with the dynamical variable being constant in a certain region. Both equations have Hamiltonian form in terms of a noncanonical Poisson bracket, a realization of an infinite-parameter Lie Algebra that is sometimes called a Lie-Poisson bracket. The derivation of the water bag model and contour dynamics and their associated Hamiltonian form by reduction will be reviewed. Formulations for both nonconvex and convex contours will be given, the former being of general mathematical interest apart from plasma physics and fluid mechanics applications. Applications of the formalism will be presented, including low mode truncations for the description of drift waves or quasigeostophic barotropic vortex dynamics and the calculation of V-states, rigidly rotation vortex states that are claimed to be exact solutions.