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A Robust Numerical Method for Integration of Point-Vortex Trajectories in Two Dimensions SPENCER SMITH, Tufts University Physics Department, BRUCE BOGHOSIAN, Tufts University Department of Mathematics — The venerable 2D point-vortex model plays an important role as a simplified version of many disparate physical systems, including superfluids, Bose-Einstein condensates, certain plasma configurations, and inviscid turbulence. Point-vortex dynamics are described by a relatively simple system of nonlinear ODEs which can easily be integrated numerically using an appropriate adaptive time stepping method. As the separation between two vortices relative to all other inter-vortex length scales decreases, however, the computational time required diverges. Accuracy is usually the most discouraging casualty when trying to account for such vortex motion, though the varying energy of this ostensibly Hamiltonian system is a potentially more serious problem. We solve these problems by a series of coordinate transformations: We first transform to action-angle coordinates, which, to lowest order, treat the close pair as a single vortex amongst all others with an internal degree of freedom. We next, and most importantly, apply Lie transform perturbation theory to remove the higher-order correction terms in succession. The overall transformation drastically increases the numerical efficiency and ensures that the total energy remain constant to high accuracy.

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