Abstract Submitted
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Sparsified-dynamics modeling of discrete point vortices with graph theory[1] KUNIHIKO TAIRA, ADITYA NAIR, Florida State University — We utilize graph theory to derive a sparsified interaction-based model that captures unsteady point vortex dynamics. The present model builds upon the Biot-Savart law and keeps the number of vortices (graph nodes) intact and reduces the number of inter-vortex interactions (graph edges). We achieve this reduction in vortex interactions by spectral sparsification of graphs. This approach drastically reduces the computational cost to predict the dynamical behavior, sharing characteristics of reduced-order models. Sparse vortex dynamics are illustrated through an example of point vortex clusters interacting amongst themselves. We track the centroids of the individual vortex clusters to evaluate the error in bulk motion of the point vortices in the sparsified setup. To further improve the accuracy in predicting the nonlinear behavior of the vortices, resparsification strategies are employed for the sparsified interaction-based models. The model retains the nonlinearity of the interaction and also conserves the invariants of discrete vortex dynamics; namely the Hamiltonian, linear impulse, and angular impulse as well as circulation.

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