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A fluid mechanical model for mixing in a plankton predator-prey system

J. Peng (1) and J.O. Dabiri (1,2)

(1) Bioengineering, California Institute of Technology, USA, (2) Aeronautics, California Institute of Technology, USA

A Lagrangian method is developed to study mixing of small particles in open flows. Particle Lagrangian Coherent Structures (pLCS) are identified as transport barriers in the dynamical systems of particles. We apply this method to a planktonic predator-prey system in which moon jellyfish Aurelia aurita uses its body motion to generate fluid currents which carry their prey to the vicinity of their capture appendages. With the flow generated by the jellyfish experimentally measured and the dynamics of prey particles in the flow described by a modified Maxey-Riley equation, we use pLCS to identify the capture region in which prey can be captured. The properties of the capture region enable analysis of the effects of several physiological and mechanical parameters on the predator-prey interaction, such as prey size, escape force, predator perception, etc. The method provides a new methodology to study dynamics and mixing of small organisms in general.