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Delay induced instabilities in self-propelling swarming particles[1]
ERIC FORGOSTON, IRA SCHWARTZ, Naval Research Laboratory — We consider a general model of self-propelling biological or artificial individuals interacting through a pairwise attractive force in a two-dimensional system in the presence of noise and communication time delay. Previous work has shown that a large enough noise intensity will cause a translating swarm of individuals to transition to a rotating swarm with a stationary center of mass. In this work, we use numerical simulations to show that with the addition of a time delay, the model possesses a transition that depends on the size of the coupling parameter. This transition is independent of the swarm state (traveling or rotating) and is characterized by the alignment of all of the individuals along with a swarm oscillation. By considering the mean field equations without noise, we show that the time delay induced transition is associated with a Hopf bifurcation. The analytical result yields good agreement with numerical computations of the value of the coupling parameter at the Hopf point.

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