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Stochastic pattern transitions in large scale swarms[1] IRA SCHWARTZ[2], BRANDON LINDLEY[3], US Naval Research Laboratory, LUIS MIER-Y-TERAN[4], Johns Hopkins Bloomberg School of Public Health — We study the effects of time dependent noise and discrete, randomly distributed time delays on the dynamics of a large coupled system of self-propelling particles. Bifurcation analysis on a mean field approximation of the system reveals that the system possesses patterns with certain universal characteristics that depend on distinguished moments of the time delay distribution. We show both theoretically and numerically that although bifurcations of simple patterns, such as translations, change stability only as a function of the first moment of the time delay distribution, more complex bifurcating patterns depend on all of the moments of the delay distribution. In addition, we show that for sufficiently large values of the coupling strength and/or the mean time delay, there is a noise intensity threshold, dependent on the delay distribution width, that forces a transition of the swarm from a misaligned state into an aligned state. We show that this alignment transition exhibits hysteresis when the noise intensity is taken to be time dependent.

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