MAR09-2008-020310

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Three dimensional reconstruction of starling flocks: an empirical investigation of collective animal behavior

IRENE GIARDINA, CNR-INFM

Bird flocking is a striking example of animal collective behaviour: thousands of birds gather above the roosting site, forming sharp-bordered flocks, which wheel and turn with remarkable coherence and synchronization. Despite an increasing theoretical interest, empirical investigations of collective motion have been limited so far by the difficulties of getting data on large systems. By means of stereoscopic photography and using statistical mechanics, optimization theory and computer vision techniques, we have measured for the first time the three-dimensional positions and trajectories of individual birds in groups of up to three thousands elements. This allowed us to analyze global morphological properties of the flocks, as well as structural and dynamical properties. Most notably, we investigated the nature of the inter-individual interaction. We found that the interaction between birds does not depend on their mutual metric distance, as most current models and theories assume, but rather on the topological distance (number of intermediate neighbors). In fact, we discovered that each individual interacts on average with a fixed number of neighbors (six-seven), rather than with all neighbors within a fixed metric distance. We argue that a topological interaction of this kind is indispensable to maintain flock's cohesion against the large density changes caused by external perturbations, typically predation. More recently, we characterized the velocity field, and computed dynamical observables. We showed that flocks exhibit long range correlations, which are a signature of their remarkable collective behavior.