Synchronization of moving integrate and fire oscillators with a minimal interaction rule

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In the framework of the study of synchronization on populations of moving agents[1,2], we present a model of moving integrate and fire oscillators[3] that interact using a first-neighbor rule in a box with periodic boundary conditions. The time spent in synchronization (T_{sync}) is shown to be strongly dependent on the velocity in a non-uniform way.

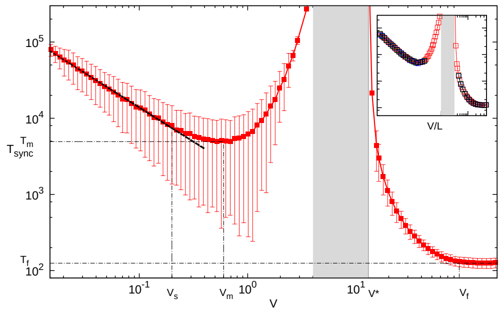

FIG. 1. Synchornization time as a function of the velocity of the agents. The shaded zone corresponds to the no-sync regime.

In doing so, we have detected the emergence of two distinct regimes that are separated by a peaked zone in which an interplay between movement and internal phases time scales inhibits the synchronization.

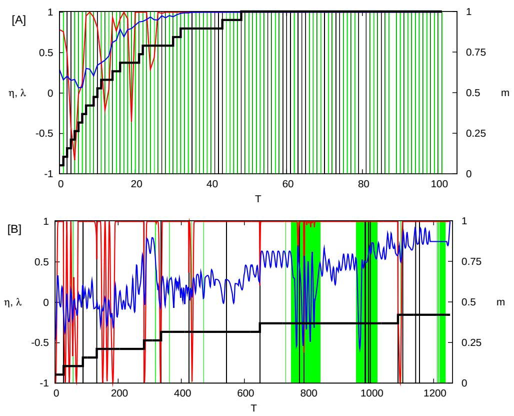

FIG. 2. Evolution of global η and local λ parameters as well as mixing m for a single run on the system as a function of reference time T. We observe sharp differences between fast (top) and slow (bottom) regime.

In order to investigate such zone we have introduced novel parameters (cumulative individual and total interaction network and mixing) providing empirical insights on the mechanisms that allow the system to reach the coherent state.

We have furthermore studied the dependence of our system with respect to the number of agents involved N, the coupling constant ϵ and the velocity v, detecting two distinct regimes[4]. A complete characterization of both the fast regime (where synchronization emerges gradually and globally on the system) and the slow one (where sync is attained through competition between local phases) is presented and scaling expression for the behaviour of the relevant magnitudes of the model are derived.

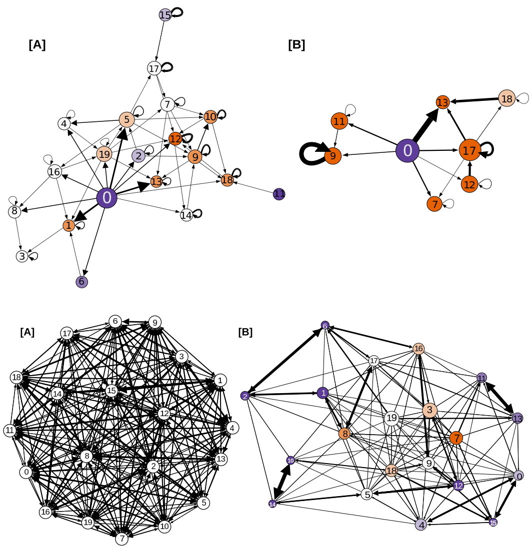

FIG. 3. Individual (top) and total (bottom) cumulative interaction networks of the system for fast (left) and slow (right) regimes that show the interaction among agents of the system using different sync mechanisms.

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[1] Frasca, M. et altr. *Synchronization of moving chaotic agents* PRL 100, 044102.

[2] Fujiwara, N. et altr. Synchronization in networks of mobile oscillators PRE 83, 025101

[3] Mirollo, R. E. & Strogatz, S. H. [1990] *Synchronization of Pulse-Coupled biological oscillators* SIAM J. Appl. Math. 50, 1645 1662.

[4] Prignano, L. et altr. *Synchronization of moving integrate and fire oscillators* IJBC D 11 00476 [in press].