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THE DYNAMICS OF RING NETWORKS OF DYNAMICAL SYSTEMS WITH PERIODICALLY FORCED INPUTS

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Networks describe how dynamical systems interact. A cell, or node, represents a component subsystem, and a connection represents an input from one cell to another. Applications are widespread and they include gene regulation networks, food webs, and neural networks, naming just a few. Networks often display patterns of synchrony, in which clusters of cells behave in the same manner. A related phenomenon, occurring when the system oscillates periodically, is phase-locking: cells behave the same way, except for a time delay. Coupled cell systems and symmetry group theory provide a general mathematical context for studying networks. The theory provides a classication, for any network, of all possible rigid patterns of synchrony and phase-locking: those that persist when the model equations are perturbed. It also provides methods for finding these patterns in a given model. Stability of synchronous states and periodic regimes in symmetric network can be analyzed with systematic methods based on a group theoretical approach. In this talk, I analyse transitions between symmetric and asymmetric regimes in ring networks with periodically forced connections. In particular, the network consists of a ring where the connections are periodically switched (ON/OFF) with a circular law. I consider, as an example, a sequence of n reactors where the feed position is periodically shifted according to a permutation law. I analyse the symmetry-breaking phenomena which are consequence of interaction between the natural and external forcing action. As the main parameters are varied due to the presence of Neimark-Saicker bifurcations, the system exhibits periodic regimes where the periods are exact multiples of the period of the forcing or quasi-periodic regimes. In addition to the standard phenomenon of frequency locking, we observe symmetry breaking bifurcations. While in a symmetric regime all the reactors in the network have the same time history, symmetry breaking is always coupled to a situation in which one or more reactors of the ring exhibit a greater temperature than the others. I found that symmetry is broken when the rotational number of the resonant limit cycle, which arises from the Neimark-Saicker bifurcation, is an specific ratio. Symmetry locking and resonance regions are computed through the bifurcational analysis to detect the critical parameters which mark the symmetry-breaking transitions. Finally, I will present numerical results when the dynamical systems of the network are PDEs.

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