



## Research Group for Nonlinear Dynamics and Complex Systems, Shaanxi Normal University

### Location

Chang'an Campus, Shaanxi Normal University  
Xi'an, China  
<http://wuli.snnu.edu.cn>

### Overview

The research group for nonlinear dynamics and complex systems is a virtual team comprised of some young researchers of common research interest in the School of Physics and Information Technology with the aim of improving the local academic environment and promoting scientific collaborations domestically and worldwide. The research interest of the group is currently focused on the dynamical behaviors of various nonlinear systems, with the subjects investigated ranging from classical to quantum systems, from low dimensional to spatiotemporal systems, and from regular network structures to complex network structures. The theoretical and numerical studies conducted on the various models shall extend our knowledge on the fascinating behaviors observed in nonlinear systems, and deepen understanding on the operation and functionality of many realistic complex systems.

### Contact Information

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### Research Topics

#### • Synchronization

We focus on the synchronization behavior of an ensemble of oscillators coupled through either the regular or complex structures. The topics under investigation include the interplay between network structure and synchronization, synchronization optimization and control, synchronization transition and transient processes, cluster synchronization, and their implication to the functions of neuronal networks. We also conduct experimental studies on synchronization behaviors in coupled mechanical oscillators and electrical circuits.

#### • Computational Neuroscience

The functions of neuronal systems rely on the collective behaviors of coupled neurons, which can be investigated numerically and theoretically by different models. We focus on the binding-by-synchrony mechanism of neuronal systems, in which cluster synchronization plays the key

role in realizing the neuronal functions. With the symmetry information of network structure, we are currently devoted to a general theorem for the dynamics of synchronization patterns in complex neuronal networks.

#### • Pattern Formation

We are interested in the emergence, control and dynamical properties of the spiral wave patterns in reaction-diffusion spatiotemporal systems. Through large-scale simulations and theoretical analysis, we try to explore the stability of spiral waves with respect to external control signals and intrinsic parameter configurations. Particular attention is paid to the impacts of obstacles on spiral wave stability and the control of spiral waves by externally added circular current.

#### • Complex Networks

The blooming of network science has stirred a new surge of research in the field of nonlinear dynamics and complex systems. We focus on the impacts of network structure on the collective behaviors of coupled dynamical units with a special interest in the cascading dynamics triggered by the simultaneous failures of a few of nodes in large-scale complex power-grid, and the control of firing patterns in complex neuronal networks by a slight change of the network structure.

#### • Quantum Cavity Optomechanics

The development of microfabrication technology makes the studies of the micromechanical motion at the quantum scale possible, thus opens a new window for investigating the nonlinear behaviors in quantum dynamical systems. The topics of interest include the dynamical transitions, the impacts of classical and quantum noises, and the mechanical control of optomechanical resonators, with the purpose of understanding the function and performance of quantum-scale devices such as nano-motor, precise sensor and quantum information processor.

#### • Complex Contagions

Motivated by the complexity of contagions in the real world, e.g., the spread of infectious diseases, dynamical models have been developed and studied with a focus on the interaction among contagions. We concentrate on the outbreak processes both in realistic networked population and their spatial propagation. The results of the studies find broad applications, ranging from epidemic spread to rumor control, social contagions, and viral marketing. We are also developing effective strategies for containment so as to combat those new scenarios of contagion outbreaks.