SFB 910 Symposium

“Dynamical patterns in complex networks”

Friday, 29th October 2021, 15:00 s.t.
via Zoom

Technische Universität Berlin
Straße des 17. Juni 135, 10623 Berlin

15:00 **Interplay between solitary states and chimeras in multiplex neural networks**

Prof. Dr. Galina Strelkova *(Saratov State University, Russia)*

15:40 **Unbalanced clustering and solitary states in coupled excitable systems**

Prof. Dr. Igor Franović *(University of Belgrade, Serbia)*

16:20 **Synchronization patterns in globally coupled Stuart-Landau oscillators**

Alexander Gerdes *(WIAS Berlin)*

Guests are welcome!

Sabine Klapp Bernold Fiedler Anna Zakharova

http://www.itp.tu-berlin.de/sfb910/

Abstracts

Interplay between solitary states and chimeras in multiplex neural networks

Prof. Dr. Galina Strelkova *(Saratov State University, Russia)*

We present numerical results for the spatiotemporal dynamics and synchronization of a heterogeneous two-layer multiplex network where each layer is represented by a ring of nonlocally coupled FitzHugh-Nagumo neurons in the oscillatory regime. Being uncoupled, individual layers can show chimera states, solitary states and combined structures (the coexistence of chimera and solitary states) depending on the values of the intralayer coupling parameters and initial conditions.

We choose different spatiotemporal patterns in the coupled layers and systematically study synchronization between them when the interlayer coupling is introduced through either the fast (activator) or the slow (inhibitor) variable of the FitzHugh-Nagumo oscillators. Our results enable to uncover the competitive behavior between the solitary states and the chimeras in the transition to synchronous regime in the considered network. We also analyze the synchronization peculiarities for two different types of the interlayer coupling by using the local and global synchronization measures.

Unbalanced clustering and solitary states in coupled excitable systems

Prof. Dr. Igor Franović *(University of Belgrade, Serbia)*

The discovery of chimera states incited a profound change of paradigm in understanding of self-organization in assemblies of coupled oscillators. Instead of synchronization transition and the onset of collective mode, the research focus has shifted toward the emergence of and the links between the states with symmetry-breaking of synchrony, including cluster states, chimeras and solitary states. While these two outstanding problems have typically been addressed for systems of coupled oscillators, a detailed insight concerning the class of coupled excitable systems is still missing.

In this talk, we report on the mechanisms of emergence and the link between two types of symmetry-broken states, namely the unbalanced periodic two-cluster states and solitary states, in coupled excitable systems, considering as an example systems of FitzHugh-Nagumo units with attractive and repulsive interactions. We show that solitary states in non-locally coupled arrays inherit their dynamical features from unbalanced cluster states in globally coupled networks. Apart from self-organization based on classical phase-locked synchrony, the interplay of excitability and local multiscale dynamics also gives rise to leap-frog (leader-switching) dynamics, characterized by an alternating order of spiking between the units. We discuss how the leap-frog dynamics, as a new mechanism of self-organization and pattern formation in coupled excitable systems, emerges as a consequence of phase-sensitive excitability of periodic orbits in vicinity of a canard transition. We further demonstrate that the noise may be used to control the multistability of system states via the effect of noise-induced preference of attractors, where the attractors with a larger basin of attraction are promoted at the expense of those with a smaller basin of attraction. In this way, small noise is capable of suppressing the multistability of cluster states and inducing the pattern homogenization, transforming the solitary states into patterns of patched synchrony.

Synchronization patterns in globally coupled Stuart-Landau oscillators

Alexander Gerdes *(WIAS Berlin)*

We study clusterized states in globally coupled Stuart–Landau oscillators as a paradigmatic model for patterning processes [Kemeth2019].

To study 2–Cluster states we set up a reduced model using collective variables, in which the cluster size ratio [Ott2015] is an additional bifurcation parameter. In the reduced system one can only observe longitudinal instabilities leading to complex 2–Cluster behaviour. By including test oscillators, we can also study instabilities transversal to the 2–Cluster manifold i.e. changes of the cluster type. Using numerical bifurcation analysis, we then find stability regions of cluster solutions of different types. In these, solitary states serve as primary patterns and allow an analytical treatment. The identified instabilities can be seen as building blocks of pathways to complex behaviour such as chimeras [Set2014] and extensive chaos [KM1994] as well as splay states [Politi2019] occuring for varying parameters. With the analytical and numerical approach presented here we identify different transition scenarios from synchrony to complex behaviour by reducing the coupling strength. We locate each of these scenarios in regions in the plane of shear parameters.

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