SOE 10: Chimera State: Symmetry breaking in dynamical networks (session accompanying symposium SYCS)

Time: Tuesday 14:00–15:00 Location: H36

SOE 10.1 Tue 14:00 H36

Controlling Chimera States - The influence of excitable units — •Philipp Hövel[1,2], Thomas Isele[1], Johanne Hizanidis[3,4], and Astero Provata[3] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Germany — [2]Bernstein Center for Computational Neuroscience Berlin, Humboldt Universität zu Berlin, Germany — [3]National Center for Scientific Research "Demokritos", Athen, Greece — [4]Crete Center for Quantum Complexity and Nanotechnology, University of Crete, Heraklion, Greece

We explore the influence of a block of excitable units on the existence and behavior of chimera states in a nonlocally coupled ring-network of FitzHugh-Nagumo elements. The FitzHugh-Nagumo system, a paradigmatic model in many fields from neuroscience to chemical pattern formation and nonlinear electronics, exhibits oscillatory or excitable behavior depending on the values of its parameters. Until now, chimera states have been studied in networks of coupled oscillatory FitzHugh-Nagumo elements. In the present work, we find that introducing a block of excitable units into the network may lead to several interesting effects. It allows for controlling the position of a chimera state as well as for generating a chimera state directly from the synchronous state.

SOE 10.2 Tue 14:15 H36

Stability analysis of long-living transient amplitude chimeras — •Liudmila Tumash, Anna Zakharova, Judith Lehnert, and Eckehard Schöll — Institut für Theoretische Physik,TU-Berlin, Hardenbergstr 36, 10623 Berlin, Germany,

Chimera states are characterized by a spontaneous break-up of a network of identical elements into coexisting domains of coherent (synchronized) and incoherent (desynchronized) dynamics. We study networks with coupled phase and amplitude dynamics. In contrast to classical phase chimeras, pure amplitude chimeras exhibit domains of coherent and incoherent dynamics with respect to the amplitude, but the phases are always regular and correlated. These states are long-living transients. In this work we investigate networks of Stuart-Landau oscillators with symmetry-breaking non-local coupling, in which amplitude chimeras can occur [1]. We verify the hypothesis that amplitude chimeras represent saddle-states in a high-dimensional phase space by calculating the Floquet exponents and the corresponding Floquet eigenvectors. In this way we can explain the dependence of the transient times upon coupling strength, coupling range and network size.

[1] A. Zakharova, M. Kapeller, E. Schöll, Phys. Rev. Lett. **112**, 154101 (2014).

SOE 10.3 Tue 14:30 H36

Chimera patterns under the impact of noise — •Sarah A. M. Loos[1], Jens Christian Claussen[2], Eckehard Schöll[1], and Anna Zakharova[1] — [1]Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany — [2]Computational Systems Biology Lab, Campus Ring 1, Jacobs University Bremen, D- 28759 Bremen, Germany

We investigate two types of chimera states, i.e., patterns consisting of coexisting spatially separated domains with coherent and incoherent dynamics, under the influence of noise [1]. Both chimera states arise in ring networks of Stuart-Landau oscillators with symmetry-breaking coupling [2]. Amplitude chimeras are characterized by temporally periodic dynamics throughout the whole network, but spatially incoherent behavior with respect to the amplitudes in a part of the system. They are long-living transients. Chimera death states generalize chimeras to stationary inhomogeneous patterns (oscillation death), which combine spatially coherent and incoherent domains. We analyze the impact of random perturbations on their occurrence and on their lifetimes, addressing the question of robustness of chimera states in the presence of additive white noise.

[1] S. A. M. Loos et al., arXiv:1508.04010v2, (2015).
[2] A. Zakharova et al., Phys. Rev. Lett. 112, 154101 (2014).

SOE 10.4 Tue 14:45 H36

A classification scheme of chimera states — •Felix P. Kemeth[1,2], Sindre W. Haugland[1,2], Lennart Schmidt[1], Ioannis G. Kevrekidis[2,3], and Katharina Krischer[1] — [1]Physik-Department, Nonequilibrium Chemical Physics, Technische Universität München, James-Franck-Str. 1, D-85748 Garching, Germany — [2]TUM Institute for Advanced Study, Lichtenbergstraße 2a, D-85748 Garching, Germany — [3]The Department of Chemical and Biological Engineering, Princeton University, Princeton, NJ 08544, USA

The vast and continuously growing number of chimera or chimera-like states discovered in recent years demands a classification of the various manifestations of these dynamical hybrid states. We propose systematic and reductive approaches to characterize chimera states in systems with and without spatial extent, respectively. For locally and non-locally coupled systems, that is for systems involving a spatial extension, we apply a discrete version of the Laplace operator on spatio-temporal data sets exhibiting coexistence of coherent and incoherent regions. Regarding its statistical properties we introduce a detailed classification of chimera states into groups sharing the same qualitative behavior. For globally coupled systems without a spatial dimension, the statistics of pairwise Euclidean distances between all oscillators allow a similar analysis. This classification helps clarify the different facets of chimera states and broadens our understanding of this peculiar phenomenon.