# SOE 20: Chimera states: symmetry-breaking in dynamical networks (joint session DY/BP/SOE)

Time: Thursday 16:30–17:00 Location: ZEU 147

SOE 20.1 Thu 16:30 ZEU 147

**The emergence of chimera states in arrays of cilia** — •Thomas Niedermayer and Markus Bär — Physikalisch-Technische Bundesanstalt (PTB), Berlin

Systems of non-locally coupled, identical phase oscillators exhibit the coexistence of coherent and incoherent regions. These intriguing dynamical states, termed chimeras, have been studied theoretically in recent years and their emergence is hypothesized for instance in unihemispheric sleep and ventricular fibrillation. However, observations directly linked to theory were only made in engineered systems.

We have reconsidered our previously published phase oscillator model for hydrodynamic interactions of flagella and cilia, thread-like projections of eukaryotic cells. This simple, yet realistic, minimal model gives rise to the well-established phenomenon of metachronal waves. Here, we show that it additionally comprises all necessary and sufficient conditions for the emergence of chimera states. In particular, the flexibility of cilia might function as a lever between synchronous and asynchronous dynamics, that is a switch between two qualitatively different motility states. Our theoretical predictions provide a testable hypothesis in experimental and computational studies of large cilia arrays.

SOE 20.2 Thu 16:45 ZEU 147

**Origins of alternating chimeras** — •Sindre W. Haugland, Felix P. Kemeth, and Katharina Krischer — Physik-Department, Nonequilibrium Chemical Physics, Technische Universität München, James-Franck-Str. 1, D-85748 Garching, Germany

Oscillatory media can exhibit the coexistence of synchronized and desynchronized regions, so-called chimera states, for uniform parameters and symmetrical coupling. In a phase-balanced chimera state, where the totals of synchronized and desynchronized regions, respectively, are of the same size, the symmetry of the system allows for an alternative solution to the underlying equations, in which the dynamics of the phases are interchanged. Recently, we observed this kind of interchange as a self-emergent, self-sustained phenomenon in simulations of an oscillatory medium governed by a complex Ginzburg-Landau equation with nonlinear global coupling, and classified it as an alternating chimera (Sci. Rep. 5, 9883 (2015)). Here, we present more systematic research on its origin and dynamics, revealing new, related states, notably a form of self-sustained alternating regular subclustering, and providing additional insights into its mechanism of emergence. Working with minimal models, we are able to reproduce important features of the oscillatory medium close to the alternating chimera, and to identify several specific bifurcations in which these features are created and destroyed. Our results broaden the knowledge about self-emergent and self-sustained chimera states, particularly regarding alternating chimeras, and may help improve our understanding of chimera-like phenomena observed in biology.