Eugene Wigner Colloquium

event of SFB 910

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"Cross frequency coupling in next generation inhibitory neural mass models"

Coupling among neural rhythms is one of the most important mechanisms at the basis of cognitive processes in the brain. In this talk we consider a neural mass model, rigorously obtained from the microscopic dynamics of an inhibitory spiking network with exponential synapses, able to autonomously generate collective oscillations (COs). These oscillations emerge via a super-critical Hopf bifurcation, and their frequencies are controlled by the synaptic time scale, the synaptic coupling and the excitability of the neural population. Furthermore, we show that two inhibitory populations in a master-slave configuration with different synaptic time scales can display various collective dynamical regimes: namely, damped oscillations towards a stable focus, periodic and quasi-periodic oscillations, and chaos. Finally, when bidirectionally coupled the two inhibitory populations can exhibit different types of theta-gamma cross-frequency couplings (CFCs): namely, phase-phase and phase-amplitude CFC. The coupling between theta and gamma COs is enhanced in presence of a external theta forcing, reminiscent of the type of modulation induced in Hippocampal and Cortex circuits via optogenetic drive.Coupling among neural rhythms is one of the most important mechanisms at the basis of cognitive processes in the brain. In this talk we consider a neural mass model, rigorously obtained from the microscopic dynamics of an inhibitory spiking network with exponential synapses, able to autonomously generate collective oscillations (COs). These oscillations emerge via a super-critical Hopf bifurcation, and their frequencies are controlled by the synaptic time scale, the synaptic coupling and the excitability of the neural population. Furthermore, we show that two inhibitory populations in a master-slave configuration with different synaptic time scales can display various collective dynamical regimes: namely, damped oscillations towards a stable focus, periodic and quasi-periodic oscillations, and chaos. Finally, when bidirectionally coupled the two inhibitory populations can exhibit different types of theta-gamma cross-frequency couplings (CFCs): namely, phase-phase and phase-amplitude CFC. The coupling between theta and gamma COs is enhanced in presence of a external theta forcing, reminiscent of the type of modulation induced in Hippocampal and Cortex circuits via optogenetic drive.

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