Berlin Center for Studies of Complex Chemical Systems

Fritz-Haber-Institut der Max-Planck-Gesellschaft, Humboldt-Universität, Max-Delbrück-Centrum für Molekulare Medizin, Otto-von-Guericke-Universität Magdeburg, Physikalisch-Technische Bundesanstalt, Technische Universität Berlin, Universität Potsdam.

Seminar

Complex Nonlinear Processes in Chemistry and Biology

Honorary Chairman: G. Ertl.
Organizers: M. Bär, C. Beta, H. Engel, M. Falcke, M. J. B. Hauser, J. Kurths, A. S. Mikhailov, P. Plath, L. Schimansky-Geier, and H. Stark.

Friday, 15th February, 2013, 16:00 s.t.
Address: Richard-Willstätter-Haus, Faradayweg 10,14195 Berlin, U-Bahnhof Thielplatz (U3).

Prof. Martin Zapotocky

Academy of Sciences of the Czech Republic

The Arnol'd tongues of a fly: mechanosensory control of wing beat in Drosophila

In many animals, rhythmic motor activity is governed by neural limit cycle oscillations under the control of sensory feedback. In the fruit fly Drosophila melanogaster, the wingbeat rhythm is generated myogenically by stretchactivated muscles and hence independently from direct neural input. In this study, we explored if generation and cycle-by-cycle control of Drosophila's wingbeat are functionally separated, or if the steering muscles instead couple into the myogenic rhythm as a weak forcing of a limit cycle oscillator. We behaviourally tested tethered flying flies for characteristic properties of limit cycle oscillators. To this end, we mechanically stimulated the fly's 'gyroscopic' organs, the halteres, and determined the phase relationship between the wing motion and stimulus. The flies synchronized with the stimulus for specific ranges of stimulus amplitude and frequency, revealing the characteristic Arnol'd tongues of a forced limit cycle oscillator. Rapid periodic modulation of the wingbeat frequency prior to locking demonstrates the involvement of the fast steering muscles in the observed control of the wingbeat frequency. We propose that the mechanical forcing of a myogenic limit cycle oscillator permits flies to avoid the comparatively slow control based on a neural central pattern generator.

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