# 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, 25th October, 2013, 16:00 s.t.
**Address**: Richard-Willstätter-Haus, Faradayweg 10, 14195 Berlin, U-Bahnhof Thielplatz (U3).


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## Sisyphus Effect in Plastic Neural Networks


The collective dynamics of excitatory pulse coupled neurons with spike-timing dependent plasticity is studied. The introduction of spike-timing dependent plasticity induces persistent irregular oscillations between strongly and weakly synchronized states, reminiscent of brain activity during slow-wave sleep. We explain the oscillations by a mechanism, the Sisyphus Effect, caused by a continuous feedback between two collective variables representing the average synaptic weight and the the level of synchronization in the system. The neuronal activity can be represented in terms of an order parameter diffusing over an effective free energy landscape displaying two coexisting equilibrium states corresponding to high and low synchronization. Small (large) synaptic weights tilt the landscape towards the strongly (weakly) synchronized state; in turn, the induced activity increases (reduces) the weights until a tilt in the opposite direction occurs. Thus, the landscape oscillates endlessly. Due to this effect, the synaptic weights have oscillating equilibrium values, and this prevents the system from relaxing into a stationary macroscopic state.


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