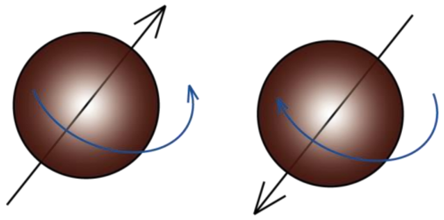
Research (What is it about?)	**Synchronization regimes in arrays of spin-torque oscillators**
UNN authors	*Pikovsky A.*
We find (The result)	It is shown that in ***arrays of spin-torque nano-oscillators*** coupled via an RC load the cluster synchronization regimes (partial or total ones) are possible and the partial synchronization regime (no clusters but a nonvanishing mean field) at the same time.
Abstract	Spin-torque oscillator is a nanoscale spintronic device generating periodic microwave (in the frequency range of several GHz) oscillations. The generation is based on the spin-transfer torque force, with which a spin-polarized electrical current (created by sending electrons through a thick layer with fixed magnetization M_0) acts on a small free precessing magnet. As the electrons with spins aligned via M_0enter the free layer, a spin transfer torque acts on its magnetization, tending to reorient. The spin transfer torque can compensate the damping of the spin precession of the free layer, and in a constant external magnetic field a sustained oscillation (rotation of magnetization vector) takes place. To increase the radiated field an array of synchronized oscillators is needed. We consider synchronization properties of those arrays coupled via an RC load. These quantum oscillators, being more complex than the classic ones, demonstrate also more complex properties of the collective dynamics. We show that while the fully synchronized state of identical oscillators may be locally stable in some parameter range, this synchrony is not globally attracting. Instead, regimes of different levels of compositional complexity are observed. These include "***chimera states***" (a part of the array forms a cluster while other units are desynchronized), "***clustered chimeras***" (several clusters plus desynchronized oscillators), ***cluster state*** (all oscillators form several clusters), and ***partial synchronization*** (no clusters but a nonvanishing mean field). Dynamically, these states are also complex, demonstrating irregular and close to quasiperiodic modulation.

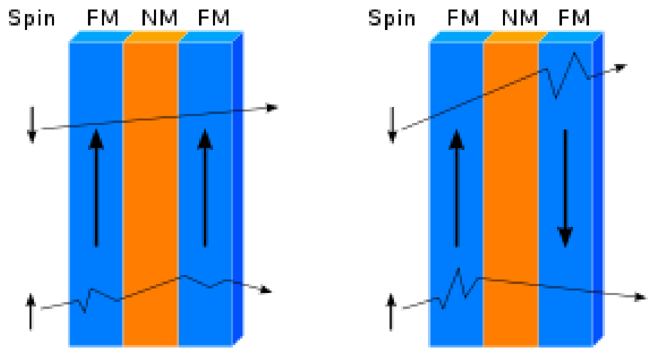
Representative articles 2017-2018, quartiles	1. *Zaks M., Pikovsky A.* Chimeras and complex cluster states in arrays of spin-torque oscillators. Sci. Reports. **7**: 4648 (2017).	Q1
	Q-index (Qi) for the result	**4**
	high blue	

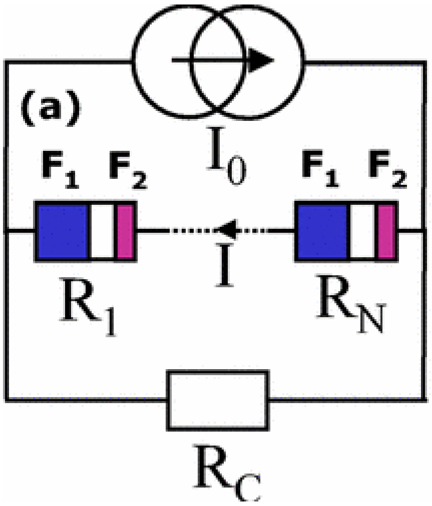
In collaboration	University of Potsdam, Potsdam-Golm 14476,Germany



Opposite spins (intrinsic magnetic moments) of two electrons.

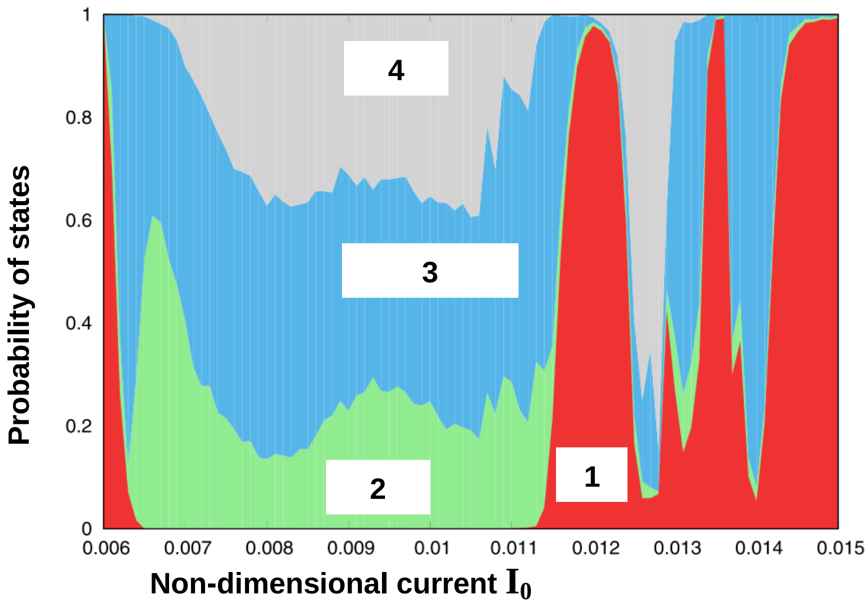
Spintronic device on the basis of giant magnetoresistance effect: when magnetization in ferromagnetic layers (FM) separated by thin nonmetal layer (NM) are antiparallel the resistance is giant.





The switching circuit for array of spin-torque oscillators coupled via an RC load.

Probability diagram for synchronization regimes:



1 – partial synchronization,
2 – one cluster while other units are desynchronized,
3 – several clusters plus desynchronized oscillators,
4 – all oscillators form several clusters.

The example of field dynamic for the different time scales