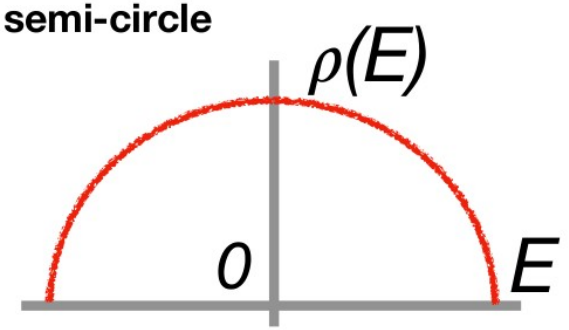
We are young and progressive group of scientists studying complex theoretical problems of condensed matter physics

Self-consistent random matrix ensembles
Teorie self-konzistentních náhodních matic

Ensemble of Hamiltonian (Hermitean) matrices

$$\hat{H} = \begin{pmatrix} H_{11} & H_{12} & H_{13} & \cdots \\ H_{21} & H_{22} & H_{23} & \cdots \\ H_{31} & H_{32} & H_{33} & \cdots \\ \cdots & \cdots & \cdots & \ddots \end{pmatrix}$$

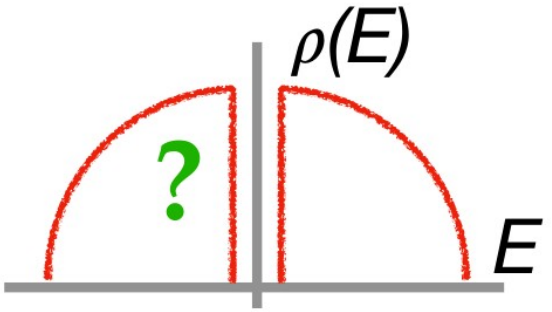
Distribution of eigenvalues: semi-circle



Interacting electrons: Hartree potential

$$V_{ij} = \delta_{ij} \sum_k v(i-k) n_k$$

Gap opening?



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Usměrněný stochastický pohyb ve dvoudimenzionálních optických mřížkách

(bakalářská/diplomová práce; školitel RNDr. **Tomáš Novotný**, Ph.D.)

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Omnidirectional Transport in Fully Reconfigurable Two Dimensional Optical Ratchets

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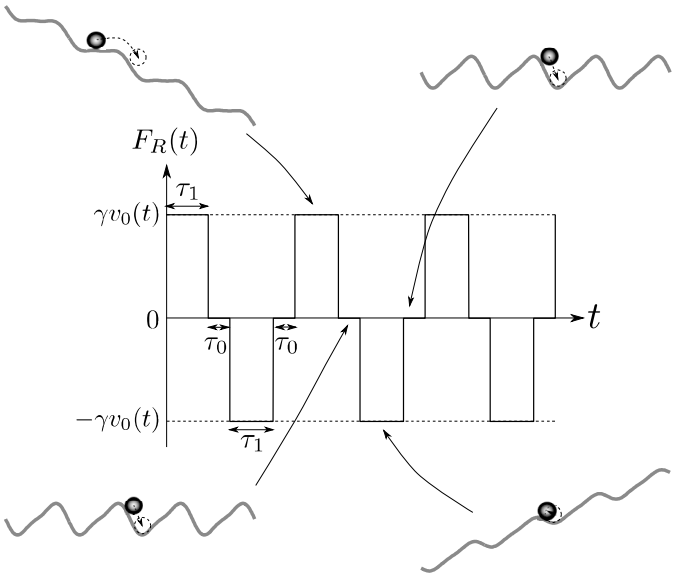
A fully reconfigurable two-dimensional (2D) rocking ratchet system created with holographic optical micromanipulation is presented. We can generate optical potentials with the geometry of any Bravais lattice in 2D and introduce a spatial asymmetry with arbitrary orientation. Nontrivial directed transport of Brownian particles along different directions is demonstrated numerically and experimentally, including on axis, perpendicular, and oblique with respect to an unbiased ac driving. The most important aspect to define the current direction is shown to be the asymmetry and not the driving orientation, and yet we show a system in which the asymmetry orientation of each potential well does not coincide with the transport direction, suggesting an additional symmetry breaking as a result of a coupling with the lattice configuration. Our experimental device, due to its versatility, opens up a new range of possibilities in the study of nonequilibrium dynamics at the microscopic level.



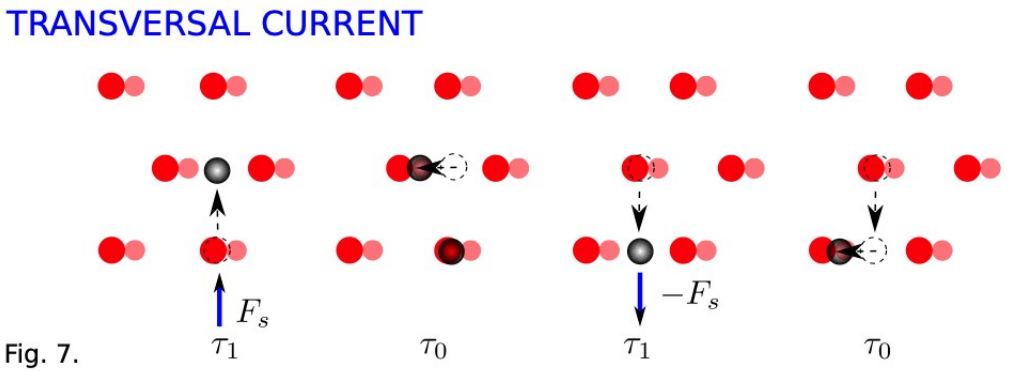
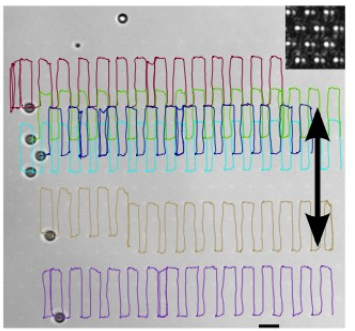


Fig. 7.



Usměrněný stochastický pohyb ve dvoudimenzionálních optických mřížkách

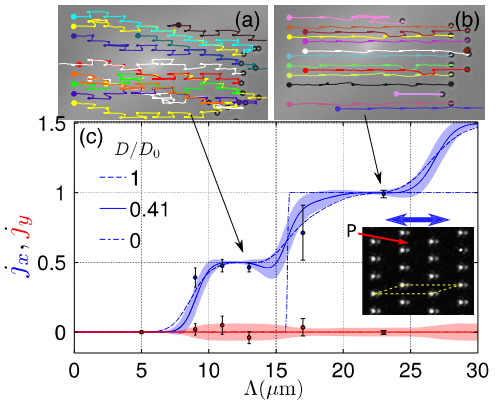
(bakalářská/diplomová práce; školitel RNDr. **Tomáš Novotný**, Ph.D.)

- Experimentálně - motivovaná práce (skupina prof. Pavla Zemánka z Ústavu přístrojové techniky AV ČR v Brně) – optické mřížky
- Veliké možnosti naladění dynamického režimu v dostupném experimentálním uspořádání (od skoro deterministické k plně stochastické dynamice; 1D nebo 2D; volba protokolu naklápění...)
- Efekt rohatky („ratchet“) vedoucí k usměrnění středního pohybu částic v kolmém směru

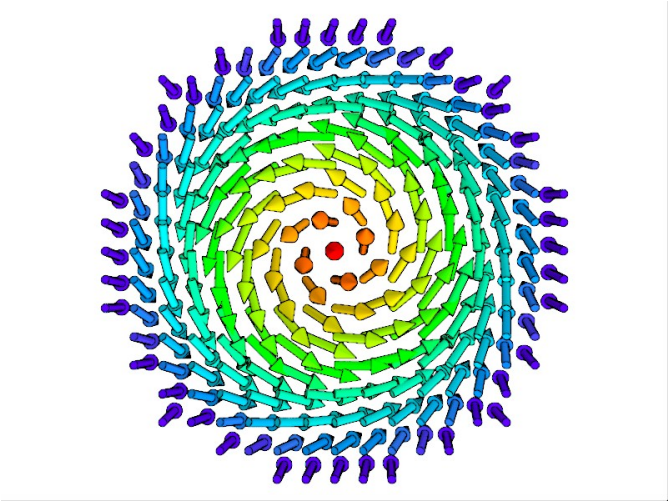
- Modelování dynamiky na různých úrovních popisu: Langevinova dynamika; (2D) Fokker-Planckova/Kramersova rovnice

- Optimalizace experimentálního uspořádání pro maximalizaci usměrnění

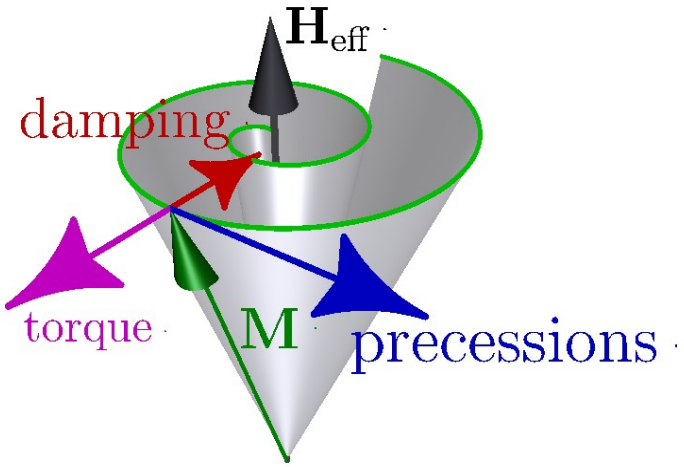
- Realizace „optických sít“

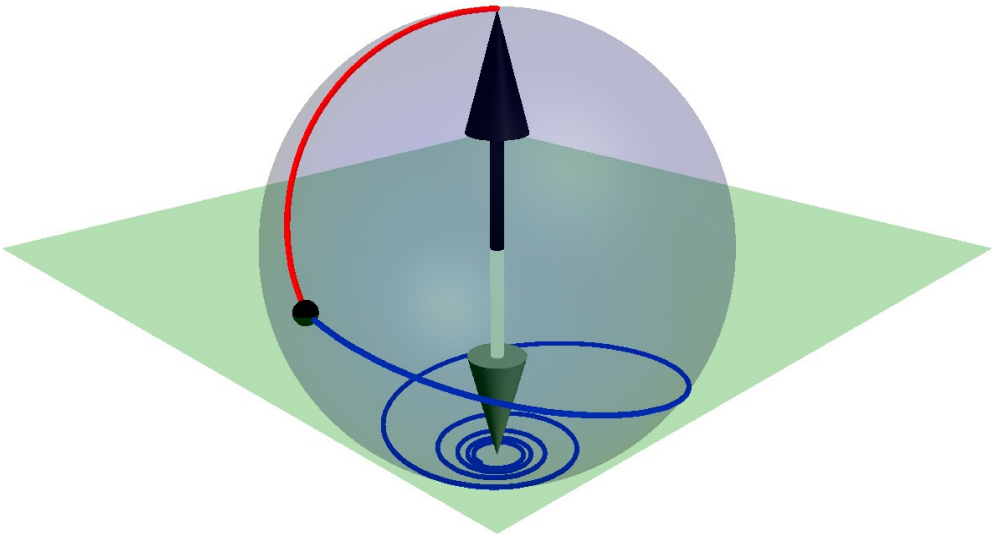


Magnetization dynamics: Coupled systems of nonlinear stochastic differential equations



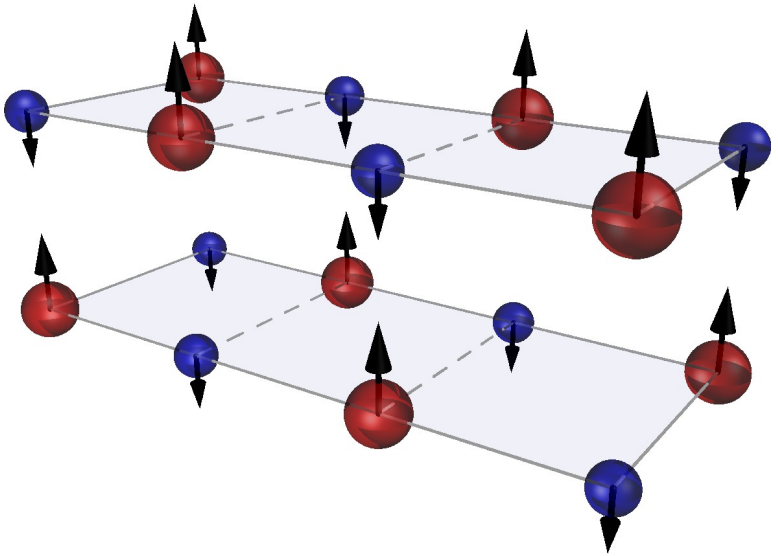
- Magnetization dynamics is described by **Landau-Lifshitz-Gilbert** equation (LLG)
- First order stochastic differential equation with time dependent coefficients
- Modeling of magnetization dynamics in certain requires numerical solution

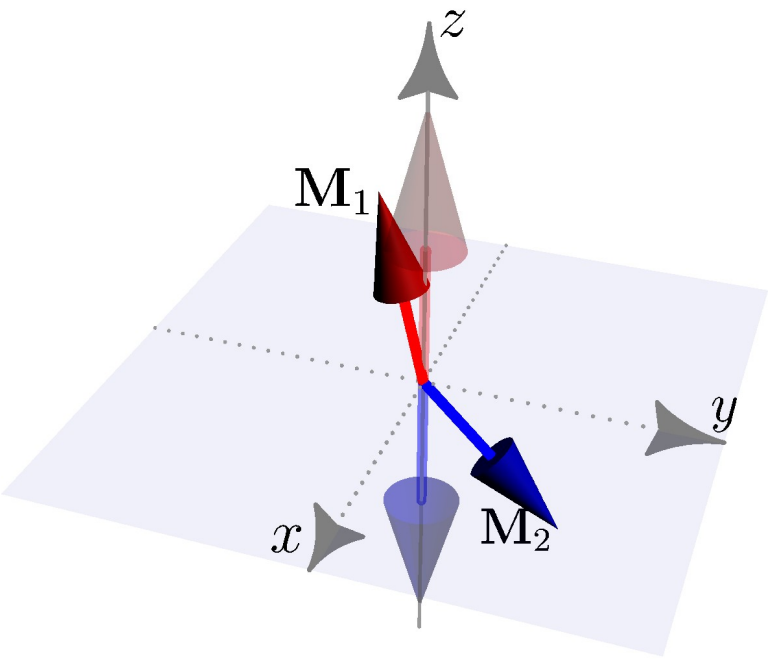




Kontakt: RNDr. Pavel Baláž, PhD (balaz@karlov.mff.cuni.cz)

Multiscale modeling





- Different important features on different time and space scales
- Atomistic spin dynamics, micromagnetic simulations, macrospcopic models

What do we need?

- Development of efficient methods for solving LLG under various conditions
- Solving semianalitical models (matrix diagonalization, solving large systems of linear equations)
- Data analysis (correlation functions, bifurcation diagrams, Poincare maps, ...)

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Benefits

- Participation in scientific projects
- Possibility of part employment
- Possibility of being a coauthor of research publications
- Worldwide collaborations
- Work on large scale supercomputing facilities

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