NEWSLETTER

CUI – Graduate School

No.17, April 2018

Main topics

- The Graduate Days
- Course programme
- Research highlights
- Personalia
- Mildred Dresselhaus Guest Professor 2017
- Important dates in 2018

Editorial

Recently, our full cluster proposal AIM has been submitted to the Deutsche Forschungsgemeinschaft and we are now looking forward to the forthcoming meeting in Bonn, where our proposal will be presented and defended in front of the review panel. Meanwhile we can enjoy some recent important scientific accomplishments of CUI scientists and the success of our last edition of the CUI Graduate Days.

We wish you a pleasant reading and a fruitful summer term!

Antonio Negretti and Peter Schmelcher

The Graduate Days

From March 19 to March 22, 2018, the fifth edition of the Graduate Days of CUI took place. About 60 participants attended the event, mostly PhD and Master students.
Highlights of the Graduate Days were the colloquium by Prof. Hendrick Dietz on Tuesday, March 20, and the industry talk by Dr. Alina Chanaewa on Wednesday, March 21. The former gave a very interesting overview of how programmable self-assembly with DNA origami allows creating custom-shaped nanoscale instruments to perform precision measurements. For instance, molecular interactions and structures with high control over positioning and orientation of the molecules under investigation can be assessed.
For this year industry talk we have invited a former PhD student of Prof. Horst Weller, Dr. Chanaewa, who provided her experience within a small start-up, where she is the only leading scientist that is responsible for the scientific aspects of the company. Furthermore, she has answered a large number of questions asked by the attendees, especially with regard to her daily work, her responsibilities, and the reasons for moving to industry.

Course programme

The summer term has started and the course programme with a rich variety of seminars and lectures has been prepared. The main lecture of this summer term is *New experiments with XFEL sources* given by Prof. Christian Bressler and colleagues. The detailed programme can be downloaded at the CUI webpage.

Research highlights

Measuring topology from dynamics: Topology plays an important role in modern solid-state physics describing intriguing quantum states such as topological insulators. It is an intrinsically non-local property and therefore challenging to access. The realization of topological bands in experimental model systems of ultracold atoms in driven optical lattices opens up novel routes for their exploration. The CUI PhD student Matthias Tarnowski and colleagues in the research group of Prof. Klaus Sengstock together with Dr. André Eckardt and Dr. Nur Ünal from the MPIPKS in Dresden now took a new approach by connecting the topology to the dynamical evolu-

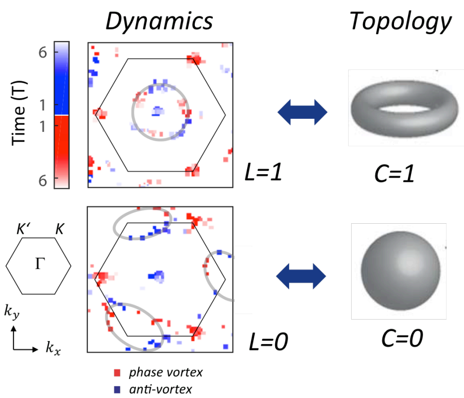

Fig. 1 Illustration of the mapping between the observed dynamics and the topology of the underlying Bloch bands. The left column shows typical data of the vorticity (red and blue squares) of the momentum-space state tomography. The hexagon marks the first Brillouin zone and the Dirac points of the driven hexagonal lattice lie at the K and Γ points. The grey line indicates the closed vortex contour, which does enclose the static vortex at the Γ point in the upper case (C=1), but not in the lower case (C=0).

Personalia

Dr. Alice Cantaluppi has recently received the doctoral degree in Physics under the supervision of Prof. Andrea Cavalleri. She investigated the response of three-dimensional organic superconductor potassium-doped fullerides to strong resonant low-energy excitations. Using ultrashort pulses of high intensity delivered by an optical parametric amplifier and a broadband THz-Time domain spectroscopy setup, Alice studied the evolution of the transient superconducting-like response under high pressure.

Alice Cantaluppi

We congratulate her for her achievements!

tion after a quench of the system. They use a direct mapping between the Chern number *C*, which characterizes the topology of the bands, to the linking number *L* of vortex trajectories that appear in the dynamical evolution. These vortices are visible in the phase of the wave function in momentum space (see also Fig. 1), which the researchers access with a previously developed state-tomography method. The researchers find static vortices at the positions of the Dirac points of the hexagonal lattice and additional dynamical vortices that move through momentum space and form a closed contour. The linking number counts the linking of this contour around one of the static vortices. The striking feature of this measurement is thus the direct observation of a topological quantity, in stark contrast to the usual detection of topology via the quantization of the Hall transport.

Matthias Tarnowski and his colleagues used this technique to map out the topological phase diagram. In their model system, the Chern number changes with the frequency of the circular lattice shaking over which they have excellent control. The presented method will also be a promising starting point to investigate topology in interacting systems.

The work is published as preprint at arXiv:1709.01046 (2017).

Tunable geometrical frustration in magnonic vortex crystals: Frustration is of great general interest as it gives rise to new physical phenomena, such as magnetic monopoles. Frustration arises when competing interactions cannot be all satisfied at the same time. A novel approach to investigate geometrical frustration was introduced using two-dimensional magnonic vortex crystals by the CUI PhD student C. Behncke and the CUI postdoc Dr. C. F. Adolff in the group of Dr. G. Meier.

The magnetic vortex state forms in ferromagnetic nanodisks and features an in-plane curling magnetization with an out-of-plane component in the centre region, the vortex core. The out-of-plane component can point up or down which is characterized by the polarization. Geometrical frustration is observed experimentally in vortex crystals that are positioned analogous to the nanoislands in artificial spin ice (see Fig. 2). The polarization state can be modified in a self-organized manner by using a high frequency magnetic field. Depending on the frequency of this state formation signal, different ground states can be tuned. The scientists demonstrated that it is possible to change the polarization configuration from a frustrated state to a non-frustrated state and vice-versa. In the frustrated state, each vortex prefers an alternating polarization with each of its neighbours. This is not possible in the triple junctions and frustration arises. In the non-frustrated state, neighbouring vortices favour equal polarizations. In the present experiments, the frustration is turned on and off within milliseconds and can be potentially accelerated to the nanosecond regime.

This work has been published in Sci. Rep. **8**, 186 (2018).

Mildred Dresselhaus Guest Professor 2017

We warmly welcome Prof. Anna Krylov as CUI guest professor. She is professor of Chemistry and Gabilan Distinguished Professor of Science and Engineering at the University of Southern California.

We wish her a very productive and successful research work during her stays at CUI.

Important dates in 2018

We remind you of the following events: May 5, Exhibition "Arts & Science" during XFEL Open Day; September 17-19, Final International Symposium; November 14-16, the CUI Annual Meeting.

You are welcome to: ... send us suggestions of topics, which you would like to be mentioned in the next newsletter (anegrett@physnet.uni-hamburg.de).

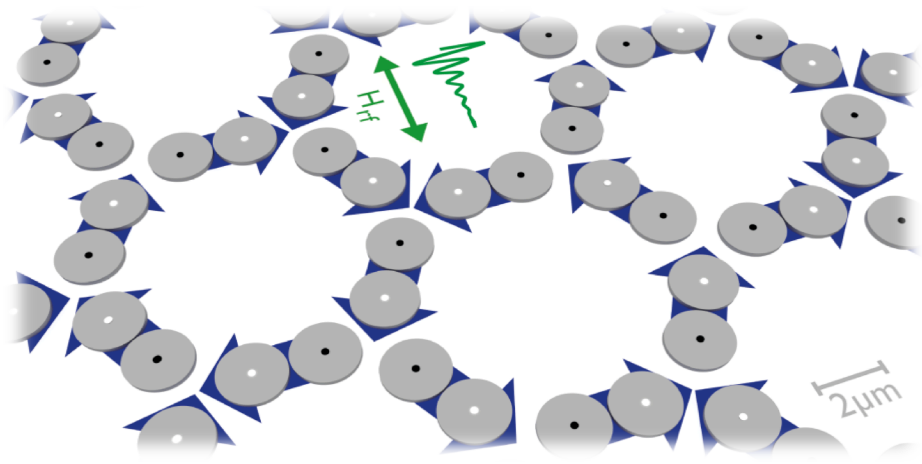

Fig. 2. Schematic representation of the investigated vortex system. The black and white dots represent the polarization of the vortices. The blue arrows illustrate the analogy of two vortices with alternating polarizations to a nanoisland in artificial spin ice systems.