**Plenary Talk** PLV I Mon 8:30 H 0105

**Opportunities from single magnetic adatoms on superconductors** — •Katharina J. Franke — Freie Universität Berlin, Berlin, Germany

Magnetic adatoms on superconductors induce bound states - known as Yu-Shiba-Rusinov (YSR) states - inside the superconducting energy gap of the underlying substrate. These states have been widely characterized by scanning tunneling microscopy/spectroscopy (STM/STS), leading to a fundamental understanding on how spin-carrying orbitals exchange couple to the substrate, how the YSR states hybridize and how they eventually form bands within the superconducting energy gap. Additionally, magnetic adatoms on superconductors have been recognized as essential components in the construction of nanostructures featuring non-trivial topological characteristics.

Adding to this versatile platform, magnetic adatoms can be included into Josephson junctions formed by approaching the atom with a superconducting STM tip. Remarkably, the presence of YSR states induces diode-like behavior of the Josephson junction. This implies that the junction allows for dissipationless supercurrent flow in one direction, while the current in the other direction underlies dissipation.

**Plenary Talk** PLV II Mon 14:00 H 0105

**How to Rectify Supercurrents Using Electron Spin?** — •Christoph Strunk — Uni Regensburg, Regensburg, Germany

The recent discovery of intrinsic supercurrent diode effect, and its prompt observation in a rich variety of systems, has shown that non-reciprocal supercurrents naturally emerge when both space- and time-inversion symmetries are broken. After an overview over different microscopic mechanisms behind the effect, I will report on the Josephson diode effect in planar Josephson junctions with strong spin-orbit interaction. The devices are based on ballistic Al/InAs-heterostructures that are exposed to an in-plane magnetic field $B_{\text{ip}}$. At low $B_{\text{ip}}$ a non-reciprocal term is found in the Josephson inductance that is linear in $B_{\text{ip}}$. At higher $B_{\text{ip}}$ a sign reversal of the non-reciprocal term is observed that can be traced back to a $0-\pi$-like transition in the current-phase relation. Different avenues for a theoretical interpretation are discussed. As pronounced gate tunability of both the $\varphi_0$ shift and the diode efficiency in an asymmetric SQUID device demonstrates that Rashba spin-orbit interaction provides a substantial contribution to the Josephson diode effect.

**Plenary Talk** PLV III Mon 14:00 H 0104

**The cell as a material** — •Gijsje Koenderink — Bionanoscience Department, Delft University of Technology, Kavli Institute of Nanoscience Delft, Delft, Netherlands

Cells are dynamic but also need to withstand large mechanical loads. This paradoxical mechanical behavior is governed by a polymer scaffold known as the cytoskeleton. It is still poorly understood how this biopolymer network can combine mechanical strength with the ability to dynamically adapt its structure and mechanics. I will summarize our recent findings obtained via quantitative measurements on living cells coupled with experiments using synthetic cells reconstituted from purified molecular components. I will focus on the role of mechanical crosstalk between the four cytoskeletal networks in the cell: actin filaments, microtubules, intermediate filaments and septins. These four filamentous systems contribute different structural and dynamical properties, but their activities are closely coordinated. I will show that combining cell and cell-free assays allows us to dissect the collaborative and individual roles of the cytoskeletal systems. Our findings may eventually be interesting to guide the search for selective anticancer drugs, since cancer cells often overexpress specific septins, intermediate filaments, and cytoskeletal crosslinker proteins leading to abnormal mechanical behaviors.

**Plenary Talk** PLV IV Tue 8:30 H 0105

**Capturing light induced phase transitions with femtosecond movies** — •Nuh Gedik — Massachusetts Institute of Technology, Cambridge, MA, USA

Materials typically undergo phase changes as a function of external parameters such as temperature, pressure or magnetic field. Light can also be used to both switch between equilibrium phases and to create new photo-induced states that may have no equilibrium counterparts. Even though there are fascinating examples of photoinduced phase transitions, the detailed microscopic mechanisms and overarching principles that govern these are still not known. In this talk, I will present two recent examples that advance our understanding of this phenomena. First, I will describe how we used ultrashort laser pulses to capture light induced melting and recovery of a charge density wave phase with femtosecond time resolution. During this process, a new state that does not exist in equilibrium is also transiently created. Secondly, I will show experiments in which high field THz pulses are used to induce metastable magnetization in a layered antiferromagnet. Understanding light induced phase transitions could pave the way for optical engineering of new quantum states of matter.

**Plenary Talk** PLV V Wed 8:30 H 0105

**Unconventional Magnetism in Spintronics: the emergence of Altermagnetism and its new variants** — •Jairo Sinova — Johannes Gutenberg University Mainz

Antiferromagnetic spintronics has been a very active research area of condensed matter in recent years. As we have learned how to manipulate collinear antiferromagnets actively and their emergent topology by means of new types of spin-orbit torques, a key problem remained: the inefficiency of relativistic mechanism. The necessity of relativistic effects to manipulate and detect Néel order arises from the spin degeneracy of collinear antiferromagnets in the non-relativistic limit * or at least it was thought. The discovery of d-wave magnetic order in momentum space motivated a closer look at the symmetry classification of collinear magnetic systems. This has emerged as the third basic collinear magnetic ordered phase of altermagnetism, which goes beyond ferromagnets and antiferromagnets. Altermagnets exhibit an unconventional spin-polarized d/g/i-wave band structure in reciprocal space, originating from the local sublattice anisotropies in direct space. This gives properties unique to altermagnets (e.g., the spin-splitter effect), while also having ferromagnetic (e.g., polarized currents) and antiferromagnetic (e.g., THz spin dynamics and zero net magnetization) characteristics useful for spintronics device functionalities. I will cover the basic introductory view to altermagnetism and its consequences to spintronics as well as new emerging exchange driven phenomena akin to spin-orbit coupling effects, such as p-wave magnetism, emerging from the basic concepts that gave rise to the discovery of altermagnetism.

**Plenary Talk** PLV VI Wed 14:00 H 0105

**Decoding and Steering Monitored Quantum Dynamics** — •Matthew Fisher — UC Santa Barbara, Santa Barbara, CA USA

When a many-body quantum system is continuously "monitored" (measured) by an observer, the resulting quantum trajectories constitute an ensemble of pure states, which can exhibit measurement-induced phase transitions (MIPT), for example between volume law and area law entanglement, or between phases with or without symmetry breaking and/or topological order. Here, measurements are being employed to induce a new non-unitary dynamics, rather than just measuring a property of a given state. While the MIPT occurs generically in a number of different models, its verification can be challenging even on an error-corrected quantum computer, due to the so-called *post-selection problem*. I will briefly describe a recent proposal to access experimentally measurement-induced phase transitions (MIPT) employing "decoding", (computing so-called quantum-classical observables), specifically the linear cross-entropy, without requiring any post-selection of quantum trajectories. With active feed forward, the ensemble of (measured) quantum trajectories can be "steered" towards a unique pure state, which does not suffer from post selection. I will illustrate this with a simple model wherein the resulting pure state spontaneously breaks a continuous symmetry for a 1d chain of qubits.

**Plenary Talk** PLV VII Wed 14:00 H 0104

**Viral odyssey: navigating genotype spaces from a virus's perspective** — •Susanna Manrubia — National Centre for Biotechnology (CSIC)

The exploration of vast genotype spaces poses a major challenge to evolving populations. As the number of genotype sequences representing viable phenotypes grows exponentially with genome length, understanding how populations navigate and adapt within such spaces becomes paramount. In this contribution, we delve into the dynamics of populations within genotype spaces using data from the environmental adaptation of populations of a small phage infecting E. coli (Qbeta phage) and SARS-CoV-2 genomes. Despite the vastness of the spaces they have in principle access to, even the largest realizable viral populations cover only a tiny fraction of possible sequences, constrained by a local, blind exploration of the nearest attainable. We explore how these populations achieve phenotypic improvements and evolutionary innovations, presenting data-driven insights from extensive datasets. Our analysis reveals crucial features of empirical populations that challenge established theoretical expectations, shedding light on the dynamic interplay between genotype and phenotype in the evolutionary process.

**Plenary Talk** PLV VIII Thu 8:30 H 0105

**Topology shapes dynamics of higher-order networks** — •Ginestra Bianconi — Queen Mary University of London — The Alan Turing Institute

Higher-order networks capture the interactions among two or more nodes and they are raising increasing interest in the study of complex systems. Here we show that higher-order interactions are responsible for new non-linear dynamical processes that cannot be observed in pairwise networks. We reveal how non-linear dynamical processes can be used to learn the topology, by defining Topological Kuramoto model and Topological global synchronization. These critical phenomena capture the synchronization of topological signals, i.e. dynamical signal defined not only on nodes but also on links, triangles and higher-dimensional simplices in simplicial complexes. Moreover will discuss how the Dirac operator can be used to couple and process topological signal of different dimensions, formulating Dirac signal processing. Finally we demonstrate how non-linear dynamics can shape topology by formulating triadic percolation. In triadic percolation triadic interactions can turn percolation into a fully-fledged dynamical process in which nodes can turn on and off intermittently in a periodic fashion or even chaotically leading to period doubling and a route to chaos of the percolation order parameter. Triadic percolation changes drastically our understanding of percolation and can describe real systems in which the giant component varies significantly in time such as in brain functional networks and in climate.

**Plenary Talk** PLV IX Thu 14:00 H 0105

**Non-reciprocal thermal radiation and ultimate solar energy harvesting** — •Shanhui Fan — Stanford University

The Kirchhoff's law, which states that the angular spectral emissivity and absorptivity must be equal, features prominently in standard textbooks on thermal radiation. It is important, however, to recognize that the Kirchhoff's law is not a requirement of the second law of thermodynamics, but rather arises simply because most objects we study are made of reciprocal materials. In this talk, we discuss non-reciprocal nanophotonic structures that are capable of maximally violate the Kirchhoff's law. We also show that such non-reciprocal structures may hold the key towards reaching the Landsberg limit, which is the ultimate efficiency limit as required by the second law, in solar energy harvesting.

**Plenary Talk** PLV X Thu 14:00 H 0104

**Active matter: the physics of self-propelled particles** — •Hartmut Löwen — Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, Germany

While ordinary materials are typically composed of inert "passive" particles, active matter comprises objects or agents which possess an intrinsic propulsion. Examples are living systems like schools of fish, swarms of birds, pedestrians and swimming microbes but also artificial particles equipped with an internal motor such as robots and colloidal Janus particles. Active matter is praised for possible technological applications ranging from micro-surgery to environmental cleaning.

This talk provides an introduction to the basic physics of active matter with an emphasis on the statistical mechanics of synthetic artificial self-propelled particles. After an introduction of basic concepts to describe self-propelled colloids in the mesoscopic soft matter regime, such as active Brownian motion, novel collective phase transition are described including motility-induced phase separation of repulsive self-propelled particles. Then the importance of inertia relevant for particles of larger size is discussed. Finally two possible paths to next generation's active materials are pointed out: either functionalized microswimmers equipped with artificial intelligence or ultracold atoms in optical fields opening the door to the new field of quantum active matter.

**Plenary Talk** PLV XI Fri 8:30 H 0105

**From bioinspired structure formation to mechanotunable metamaterials** — •Andreas Fery — Leibniz Institut für Polymerforschung Dresden e.V, Institute of Physical Chemistry and Polymer Physics; Hohe Str. 6, 01069 Dresden — Technical University Dresden Chair for Physical Chemistry of Polymeric Materials

Wrinkling is widely encountered in nature and can even result in submicrometer periodic features e.g. on flower petals. Understanding the physics of wrinkling allows harnessing the process for structure formation in a non-biological context and for metrology of thin film mechanics. The latter is especially interesting for 2D materials and I discuss recent examples including the extension of this work to strain engineering of 2D materials. Controlled wrinkling for structure formation on the other hand offers interesting opportunities for scalable surface patterning. I will discuss the use of wrinkling templates for the formation of particle based metamaterials.