TOPOLOGICAL PHYSICS

Hot quantum spin Hall effect

Science **359,** 76–79 (2018).

The quantum spin Hall effect is a unique phase of matter in which the bulk of the material is an insulator, but topological quantum states exist at the edges — carrying up spins and down spins in opposite directions. If these edge states can be controlled, they may have applications in spintronic devices.

This phase was recently confirmed in a two-dimensional crystal by Sanfeng Wu and collaborators in an experiment that measured the properties of the edge states in monolayer WTe_2. In particular, they saw the quantized electronic conductance associated with the edge states, which vanished when a magnetic field was applied and the edge states were destroyed.

The edge states persisted at temperatures up to 100 K, which is much easier to achieve in the laboratory than the liquid helium temperatures that were previously needed to observe them in semiconductor heterostructures. That, and the fact that the naturally two-dimensional nature of WTe_2 makes it easier to synthesize and process in devices, indicates that the quantum spin Hall effect can be employed in more exotic contexts in the near future. *DA*

ULTRA-COLD GASES

A homogeneous sheet

Phys. Rev. Lett. (in the press); preprint at https://arxiv.org/abs/1704.06315

Ultracold atomic gases have long served as a textbook paradigm of many-body physics, allowing studies of, say, Bose–Einstein condensation and superfluidity, in clean and well-controlled environments. However, the spatial inhomogeneity caused by the external harmonic trap can be problematic. It can smear or even qualitatively change the expected experimental signatures, such as the divergence of the correlation length close to phase transitions. This has motivated the search for homogeneous gases, a goal that has been achieved previously for fermions in three dimensions.

Now, Klaus Hueck and colleagues have reduced the dimension to two, by making a homogeneous sheet of Fermi gas well suited to investigating the interplay between reduced dimensionality and strong interactions in quantum many-body systems. As a first benchmark experiment, Hueck *et al.* measured the two-dimensional equation of state and the momentum distribution in the non-interacting case, showing a textbook example of statistical physics. Introducing an attractive interaction, atoms form tightly bound dimers and a macroscopic occupation of low-momentum modes compatible with Berezinskii–Kosterlitz–Thouless superfluidity. *YL*

STATISTICAL MECHANICS

Einstein by implication

Am. J. Phys. **86,** 31–35 (2018).

There is something irresistible about Albert Einstein — no matter how often his results are confirmed or revisited in fresh contexts, having a theoretical or experimental finding anchored to Einstein's works lets us rest, it seems, a tad easier. But such connections can be rather inspiring, too, as Fred Gittes has proven.

Gittes derived two distinctly different results from Einstein's opus using the Jarzynski equality, a general relation between the change in free energy of a system and the amount of irreversible work performed on it. That equality, introduced in 1997, has become central in several branches of non-equilibrium thermodynamics, but has not found its way into general physics curricula and textbooks quite yet.

Gittes's contribution might help to change that. It shows that the Jarzynski equality implies both Einstein's classical relation between diffusion and drag coefficients in Brownian motion and his results on absorption and emission in quantum two-state systems. Adding to the scope, the latter connection is obtained without explicit reference to the bosonic nature of photons, whereas the former leads to apparently paradoxical, but explained, behaviour in the macroscopic limit. *AHT*

LASERS

Scalable vortices

ACS Nano https://doi.org/ch7x (2018)

One promising way of controlling light waves is by topologically structuring laser beams with vortices. A helical wavefront and a central phase singularity then make the light amenable to ultrahigh-resolution microscopy, and its optical angular momentum can be used to store and transfer information — offering scope for holographic applications and 3D displays. But existing implementations operate in the unfavourable infrared frequency range and claim limited control over the angular momentum. Now, Thomas Krauss and co-workers have developed an integrated approach that provides access to miniaturization and a facile scaling.

Krauss *et al.* realized an organic semiconductor laser emitting in the visible frequency range with a controllable optical vortex. The key element is an Archimedean spiral grating, which gives access to the phase, handedness and angular momentum of the beam through the number of spiral arms. This effectively transfers the concept of optical vortices to the microscale and makes it possible to construct two-dimensional arrays of cheap, easy-to-fabricate and spectrally tunable emitters in a single lightweight device. *JPK*

APPLIED MATHEMATICS

The discovery of skewness

eLife **6**, e30212 (2017).

CHRIS HOWES/WILD PLACES PHOTOGRAPHY / ALAMY STOCK PHOTO

Most of us remember the frustration of trying to complete a collection of cards or stamps — you can never find the last one. In probability theory, this is known as the coupon collector's problem: owing to those long waits, the probability of completing a collection after a certain number of random draws is skewed to the right. Now it seems that the very same process may be at the origin of the incubation time for many diseases.

Take measles, polio or leukemia: extremely different diseases, and yet their incubation periods all follow an approximately log-normal distribution. Clinical experiments have ruled out the heterogeneity of conditions, such as patients' resilience, as the reason for this phenomenon.

Instead, Bertrand Ottino-Loffler and colleagues modelled the disease progression as that of a pathogen invading a network-structured population of cells. A right-skewed, approximately log-normal incubation time would naturally appear if symptoms were assumed to emerge just as a share of the network had been taken over. This explanation relies on the fundamental stochastic dynamics of the incubation process, afflicted by the same long waits experienced by the stamp collector. *FL*

Written by David Abergel, Jan Philip Kraack, Federico Levi, Yun Li and Andreas H. Trabesinger.