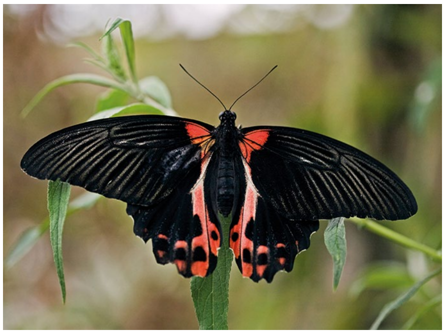
BIOPHOTONICS

Wings of a butterfly

Nat. Commun. **11**, 1294 (2020)



Credit: Krys Bailey / Alamy Stock Photo

We often admire butterflies for the splendid colours on their wings, but a dark background can make them shine even brighter. Just like strong colours in nature are often the result of diffraction from microstructures rather than pigmentation, the near-perfect absorption we perceive as black can have a similar origin. Alexander Davis and colleagues have now shown that several butterfly species have independently evolved wing-scale structures with less than one per cent reflection, which together with melanin pigments create ultra-black colouration.

The team compared the optical response and the wing-scale structures of different black and ultra-black species. They only found low reflectance in scales with pronounced trabeculae — rod-shaped structures — and holes on the order of a few hundred nanometres in size, regardless of the details of their quasi-periodic arrangement. Numerical modelling of the different structures confirmed these conclusions. Although the evolutionary pressures behind ultra-black colouration are unclear, Davis and colleagues believe it improves the contrast for signalling displays in bright-light conditions. *NM*

https://doi.org/10.1038/s41567-020-0883-z

SOFT MATTER

Active material in bulk

Science **367**, 1120–1124 (2020)

Nematic liquid crystals consisting of elongated units have long-range orientational order and topological defects. If the units can move, the nematic becomes 'active' with swirling flows and creation and annihilation of the defects. Active nematic systems arise in biological settings such as bacterial colonies and epithelial tissue but they have so far only been studied in two-dimensional (2D) systems. Guillaume Duclos and colleagues have now developed a 3D bulk active nematic and reconstructed its director field for the investigation of the structure of topological defects.

The team combined passive liquid crystals with a mixture of microtubules and molecular motors to create a 3D active nematic. They exploited the birefringence of the liquid crystal to track the director field using light-sheet microscopy and found that topological defects manifest as loops. The study offers a useful setup for developing and testing theoretical models of 3D active nematics and investigating the 3D counterpart of well-known 2D phenomena such as active turbulence. *ED*

https://doi.org/10.1038/s41567-020-0882-0

TOPOLOGICAL MATERIALS

Chern it up

Nature **579**, 56–61 (2020)

The prototypical topological material — the topological insulator — can be in either topological or trivial states. However, there is a richer class of topological materials called Chern insulators, where there are many non-trivial states characterized by a Chern number that can take any integer value. Researchers from the USA and China have now demonstrated a state with a Chern number of two in trilayer graphene with a moiré pattern.

The team showed that at a particular electron density, a plateau appears in the transverse resistivity that is quantized in the same way as the quantum Hall effect with filling fraction equal to two. This indicates that a state has been formed with that Chern number, and its hysteresis in a magnetic field shows that it is ferromagnetic. The manifestation of these states in a material with strong electron interactions opens the possibility that this material can also host non-abelian 'fractional' Chern states. *DA*

https://doi.org/10.1038/s41567-020-0881-1

PLASMA PHYSICS

Permanently simplified

Phys. Rev. Lett. **124**, 095001 (2020)

Magnetically confined fusion devices rely on electromagnets to generate magnetic fields to keep the extremely hot plasma in place. In stellarators, external coils with complicated shapes twist the magnetic field lines into a helical shape. This comes with a certain price tag. Per Herlander and colleagues have now proposed a concept that could relax constraints on the design of the magnetic field coils.

Herlander and colleagues showed that adding permanent magnets to a stellarator can simplify the design of the magnetic-field coils and, in principle, reduce the overall cost of the device. They theoretically studied a quasi-axisymmetric configuration with eight identical coils and permanent magnets. Although the permanent magnets cannot generate a toroidal magnetic field, they produce a poloidal flux and a rotational transform of the magnetic field. By shaping the plasma through permanent magnets, the requirements on the coils are less stringent. Future studies will have to address the feasibility of this proposal. *SR*

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SINGLE-ATOM MANIPULATION

At a long distance

SciPost Phys. **8**, 038 (2020)

Quantum-state engineering requires the ability to manipulate small sets of particles at their individual level. For neutral atoms, optical tweezers, which use optical dipole forces to capture dielectric particles in a tightly focused laser beam, provide a unique tool to achieve this goal. Usually tweezers are created using high-numerical-aperture lenses with very short working distances. Dielectric surfaces close to the trapped atoms may lead to unwanted systematic errors in atom detection.

Niamh Christina Jackson and co-workers have now overcome this obstacle by constructing an optical tweezer with a working distance almost twice that of similar setups based on in-vacuo lenses. The lens design was optimized at wavelengths that are suitable for capturing and detecting strontium atoms. By demonstrating high-fidelity individual-atom isolation and number-resolved atom detection, the new tweezer has proved a promising building block of an ideal platform for further studying quantum physics. *YL*

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