ELASTICITY

Knot so simple

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You may not have realized, but when tying shoelaces, you're employing a handy combination of topology and elasticity. Despite being such a routine thing, understanding how shoelace — and other — knots work is far from trivial, because of the many physical parameters involved.

Khalid Jawed and colleagues have now started tackling the physics of simple overhand knots. Such knots consist of a loop, a braid with a certain uneven number, $2n + 1$, of crossings and two ends (pictured above for $n = 1$). The authors made macroscopic knots from Nitinol, a highly elastic nickel titanium alloy, and measured the force needed to pull the knotted rope over a given distance. They also imaged how the knot's shape changes when pulled.

Jawed *et al.* were able to explain the resulting data in terms of a model that properly takes into account the bending stiffness of the ropes and draws on Gustav Kirchhoff's treatment of the elastic rod. They found that the applied tensile force depended on the end-to-end shortening of the rope in a nonlinear way, and that the dependence changed drastically with the unknotting number n. *BV*

ATTOSECOND PULSES

Vortex mixer

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If you're on the hunt for vortex patterns, you might not think to look at ionized helium. But Jean Marcel Ngoko Djiokap and colleagues have suggested that ultrafast lasers could stir up beautiful helical vortices in the electron momentum distribution of ionized helium atoms. The trick, they say, is to use two delayed attosecond laser pulses of opposite circular polarization.

Ngoko Djiokap *et al.* solved the two-electron time-dependent Schrödinger equation numerically and plotted the photoelectron momentum distributions for various time delays between the laser pulses, relative phases and polarization directions. They found vortex patterns akin to the spiral interference fringes observed in experiments with optical beams carrying orbital angular momentum. The photoelectron momentum distribution vortices were shown to be two-arm Fermat spirals — their handedness determined by the combination of the two directions of the circular polarization of the laser beams.

Seeing these vortices in experiment would certainly be rewarding, not only aesthetically, as they might also find applications in attosecond science. *IG*

MAGNETIC MATERIALS

Skyrme meets Néel

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The stabilization of skyrmions in different magnetic materials has been one of the more arresting developments in condensed-matter physics of the past few years. Named after the particle physicist Tony Skyrme, these vortex-like excitations share the same topology as a set of magnetic moments wrapped around a sphere. Although their microscopic origin has long been known, the extent of their stability to external perturbations has come as a pleasant (and potentially useful) surprise.

One of the remarkable properties of skyrmions is that under suitable conditions they can order into periodic arrays, known as skyrmion lattices, which in many ways resemble a close-packed arrangement of spheres. These are mostly observed in chiral magnetic crystals, but so far they have always consisted of Bloch-like domain walls, in which the spins rotate in the plane parallel to the domain boundary.

Now, Alois Loidl and colleagues have reported the observation of a Néel-type skyrmion lattice in the magnetic semiconductor GaV_4S_8. In this case, the excitations can be described by a superposition of spin cycloids, in which the spins rotate in a plane perpendicular to the domain boundary — an arrangement named after Louis Néel, the discoverer of antiferromagnetism. *AT*

INTERMEDIATE-MASS STARS

Our nearest solar system

Mon. Not. R. Astron. Soc. **453,** 2126–2132 (2015)

Low-mass stars and high-mass stars have distinctly different formation processes, but what of intermediate-mass stars? HD 100546 is such a star, and the recent discovery of up to two planetary objects makes this star system our closest 'solar system'. It is an ideal source for Ignacio Mendigutía and collaborators, who used the Very Large Telescope Interferometer in Chile to study the conditions for planet formation around the young star.

The authors focused on the high-excitation hydrogen emission line known as Br γ (at wavelength 2.166 μm), which is a standard tracer for a star's accretion of matter. HD 100546 is unusual in that it is surrounded by an inner disk of gas and dust, which is separated from an extensive outer disk by a large gap. Their estimated mass accretion rate of the inner disk turns out to be greater than the amount of material that the gaseous inner disk can provide in a year, so Mendigutía *et al.* suggest that the gas within the inner disk must be replenished, perhaps by planet-boosted flows from the outer disk. *MC*

SOLAR CELLS

Kirigami tracking

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To maximize the power output of flat solar cells, the panels can be tilted to track the position of the sun. But solar-tracking technologies are not widely used due to their high costs and often cumbersome structural components. This means that conventional tracking options are rarely even available for residential, pitched rooftop systems, which account for around 85% of installations. Inspired by the design principles of kirigami — the Japanese art of cutting paper — Aaron Lamoureux and colleagues have demonstrated a tracking system that is integral to the structure of the cell.

The team cut a relatively simple linear pattern into thin-film gallium arsenide solar cells. By pulling the cells along the direction perpendicular to the cuts, the structure buckled. This created arrays of tilted surface elements, whose angles were controllable to within one degree by simply changing the strain. The optical tracking efficiencies of such devices showed similar performance to conventional single-axis tracking systems. Requiring little more than a stretch, these designs could find their way into a range of optoelectronic devices. *LF*

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