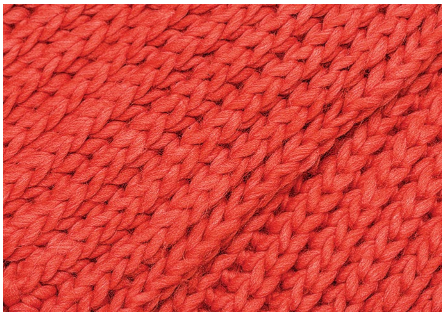
research highlights

TOPOLOGICAL MECHANICS

All stitched up

Phys. Rev. X (in the press); preprint at https://arxiv.org/abs/1801.08355



Credit: Maryana Lyubenko/Alamy Stock Photo

Being an ancient yet powerful technology, knitting has long been known for its broad utility in crafting beautiful structures with extreme three-dimensional flexibility. But the topological mechanics of these structures is not entirely understood. Now, Samuel Poincloux and colleagues have applied themselves to this industrially relevant gap in mechanical physics, delivering an insightful first-principles model for knitted threads.

Knitting fabric in the so-called stockinette pattern (pictured), a structure described by an array of singly stitched unit cells, Poincloux et al. monitored the structures' mechanical response under different loading cases. By comparing the results to theoretical predictions and achieving quantitative agreement, they demonstrated that the key factors of the model are the yarn's bending energy and the conservation of its length, along with the topological constraints of the stitches. The model provides a theoretical basis for a technique that has so far been based on empirical knowledge. In doing so, it paves the way to harnessing knitting technology for next-generation smart materials. *JPK*

https://doi.org/10.1038/s41567-018-0222-9

SOCIAL CONVENTIONS

#Change

Science **360**, 1116–1119 (2018)

Models of emergent phenomena in human populations have become a familiar sight in the physics literature. Calibration of and motivation for these models typically has to come from social science, ideally in the form of quantitative studies such as the one of Damon Centola and colleagues, who explored at which size a committed minority group can successfully shift social norms.

Empirical estimates for the critical mass needed to overturn established behaviour — for example, linguistic or gender conventions — range from 10% to 40% of the total population. Centola and co-workers examined these tipping points in the well-controlled setting of an online experiment.

They assigned 194 participants to groups of different sizes. The players then had to agree on names for pictured objects. In this scenario, a relatively sharp 'phase transition' emerged: once a minority group comprised more than 25% of all participants, they managed — stimulated by financial incentives — to establish a new equilibrium in which their choice was widely accepted. That percentage is unlikely to be universal, but a valuable benchmark for future studies, in particular those of online networks. *AHT*

https://doi.org/10.1038/s41567-018-0219-4

COLLIDER PHYSICS

Mining the laws of nature

Phys. Rev. Lett. **120**, 231801 (2018)

It has been six years since the final elementary particle of the standard model, the Higgs boson, was first detected at CERN's Large Hadron Collider. Nevertheless, not all its properties have been established — meaning that our understanding of the fundamental laws of nature is still incomplete. One of the obstacles is the insufficient size of the datasets that can be used to derive the coupling between Higgs bosons and other elementary particles.

Now the Compact Muon Solenoid (CMS) Collaboration at CERN's Large Hadron Collider has overcome this problem, and provided the most definitive measurement to date of the interaction strength between the Higgs boson and the top quark — the heaviest known elementary particle. To acquire the necessary precision, they combined data collected by the CMS detector in 2011, 2012 and 2016 involving searches for the Higgs boson produced in association with top quark–antiquark pairs, and applied sophisticated analysis methods to extract signals in the presence of challenging backgrounds. *YL*

https://doi.org/10.1038/s41567-018-0223-8

PLASMONICS

Gold trappings

J. Phys. B **51**, 135005 (2018)

Trapping cold atoms near a solid surface induces the kind of coupling required to build hybrid quantum devices. And introducing plasmonic surfaces into the mix can increase the strength of this coupling still further. Now, Matthias Mildner and colleagues have come up with a new trap design that uses a thin gold layer to exploit and control this plasmonic enhancement. The team has presented a numerical characterization of their proposed trap, together with a first test structure.

The working principle is based on two overlapping evanescent waves that are both plasmonically enhanced: one wave with red detuning gives rise to an attractive surface potential, while the other has blue detuning that induces a repulsive surface potential. By manipulating the local thickness of the gold layer in their simulations, Mildner and co-workers showed that they could modulate the depth of the trap. Exploiting this level of control should enable the generation of non-periodic potential landscapes — including heterostructures with custom-designed defects. *AK*

https://doi.org/10.1038/s41567-018-0220-y

COLD ATOMS

Inside the cloud

Commun. Phys. **1**, 24 (2018)

How can you best cool a cloud of atoms to the nanokelvin temperature range required by modern experiments? And what happens at the phase transition between a thermal gas and a Bose–Einstein condensate? I-Kang Liu and co-workers have answered these questions using detailed numerical simulations.

As expected, the non-equilibrium nature of the quenching process creates Kibble–Zurek topological defects, but the numerics were able to track the path of individual defects as they annihilated or were ejected from the condensate. This allowed the authors to follow the build-up of phase coherence and show that the number of atoms in the condensate and the coherence growth were decoupled during re-equilibration. They were also able to investigate the quasi-condensate regime — where defects separate regions with different local phase coherence — and its crossover to the true condensate. They showed that the quasi-condensate is enhanced by the long lifetime of the defects and so is very sensitive to the quench rate. *DA*

https://doi.org/10.1038/s41567-018-0221-x

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