EXOPLANETS

Waterworld of difference

Icarus **277,** 215–236 (2016)

Earlier this year, the NASA Kepler mission announced the discovery of 1,284 new planets. Nine of these reside in the 'habitable zone', that is, liquid water can pool on them. But that criterion alone, Lena Noack and colleagues say, isn't sufficient for making an exoplanet a potential birthplace for life as we know it.

Based on a novel ocean model for water-rich planets, Noack *et al.* argue that the formation of high-pressure ice has to be factored in when assessing habitability. On Earth-sized planets such ice phases form for oceans with depths on the order of hundreds of kilometres. The dense ice layer can then separate the liquid water from the mineral surface at the ocean–mantle boundary, shutting off a vital source of nutrients and building blocks.

Nonetheless, Earth-size planets could still be habitable for water layers up to almost 1,000 km, provided that the submarine surface is hot enough to melt the ice. In that scenario, a second ocean layer would form below the ice — although from the outside it would be difficult to detect signs of life there. *AHT*

NEUTRINO PHYSICS

Limits of coherence

Eur. Phys. J. C http://doi.org/bj6w (2016)

Detecting neutrinos is hard at the best of times, but detecting neutrino bursts from supernovae — the relatively rare astronomical events that occur when a massive star has exhausted its nuclear fuel and collapses — is harder still. The celebrated 1987A core-collapse supernova (SN 1987A) is, to date, the only supernova from which neutrinos have ever been detected. Since 1987, detection capabilities for supernova neutrinos have increased dramatically — all we need to uncover a great deal more new physics and astrophysics is another core-collapse supernova to occur near planet Earth.

Of course, the huge distances travelled by supernova neutrinos from a star to the Earth means that careful thought is required to predict and interpret their detection signatures. As Jörn Kersten and Alexei Smirnov showed, that also extends to their quantum mechanical description as wave packets: on their way to Earth, neutrino wave packets spread and separate over macroscopic length scales, and can reach coherence lengths comparable to the radius of the Earth. The authors considered these features and their consequences, uncovering a 'catch-up' effect that leads to an increase in the coherence length as the neutrinos cross the core of the Earth. *AT*

TOPOLOGICAL PHASES

Impurities for sensors

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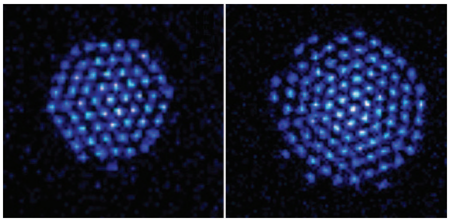
Many situations in physics can be formulated as a many-body problem — and for systems displaying spontaneous symmetry breaking, such as superconductors, superfluids and ferromagnets, the many-body description involves local order parameters. For some other systems, however, such parameters do not exist — they need to be characterized by nonlocal topological invariants. The integer and fractional quantum Hall effects, for example, are described by topological order parameters.

Experimentally probing the topological order of quantum phases is challenging. But Fabian Grusdt and colleagues have now proposed an approach whereby impurity atoms, deliberately introduced into a many-body system, act as probes for the topological invariants. Importantly, the method would enable probing the bulk of the system. They extended the concept of the 'topological polaron' — an impurity bound to a topological excitation — and developed a scheme for interferometric measurements of topological invariants. Grusdt *et al.* applied their ideas to quantum Hall systems and Chern insulators, and argue that cold-atom ensembles would be ideal platforms for realizing topological polaron interferometry. *BV*

QUANTUM SIMULATION

The power of many

Science **352,** 1297–1301 (2016)



AAAS

The idea of quantum simulation is to emulate the classically intractable dynamics of quantum many-body systems using a well understood and controllable quantum system. Certainly very elegant in theory, such quantum simulators promise breakthroughs in many fields. But to be useful in practice, they need to scale up. One has to be able to control hundreds of particles (or more). And in the quantum regime, the more particles, the trickier they are to handle.

Justin Bohnet and colleagues have now gone beyond the existing proof-of-principle experiments involving up to twenty ions and demonstrated the emulation of the transverse-field Ising model with more than 200 trapped ions. Beryllium ions were trapped and laser-cooled in a Penning trap, forming an orderly structure in a two-dimensional array (pictured). Bohnet *et al.* studied the quantum spin dynamics and characterized the entanglement of spin-squeezed states, benchmarking the results against theoretical calculations for the still-tractable case of the homogeneous Ising model. *IG*

COMPLEX NETWORKS

Same on the inside

Nature **534,** 259–262 (2016)

We've known for a while that the flora lining our guts can have pronounced effects on our health. And studies like the Human Microbiome Project are fast providing us with the data necessary to put these effects to therapeutic use. But these data attest to the fact that microbial communities are highly variable, and knowing how they interact with their human hosts is essential to the success of new therapies. Now, Amir Bashan and co-workers have come up with a way of determining whether microbial dynamics are host specific — with profound implications for the development of microbiome-based treatments.

Bashan *et al.* designed a computational method to detect universal dynamics in microbial data by quantifying overlap in the relative abundance of shared species and the degree to which these species' abundance profiles differ. If the dynamics are universal, as the team determined is the case for some gut and mouth microbiomes, general intervention strategies can be used. But if the dynamics are host specific, then therapies need to be tailored to the individual — designed specifically for their own microbial state as well as the dynamics of the ecosystem inside them. *AK*

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