Millikan recharged

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It's always worth reading the classics, and Filip Beunis and colleagues would no doubt agree. Their extension to Robert Millikan's celebrated oil-drop experiment has afforded them unprecedented resolution of individual charging events on a solid/liquid interface.

In the century-old experiment, the force balance on an oil drop suspended between metal electrodes enabled Millikan to make an accurate estimate of the charge on an electron. (Millikan is pictured here, right, in 1919 with Arthur Noyes and George Hale, his fellow founding scientists of what would become the California Institute of Technology.)

The new variant developed by Beunis *et al.* involves a colloidal microsphere immersed in a nonpolar liquid, and optically trapped between two electrodes. By monitoring the position of the particle with a coaxial beam, the team was able to infer the particle's charge from its response to a sinusoidally varying voltage. Discrete levels in this response belied individual events, and corresponded to values within 10% of the accepted value for elementary charge.

The speed and accuracy of the method are integral to its success. But the most promising aspect of the experiment arguably lies with the stability of the trap, which allowed Beunis *et al.* to measure over long times, prompting a statistical analysis that resulted in a realistic physical model for the surface-charging mechanism. *AK*

How the galaxy got its field

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The magnetic fields seen to exist in galaxies are thought to have been seeded early in their history, then amplified through dynamo or turbulent processes. In magnetohydrodynamic simulations, a favoured explanation of the seeding is by the Biermann battery process, through which currents are generated owing to the misalignment of temperature and pressure gradients. Gianluca Gregori and colleagues now have experimental evidence to support it.

At the Laboratoire pour l'Utilisation de Lasers Intenses, close to Paris, France, Gregori *et al.* trained intense, short-duration laser pulses on a carbon rod held inside a low-pressure chamber. They monitored the shock evolution as the hot matter first expanded ballistically and then formed a blast wave, and also measured the magnetic-field components normal and perpendicular to the shock. Their results are consistent with protogalactic simulations, and, when appropriately scaled to galactic conditions, are the first experimental verification of the Biermann battery process, proposed more than 60 years ago. *AW*

Quantum speed limit

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The non-local nature of quantum mechanics is now firmly established experimentally, and quite a number of these studies have explored ways to harness quantum non-locality for computational or communication tasks. But in certain quantum systems aspects of locality do matter, as Marc Cheneau and colleagues demonstrate. They have measured the speed with which correlations spread in a quantum many-body system, and show that the dynamics is bounded by a maximal velocity that plays a role similar to the speed of light.

That there can be a limit to the speed with which correlations propagate in quantum many-body systems had been known from theoretical work. But how such bounds manifest in practical settings is, in most cases, difficult to predict. Thus the appeal of the work by Cheneau *et al.*, who have directly measured the evolution of correlations in an ensemble of cold atoms confined to an optical lattice. They observe that the correlations spread along an effective 'light cone', characterized by a finite maximum velocity. The exploration of such bounds to non-relativistic quantum dynamics is not only of fundamental interest; they possibly also affect, for example, the speed at which quantum computations can be performed. *AT*

Upholding the law

Science **335,** 64–67 (2012)

In this digital age, electronic hardware is being packed into ever smaller spaces. Now Bent Weber and co-workers have shown that one of the most fundamental rules governing electrical flow — Ohm's law — still applies in wires that are just a few atoms in diameter.

Narrower wires have a greater surface area to volume ratio. This, in turn, increases the influence of surface defects, which disrupt the flow of electrons and increase the resistivity of the wire. Weber *et al.*, however, show that they can create 'interface-free' wires by embedding phosphorous atoms in a silicon crystal.

The team used the latest lithographic techniques to write their dopant wires, which were then covered by more silicon. Although the wires were just one atom in height and four atoms in width, they still had an electrical resistivity of the same order as bulk materials. This result shows that, despite decades of miniaturization, there is still scope for further generations of electronic circuitry. *DG*

Quantum chemistry cut short

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Using Schrödinger's equation, the atomic and electronic structure of molecules can be calculated from first principles — that is, without the need to make assumptions that might bias or restrict the numerical accuracy of the calculation. Or, rather, in principle it can. In practice, the computational effort needed to solve Schrödinger's equation increases rapidly with the number of atoms involved, which constrains the size and complexity of the molecules that can be practically modelled. And so, assumptions must be made, limiting the accuracy with which the properties of all but the simplest of molecules can be calculated.

Matthias Rupp and colleagues have found what seems to be a short cut. Rather than calculating a given property of an unknown molecule from scratch, they have developed an algorithm that predicts its value by learning from a database of molecules whose properties are already known. To test their approach, the authors use it to predict the atomization energy of unknown molecules from a set of 7,165 known molecules. Their predictions achieve an order of magnitude greater precision than other approximate methods, in a billionth of the time required for a full quantum calculation. *EG*

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