Rademacher and colleagues' results demonstrate the potential of STD NMR for the rapid, unequivocal identification of small molecules that bind to proteins. The technique offers several benefits — for example, no structural information about the protein is required, and the mode of binding of the molecules is also revealed. It has already been shown that, of all the current NMR screening techniques[9–11], STD NMR is the most efficient at identifying false-positive hits from high-throughput biological assays. Rademacher *et al.*[1] have provided further compelling arguments for the routine use of this technique in drug development. ■

Andreas O. Frank and Horst Kessler are in the Center of Integrated Protein Science, Technische Universität München, Lichtenbergstrasse 4, D-85747 Garching, Germany.
e-mails: andreas.frank@ch.tum.de; horst.kessler@ch.tum.de

1. Rademacher, C., Krishna, N. R., Palcic, M., Parra, F. & Peters, T. *J. Am. Chem. Soc.* **130,** 3669–3675 (2008).
2. Thiel, H. J. & König, M. *Vet. Microbiol.* **69,** 55–62 (1999).
3. Parra, F. & Prieto, M. *J. Virol.* **64,** 4013–4015 (1990).
4. Ruvoën-Clouet, N., Ganière, J. P., André-Fontaine, G., Blanchard, D. & Le Pendu, J. *J. Virol.* **74,** 11950–11954 (2000).
5. Harrington, P. R., Vinjé, J., Moe, C. L. & Baric, R. S. *J. Virol.* **78,** 3035–3045 (2004).
6. Laurent, S., Vautherot, J. F., Madelaine, M. F., Le Gall, G. & Rasschaert, D. *J. Virol.* **68,** 6794–6798 (1994).
7. Mayer, M. & Meyer, B. *Angew. Chem. Int. Edn* **38,** 1784–1788 (1999).
8. Meyer, B. & Peters, T. *Angew. Chem. Int. Edn* **42,** 864–890 (2003).
9. Klages, J., Coles, M. & Kessler, H. *Analyst* **132,** 692–705 (2007).
10. Manzenrieder, F., Frank, A. O. & Kessler, H. *Angew. Chem. Int. Edn* **47,** 2608–2611 (2008).
11. Pellecchia, M. *et al. Nature Rev. Drug Disc.* (in the press).

QUANTUM PHYSICS

Debut of the quarter electron

Eduardo Fradkin

A particle-like object with a quarter of an electron's charge is the latest find in a hotbed of quantum-physical experimentation, the fractional quantum Hall fluid. Its significance is more than esoteric.

On page 829 of this issue, Dolev *et al.*[1] report the detection of vortices in a fluid of electrons confined to two dimensions within a semiconductor structure that carry just 1/4 of the electron's charge. These 'quasiparticles' are an exciting find: according to theoretical predictions, their collective behaviour should be described by an unusual type of particle statistics known as non-abelian statistics. Above all, that could make them useful in an exotic, but highly promising, brand of quantum computer — the topological quantum computer (see News Feature on page 803)[2].

It is an established fact that, if a large magnetic field is applied perpendicular to the plane confining a soup of mobile electrons in a gallium arsenide semiconductor structure, the confined electrons can be made to enter correlated states with very unusual properties. When an electric field is applied in the plane, and at certain values of the 'filling fraction' ν (defined as the ratio of the number of electrons in the fluid to the number of magnetic field quanta penetrating through the sample), the electrons will flow without encountering any resistance. In such states, the conductivity transverse to the electric field, the Hall conductivity, takes on the universal value $\nu e^2/h$, where e is the electron charge, h is Planck's constant and $\nu = 1/m$; m is an odd integer.

This 'fractional quantum Hall effect' was discovered[3] in 1982, and explained theoretically[4] a year later — achievements that were rewarded with a Nobel prize in 1998. In the theoretical treatment, a quantum Hall state at filling fraction $1/m$ will involve quasiparticles of fractional electric charge e/m. Such quasiparticles were first detected in 1997 through measurements of the statistical fluctuations of electrical current ('shot noise') on a single point contact in a quantum Hall device[5,6].

As well as having a charge somewhere between 0 and 1, these quasiparticles obey an intermediate form of quantum statistics that lies somewhere between the two established forms, Fermi–Dirac statistics and Bose–Einstein statistics. Fermi–Dirac statistics applies to systems of spin-1/2 'fermions', which obey the Pauli exclusion principle; particles covered include electrons, protons, neutrons, quarks, neutrinos and atoms with an odd number of constituent particles. Bose–Einstein statistics governs the behaviour of collections of integer-spin 'bosons': atoms with an even number of constituents such as photons, gluons and the yet-to-be-found Higgs particle.

A crucial difference between fermions and bosons is that a wavefunction describing two bosons is symmetrical when the two particles are swapped around in space: it does not change sign, and the wavefunctions before and after the particle exchange are said to have a phase factor of 0. The wavefunction describing two fermions, on the other hand, is antisymmetrical, flipping sign when particles are exchanged (phase factor π). But the phase of the wavefunction representing two quasiparticles in a two-dimensional system such as a quantum Hall fluid can change by an arbitrary phase factor, not just 0 or π. The precise value of this phase

50 & 100 YEARS AGO

50 YEARS AGO

'Recent discoveries at Olduvai Gorge, Tanganyika' By Dr. L. S. B. Leakey — Work has, in the main, been concentrated upon two sites: *BK* II at the lowest level of Bed II Olduvai, where it rests uncomfortably upon the eroded top of Bed I, and at *SHK* II at a level about 10 ft. above the base of Bed II ... At each of these two sites, living floors of Chellean man have been found, with big accumulations of stone tools, waste flakes and the fossilized remains of the animals upon which Chellean man lived ... In addition [were found] ... two hominid teeth. It was hoped that this important discovery, made at the close of the 1955 season, was the precursor of further finds of hominid material, but the hope has not been fulfilled and, therefore, a preliminary description of these teeth is given here.

From *Nature* 19 April 1958.

100 YEARS AGO

'The condensation of helium' — In NATURE of March 12 I have found a note referring to my experiments on the expansion of helium, made in consequence of my determinations on the isothermals of helium, at −252° C. and −259° C., which yielded nearly −5° K. for the critical temperature of helium. The prosecution of the experiments has shown that what I observed in expanding the gas was not the evaporation of solid helium, but solution phenomena of solid hydrogen in gaseous helium. I have communicated to the Amsterdam Academy a note on my experiments, which at the moment leave the condensation of helium a yet undecided question. Of course, I have written the details to Sir James Dewar, and I hoped to do so to you to-day, but by pressing duties I cannot do it before to-night, and you will probably go to press before that letter reaches you. So I beg to be allowed to send you this first short notice.

H. Kamerlingh Onnes

From *Nature* 16 April 1908.