100 YEARS AGO

"The treatment of cancer with radium" — The discovery of radium was speedily followed by its use in the treatment of cancer, and it was hoped that at last a remedy had been found for this terrible disease… A very large number of cases of cancer have been treated by radium in this country, on the Continent, and in America. Some have improved remarkably, but in most instances there has been no apparent benefit, and in no case has sufficient time elapsed to speak with certainty of cure… Radium is applied in small tubes to the surface of a tumour, and in some cases it has been found possible to place it in the interior of a growth through a small incision. The quantities available are so minute that only a small area can be treated at one time… Fortunately the radium can be used again and again, for its energy appears practically to be inexhaustible.
From *Nature* 20 April 1905.

50 YEARS AGO

"Biological hazards of radiation" — In the same week as the "Statement on Defence, 1955" and the White Paper "A Programme for Nuclear Power" were published in Great Britain, the Atomic Energy Commission of the United States produced a long and detailed report on the radiation and 'fall-out' produced by thermonuclear explosions. In the following week, the Federation of American Scientists communicated proposals for an international study of the potential dangers in tests of nuclear weapons… When on March 10 the Prime Minister was asked in the House of Commons to take the initiative and propose the establishment of a United Nations Commission… Sir Winston replied that experts at the disposal of the Government saw no reason to dissent from the opinion of the United States Atomic Energy Commission's report, issued on February 15, that the tests so far carried out have only released enough radioactive material into the atmosphere to cause an individual living in the United States to receive the same quantity of radiation that he would have received in an X-ray chest examination at a hospital… in making its proposal for an immediate study of the potential genetic risks of nuclear weapons, the Federation of American Scientists appeared to be envisaging dangers from a number of tests greatly in excess of those likely to be carried out in the foreseeable future.
From *Nature* 23 April 1955.

glucose production by opening hypothalamic K_{ATP} channels.

The implications of these findings deserve reflection, although the contribution of this pathway to the control of hepatic glucose output in intact animals, and in humans in particular, remains to be established. There are several inherited insulin-secretion disorders that are caused by altered K_{ATP}-channel activity in pancreatic β-cells, and assessment of liver glucose handling in such disorders would be of great interest. The authors raise the possibility that hypothalamic resistance to insulin might contribute to the raised liver glucose output typical of type 2 diabetes, suggesting that agents targeting such resistance (or even targeting hypothalamic K_{ATP} channels themselves) might be useful in treating this condition. On a more sobering note, however, K_{ATP}-channel inhibitors are used routinely to increase insulin secretion in type 2 diabetes, and it may be that, if these oral hypoglycaemic agents gain access to and inhibit hypothalamic K_{ATP} channels, they might adversely affect glucose handling in the liver. There are clearly a number of critical studies needed to address these issues. ■

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Techniques

NMR on a chip

Robert Tycko

If a nanoscale gallium arsenide structure is excited with an oscillating magnetic field, superpositions of nuclear spin states can be created and detected electrically. Quantum computing could be the beneficiary.

Nuclear magnetic resonance (NMR) spectroscopy is a near-ubiquitous technique in the physical and biological sciences. Applications include the verification of molecular structures in synthetic chemistry, investigation of superconductivity in solid-state physics, the determination of protein conformations in structural biology, and diagnostic imaging in medicine. Typically, an adequate signal-to-noise ratio in NMR can be achieved only with a relatively large sample of 10^{15}–10^{18} molecules or atoms. On page 1001 of this issue, Yusa *et al.*[1] demonstrate an unconventional approach to NMR in a cleverly designed semiconductor nanostructure with which strong signals can be detected from around 10^8 atoms.

NMR depends on manipulations of the spin states of atomic nuclei that possess magnetic moments. When an external magnetic field is applied to such nuclei, the energy levels allowed by the rules of quantum mechanics split — in the simplest case of a nucleus with a spin of magnitude 1/2, they split into two levels close to one another. If resonant radio-frequency pulse sequences with precisely controlled amplitudes, phases, frequencies and timing are then applied, transitions can be induced between these energy levels, creating coherent superpositions of spin quantum states. The frequencies at which these transitions occur ('NMR spectra') correspond to the gaps between spin energy levels and are therefore characteristic of a particular nucleus and its environment.

It is the ability to control quantum mechanical states more precisely than in any other type of spectroscopy that makes NMR spectroscopy useful in many disparate disciplines. The 'controllability' of nuclear spin states has also made NMR of interest in quantum computation (for an example see ref. 2). Here, mathematical problems can be efficiently solved by algorithms that depend on the manipulation of coherent superpositions of quantum mechanical states.

The main weakness of conventional NMR, which uses metal coils with centimetre-scale dimensions to detect nuclear-spin magnetism from samples with similar dimensions, is its relatively low sensitivity. Not only have Yusa *et al.*[1] significantly reduced the minimum sample needed to perform NMR spectroscopy, but they have also shown that, by exciting the nanostructure with radio-frequency magnetic fields, arbitrary superpositions of spin states can be created. These include 'multiple quantum coherences', superpositions of states that differ by more than one quantum of angular momentum[3] in nuclei with a total spin greater than a half. Although this work is motivated by the goal of developing a solid-state electronic device for quantum computation, other applications and extensions of this nanotechnological approach to NMR may be possible.

A schematic representation of the device described by Yusa *et al.* is shown in Figure 1. Using a combination of semiconductor-growth, lithography and electrical-gating