news and views

Nuclear antiferromagnetism

from Graham Richards

AT the end of March an experiment which truly merits the overworked appellation 'beautiful' was performed at Saclay by Professor Anatole Abragham and his colleagues (G. L. Bacchela, V. Bouffard, M. Goldman, P. Meriel, M. Pineau, Y. Roinel & P. Roubeau); the first direct observation of a nuclear antiferromagnetic structure by neutron diffraction. It was presented at the weekly meeting of the Académie des Sciences in Paris on 14 April and published in the *Comptes rendus* of the same date. For almost 40 years electronic antiferromagnetism has been known: at temperatures below the Néel temperature atomic magnetic moments can form two sublattices with equal and opposite magnetisation. This can be confirmed by bulk magnetic measurements or microscopically by neutron diffraction.

Diamagnetic solids may also have antiferromagnetic structures if the constituent nuclei possess magnetic moments arising from their spins. However, the conditions required to achieve the ordered state of nuclei are considerably more rigorous. Since the interactions between nuclei are only feeble, any orientation effects may easily be disrupted by thermal agitation and the Néel temperatures for nuclear ordering are much lower than those for electronic magnetic moments; within one millionth of a degree of absolute zero.

Although nuclear spins can be magnetised to nearly saturation by the application of a strong magnetic field of the order of 10 Tesla (100 kgauss) at a temperature of a few millikelvin, the dynamic polarisation method—also developed at Saclay—was used in these, as in previous experiments. In this technique the sample needs to be cooled to only a few hundreds of millikelvin by use of a dilution refrigerator and the nuclear polarisation is achieved by the simultaneous application of a strong steady field and a microwave field acting on the paramagnetic impurities introduced for this purpose. The adiabatic demagnetisation can be carried out either by the reduction of the steady field, or, as was done here by using a radiofrequency field; the so-called demagnetisation in the rotating frame (M. Chapellier *et al. C.r. hebd. Séanc. Acad. Sci. Paris* **268,** 1530; 1969). Thanks to the slow energy exchange between the nuclear spins and the crystal lattice, nuclear spin temperatures many orders of magnitude below that of the lattice can be maintained for relatively long periods. In this present experiment the antiferromagnetic state persisted for about half an hour.

To prove the existence in the nuclear antiferromagnetic state of two sublattices magnetised in opposite senses one must use neutron diffraction, relying on the fact that the scattering of neutrons depends on the relative orientations of the spins. Purely magnetic interaction between neutron spin and nuclear spin would have a negligible effect because of the smallness of the nuclear magnetic moment. However it was discovered (Abragham *et al. C.r. hebd. Séanc. Acad. Sci. Paris* **274,** 423; 1972) that thanks to nuclear interaction, the nucleus behaves as if it possesses a large pseudo-magnetic moment, and effects similar to those found in the electronic antiferromagnetic case are observed.

The spins of the nuclei ^{7}Li and ^{1}H in LiH were dynamically polarised in a field of 6.5 teslas produced by a superconducting solenoid followed by adiabatic demagnetisation in the rotating frame. The existence of the nuclear antiferromagnetic structure was then demonstrated by the observation of antiferromagnetic superstructure Bragg reflection from the 110 plane of the crystal. Successive planes have the nuclear spins pointing in opposite directions, so that if we neglect the small differences in nuclear moments of ^{7}Li and ^{1}H we can consider the crystal as a simple cubic lattice. The Bragg reflection is absent before nuclear demagnetisation but appeared immediately after demagnetisation and remained for about 30 minutes (corresponding to the nuclear spin-lattice relaxation time) until the long-range antiferromagnetic order faded.

The Saclay group believe that the direct application of neutron diffraction opens a new avenue for the exploration of nuclear antiferromagnetism and more generally of ordered nuclear magnetic states of all types. □

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T and B cell hybridomas

from Elizabeth Simpson

FURTHER progress in the production of 'immortal' lines of functional T or B lymphocytes was reported at a workshop held recently at the National Institutes of Health*. Normal T or B lymphocytes can be 'immortalised' by fusing them with appropriate T or B cell tumours. The isolation of these monoclonal functional T or B cell 'hybridomas' is allowing an examination of certain aspects of the immune system and the antigens to which its responses are directed, in a way not previously possible.

The initial experiments of Köhler and Milstein (*Nature* **256,** 495; 1975) established that cells from a mouse myeloma could be fused with splenic B cells from a mouse recently stimulated with antigen, and that a proportion of the resulting hybrids secreted antibodies specific for the stimulating antigen. Subsequently Goldsby *et al.* (*Nature* **267,** 707; 1977) reported that a T cell tumour would

*Held on 3 5 April 1978, and organised by Drs M. Potter and F. Melchers.

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