Figure 2 is a photograph, taken with an exposure of 1/40 sec, 4 minutes after raising the beaker and covering the mirror from close to B to just above C. The number of drops entering the liquid at C per sec decreased continuously with time, becoming zero when the inner liquid level was at B.

The drops gave very strikingly the impression of being squeezed out of the film. They then fell like raindrops on a window, presumably sliding down the solid surface, either under the very much thinner helium II film or displacing the latter locally. Their behaviour is in reasonable agreement with the theory of Frenkel (1948) of liquid drops on the surface of a solid which is wetted by the liquid. Thus Frenkel calculates that the drop should leave a trail behind it (observed in some of the helium II drops) and should only roll down the vertical solid surface if the radius of the undeformed drop is greater than $(3\sigma/\pi\rho g)^{1/2}$ where σ=surface tension and ρ=density of the liquid. Inserting the values for helium II at 1·59°K gives R=0·5 mm, which agrees as regards order of magnitude with the observed drops. Drops smaller than this should not run, and the smallest drops were indeed seen to be stationary. The discrete drops were observed only if conditions were clean, i.e. the surface of the mirror was free from condensed gaseous impurities. If this was not the case the bulk liquid could just be observed as a stream of liquid of uneven thickness flowing on an irregular substrate.

References

Burge, E. J., and Jackson, L. C., 1951, *Proc. Roy. Soc.* A, **205**, 270.
Chandrasekhar, B. S., 1952, *Thesis, Oxford.*
Daunt, J. G., and Mendelssohn, K., 1939, *Proc. Roy. Soc.* A, **170**, 423.
Frenkel, Y. I., 1948, *Journ. Expt. Theor. Phys.*, **18**, 659.
Jackson, L. C., and Henshaw, D. G., 1950, *Phil. Mag.*, **41**, 1081 ; 1953, *Ibid.*, **44**, 14.
Mendelssohn, K., 1951, *Proc. Internat. Conf. on Low Temperature Physics, Oxford*, p. 66.

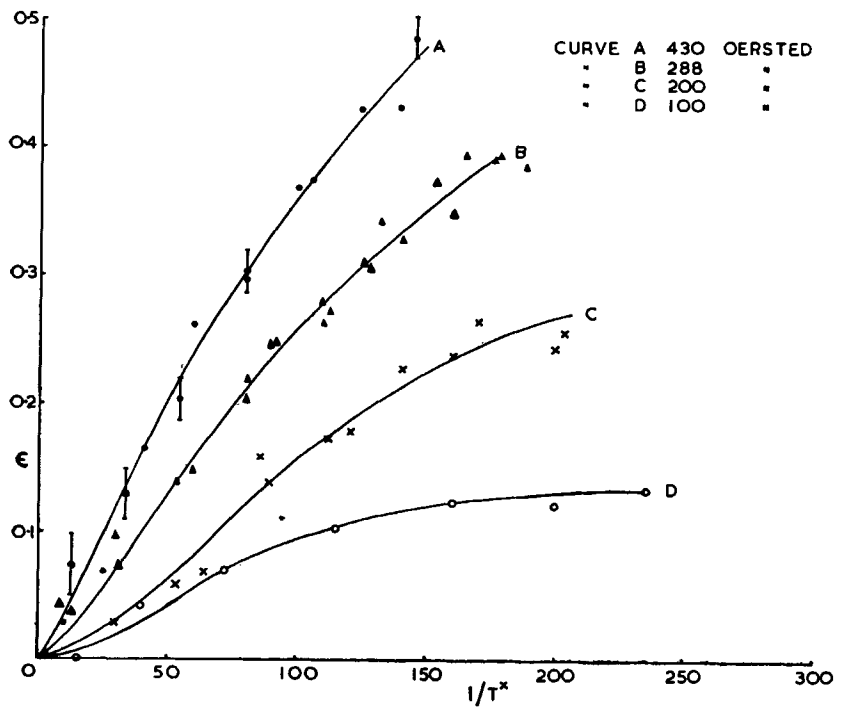
Nuclear Polarization of Cobalt 60

By E. Ambler, M. A. Grace, H. Halban, N. Kurti, H. Durand, C. E. Johnson and H. R. Lemmer
Clarendon Laboratory, Oxford

[Received January 2, 1953]

Gorter (1948) and Rose (1949) have independently suggested that nuclei of paramagnetic ions may be polarized at sufficiently low temperatures through the magnetic hyperfine structure coupling, provided the electron spins are polarized by an external field. Bleaney

(1951) has pointed out that in salts having anisotropic hyperfine structure ($A \neq B$ in the spin Hamiltonian) nuclear alignment may be produced under certain circumstances in zero external field (Daniels, Grace and Robinson 1951), while application of an external field will in general result in a reduction in the degree of alignment. The difference between nuclear polarization and alignment has been discussed by Bleaney (1951) and by Simon, Rose and Jauch (1951). Where the hyperfine structure is isotropic (i.e. $A=B$) there is no alignment in zero field, and we have a favourable case for producing directional effects in radioactive emission solely by nuclear polarization. Recent measurements by Trenam (1953) have shown that in certain salts of the composition $3Co(NO_3)_2.2M(NO_3)_3.24H_2O$, where M is a trivalent ion, $A=B$ for probably two-thirds of the Co ions, while for the remaining one-third $A \gg B$.



The variation with $1/T^*$ of the anisotropy (ϵ) of γ-radiation from polarized cobalt 60 nuclei for different values of the polarizing field.

We have carried out experiments to try to polarize cobalt nuclei in such salts. We first used powdered magnesium lanthanum nitrate in which 5% of the magnesium was replaced by cobalt containing 100 μ Curie of ^{60}Co. This was mixed with the cooling agent, chromium potassium alum, and pressed to form a bonded pill. The specimen was

demagnetized from 30 kø at 1° K to a final field of 250 ø. Under these conditions a significant polarization should have been set up in the cobalt nuclei of the ions for which $A=B$. No spatial anisotropy of the γ-emission was detected however.

The absence of an appreciable nuclear polarization could be ascribed to one or several of the following causes : (*a*) decomposition of the double nitrate through chemical reaction in the pill ; (*b*) bad thermal contact between the grains of the double nitrate and of the alum ; (*c*) insufficient cooling in the partial demagnetization to 250 ø.

All these difficulties were overcome by incorporating as cooling agent cerium in the same crystal as the cobalt. Apart from the proven superiority of this technique (Daniels *et al.* 1951), the substance used, namely $3[0{\cdot}5\%\mathrm{Co}, 99{\cdot}5\%\mathrm{Mg(NO_3)_2}].2\mathrm{Ce(NO_3)_3}.24\mathrm{H_2O}$ containing 50 μ Curie of ^{60}Co, had the following additional advantages. Along one crystallographic axis the g-value of the cerium ion is very small, so that when, after demagnetization, a polarizing field is applied in this direction the resulting temperature rise is small (Cooke, Duffus and Wolf 1953). Furthermore, very low temperatures 0·004° K can be reached by demagnetizing from moderate values of H/T (Daniels and Robinson 1953).

The sample used consisted of twelve single crystals (total weight 4 g) mounted with their crystallographic axes parallel. They were magnetized in 25 kø at 1° K along a direction in which cerium has a large g-value. After demagnetization the polarizing field was applied, and while the crystals warmed up to 1° K (this took about 10 minutes) the γ-ray intensity in the direction of the polarizing field $I(0)$ and perpendicular to it $I(\pi/2)$ was measured by means of G–M counters. Values of the anisotropy $\epsilon=[I(\pi/2)-I(0)/I(\pi/2)]$ of up to 50% have been observed. The figure shows ϵ as a function of the reciprocal of the magnetic temperature T^* for various values of the polarizing field. Further measurements are in progress to determine the contribution to ϵ from the ^{60}Co nuclei of ions with $A \gg B$ and also to obtain a correlation between T^* and T° K in the polarizing fields used.

As always, we are greatly indebted to Professor F. E. Simon for his stimulating interest.

References

Bleaney, B., 1951, *Phil. Mag.*, **42,** 441.
Cooke, A. H., Duffus, J., and Wolf, W. P., 1953, to be published.
Daniels, J. M., Grace, M. A., and Robinson, F. N. H., 1951, *Nature, Lond.*, **168,** 780.
Daniels, J. M., and Robinson, F. N. H., 1953, to be published.
Gorter, C. J., 1948, *Physica*, **14,** 504.
Rose, M. E., 1949, *Phys. Rev.*, **75,** 213.
Simon, A., Rose, M. E., and Jauch, J. M., 1951, *Phys. Rev.*, **84,** 1155.
Trenam, R. S., 1953, *Proc. Phys. Soc.* A, **66,** 118.