It is unfortunately not possible to obtain the quadrupole moment of Be^9 from the observed splitting since the electric field gradient at the nucleus is unknown. Since the observed quadrupole interaction energy $eQ\partial^2V/\partial z^2$ is about ten times smaller for Be than Al, and since the nuclei occupy fairly similar positions in the crystal,[2] it seems reasonable to suppose that the quadrupole moment of Be^9 is appreciably smaller than that of Al^{27} and probably of the order of 0.02×10^{-24} cm^2.

In addition to the lines due to Al and Be, a very weak resonance was also observed at a field corresponding to a g factor of 1.11. As there was no detectable shift of the resonance on rotation of the crystal axis with respect to the magnetic field it was due to a nucleus with very small or zero quadrupole moment. We have also observed the same resonance in two specimens of glass and we think it is probably the result of Si^{29}. According to the theory of Mayer[3] the spin of Si^{29} should be $\frac{1}{2}$, and experiments by Townes *et al.*[4] have shown that the quadrupole moment is small or zero. If we assume $I=\frac{1}{2}$, the magnetic moment is 0.55 nuclear magnetons which is in very good agreement with the value predicted for Si^{29} by the theory of Schawlow and Townes.[5]

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The Effect of Scattering on Angular Correlation Measurements

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THE purpose of this note is to describe a simple method for correcting measurements of angular correlations (involving electrons) for multiple scattering in the source and for the finite solid angle of the detectors, which will allow the experimenter to determine specific activities needed for such measurements.

Consider an e-γ-experiment, where $W(\theta)$ is the correlation function and $F(\alpha)$ is the scattering function. The probability that a γ-ray will enter $d\Omega_1$ and that any electron correlated to it by $W(\theta)$ will be scattered through an angle α and enter $d\Omega_2$ is

$$P=d\Omega_1 d\Omega_2\int d\Omega_\theta W(\theta)F(\alpha). \tag{1}$$

The experimental correlation may be determined by the tedious process of evaluating $F(\alpha)$ numerically, expressing α in terms of θ, φ, etc., and carrying out the integral (1) numerically. However, in general,

$$W(\theta)=(1/2\pi)\Sigma\tfrac{1}{2}(2l+1)a_lP_l(\cos\theta) \tag{2}$$

$$F(\alpha)=(1/2\pi)\Sigma\tfrac{1}{2}(2k+1)b_kP_k(\cos\theta). \tag{3}$$

By expressing $P_k(\cos\alpha)$, via the addition theorem, in terms of θ and of β, the angle between $d\Omega_1$ and $d\Omega_2$, one obtains

$$P=d\Omega_1 d\Omega_2[(1/2\pi)\Sigma\tfrac{1}{2}(2l+1)a_lb_lP_l(\cos\beta)]. \tag{4}$$

Similar expansions of $P_l(\cos\beta)$ and integrations over $d\Omega_1$ and $d\Omega_2$ yield:

$$P=S_1S_2(1/2\pi)\Sigma\tfrac{1}{2}(2l+1)a_lb_lg_lh_lP_l(\cos\theta), \tag{5}$$

where now θ is the angle between the centers of two circular counters of solid angle S_1 and S_2 and half-angles g_0 and h_0 respectively, and

$$g_l\equiv\int_0^{g_0}P_l(\cos\alpha)d(\cos\alpha)\Big/\int_0^{g_0}d(\cos\alpha) \tag{6}$$

with a similar definition for h_l. We note that S_1g_l is the coefficient in (3) for $F(\alpha)=1$, $0\leq\alpha\leq g_0$; $F(\alpha)=0$, $g_0\leq\alpha\leq\pi$, so that the solid angle correction is identical with a scattering correction. The bracket in (4) represents a new correlation function so that similar treatment extends the result to many "scatterings." Thus, given n events such that the $k+1$th event is correlated to the kth event by $W_k(\theta_k)=(1/2\pi)\Sigma\frac{1}{2}(2l+1)a_{lk}P_l(\cos\theta)$, then the correlation between the first and the nth event is just

$$W_n(\theta_n)=\frac{1}{2\pi}\Sigma\frac{2l+1}{2}\Big(\prod_{k=1}^{n-1}a_{lk}\Big)P_l(\cos\theta_n) \tag{7}$$

where θ_n is the angle between the first and the nth events.

(1) Equation (7) extends (5) to $e-e$ angular correlations. (This formula is valid only if the correlation between the $k+1$th and kth events, W_k, is independent of the previous events. Thus it should not give the angular correlation between the first and last events of a cascade transition.)

(2) The form of the correlation is unaffected by the presence of scattering or finite φ-symmetric detectors. For example, if only P_2 appears in the experimental data, (say $W(\theta)=1+A\cos^2\theta=1+aP_2$) then only P_2 is present in the correlation function. This is of interest since often the highest power of l appearing in $W(\theta)$ is of importance even when the a_l are not accurately known. (Where lens spectrometers are used to detect the electrons the form is still unaltered but g_1 and g_2, the acceptance angles of the spectrometer, replace 0 and g_0 in the limits in (6).)

(3) The multiple scattering coefficients b_l are just the correction factors for a_l so that one need not evidence $F(\alpha)$ explicitly. Usually only b_2 or b_2 and b_4 are needed. In the Goudsmit and Saunderson[1] treatment of multiple scattering

$$b_l=\exp[-q(1-C_l)/b_1]\equiv\exp(-mt) \tag{8}$$

where $q=Nst$ (N=atomic density; s=total single scattering cross section; t=effective source thickness) and c_l is just the coefficient of the P_l expansion of $f(\theta)$, the single scattering function. The reader is referred to this treatment for a discussion of assumptions inherent in (8) and for simple expressions for b_l in terms of electron energy, source thickness, atomic number, etc.

(4) Electrons originating near the surface of a source are scattered less than Eq. (8) indicates. (8) applies to a collimated electron beam traversing a foil. A first-order approximation valid when (8) is valid and applicable to thin sources would replace b_l by $(1-b_l)/mt$.

(5) Order of magnitude results using the above approximations: for a source thickness of 200 micrograms ($Z=52$; $A=120$; $E=100$ kev) $b_2=0.9$, $b_4=0.77$. For a half-angle of 18° $g_2=0.9$, $g_4=0.75$.

[1] S. Goudsmit and J. L. Saunderson; Phys. Rev. **57**, 24 (1940); **58**, 36 (1940).

Emission of Long-Range Particles in the Fast Neutron Ternary Fission of U-238 and Th-232

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FOLLOWING a detailed investigation of the long-range particles emitted in the slow neutron ternary fission of U-235 by the photographic plate method,[1] experiments were undertaken to determine whether similar phenomena occur in the fast neutron fission of U-238 and Th-232. Although Tsien *et al.*[2] reported that U-238 gave no such long-range particles when irradiated by neutrons from the bombardment of beryllium by 6.7-Mev deuterons and Tsien and Faraggi[3] obtained a similar result for Th-232, yet the observation of such a mode of photofission in uranium by Titterton and Goward[4] and in thorium by Titterton and Brinkley[5] threw doubt on the validity of the argument used by the French group to explain the absence of the long-range particles in their experiments.

In the present experiments two sets of plates, each including Ilford C_2 and D_1 emulsions, were loaded with uranium acetate and thorium nitrate respectively, as described elsewhere[4,5] and were exposed to neutrons of energy 2.5 Mev obtained from the