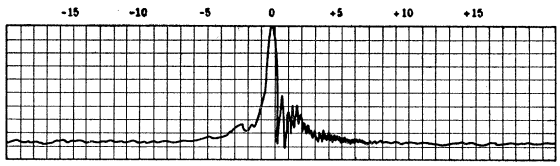

FIG. 2. Proton spectrum at 30 Mc/sec of CH_3I enriched with 51 percent C^{13} with strong $7\frac{1}{2}$ Mc/sec rf-coupled into the transmitter. The side peaks are almost completely collapsed.

of the peaks give a spin of $\frac{1}{2}$ for the C^{13} nucleus, verifying the earlier result obtained by Jenkins from hyperfine structure measurements.[6]

An auxiliary transmitter was link-coupled into the transmitter section of the probe and its frequency varied slightly around 7.544 Mc/sec. At the C^{13} resonance frequency, the two side peaks of the 30-Mc/sec proton spectrum coalesced with the central peak, which doubled in amplitude and became quite sharp (Fig. 2). The frequency of the auxiliary transmitter at which this occurred and the frequency of the 30-Mc/sec transmitter were then counted with a frequency counter.

A comparison of the resonant frequency of C^{13} in CH_3I to that of H^1 in the same molecule gave

$$\nu(C^{13})/\nu(H^1)=0.2514431\pm0.0000005.$$

This result is in excellent agreement with that previously obtained by Poss.[7] The proton resonances in CH_3I and in mineral oil occur, within experimental error, at the same frequency; hence a direct comparison of the above result with that of Poss is justified.

The C^{13} line is a quadruplet, being split into $2I+1$ equally spaced lines, where I refers to the total spin of $\frac{3}{2}$ for the three protons in CH_3I. Since the side peaks of the proton resonance split out symmetrically as a function of frequency as the auxiliary oscillator is tuned above and below the coalition frequency, that frequency was assumed to be at the center of the C^{13} quadruplet.

It is interesting to note that although the 7.5-Mc/sec rf field had a peak-to-peak amplitude of 0.75 gauss, a shift in frequency of 30 to 40 cps was sufficient to broaden the central peak markedly and to decrease its amplitude proportionately. This is more sensitive by a factor of ten than one is led to expect on the basis of rf line broadening. The crystal controlled auxiliary oscillator could be varied about 300 cps above and below the C^{13} frequency, a variation sufficient for the irradiated doublet to be in part reconstituted. Nine measurements of the C^{13} and H^1 frequencies in CH_3I were made, the maximum discrepancy between any two C^{13} measurements being 20 cps.

The magnetic field was swept with a 50-milligauss recurrent sawtooth sweep, and it was suggested that the measurement of the frequency ratio might be in question by the amount by which the position of the proton resonance in the magnetic field was undetermined. The uncertainty was minimized by keeping the sweep frequency low enough to ensure "slow passage" through the resonance.

The incorporation of both the nucleus to be measured and the reference nucleus into a single sample, and the measurement of both resonance frequencies with a single coil gives assurance that any field difference at the two nuclei must be a chemical shift inherent in the molecule since all external experimental factors are the same. A merit of this technique is that it was possible to determine the C^{13} frequency by observing a sensitive change in the strong narrow H^1 resonance with a high resolution spectrometer. No sweep field calibration is involved, the measurement being reduced to the simultaneous determination of two frequencies. Both H_1 and F^{19} give strong sharp lines and make excellent companions for more refractory nuclei.

The author wishes to thank C. Reilly of Shell Development Research Laboratories, Emeryville, California for supplying the sample of $C^{13}H_3I$ used in this experiment.

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Differential Cross-Section Measurements for 1-Mev Bremsstrahlung*

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THE energy and angular distribution of the bremsstrahlung, produced in thin targets of beryllium and gold by electrons with a kinetic energy of one Mev, has been measured with a large NaI(Tl) scintillation spectrometer. The electron beam from the NBS constant-potential accelerator[1] passed through baffle openings into the target chamber, which was electrically insulated from the accelerator tube to serve as a Faraday cup. Target currents from 10^{-10} to 10^{-6} amperes were measured with 2-percent accuracy by a Higinbotham-Rankowitz type current integrator.[2] The targets used were a 0.22-mg/cm^2 gold foil, a 0.43-mg/cm^2 gold foil, and a 4.3-mg/cm^2 beryllium foil. The results obtained with the two gold targets indicated that electron energy loss and scattering in the foils were negligible. The radiation emitted from the target at an angle θ with respect to the direction of the incident electron beam was detected by the spectrometer with an angular resolution of approximately one degree.

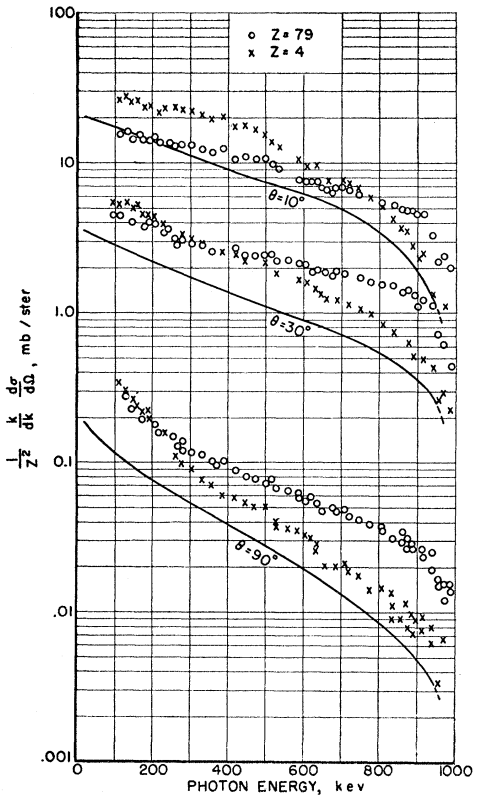

FIG. 1. Differential cross section for 1-Mev bremsstrahlung at photon energies k and angles θ, of 10°, 30°, and 90°. The fractional standard deviations of the experimental points due to counting rate statistics are less than 10 percent for points below 800 kev, less than 20 percent for points below 900 kev, and less than 30 percent for points below 1000 kev. The theoretical cross sections are shown by the solid curves which were obtained from the results of Sauter (see reference 5) and Gluckstern and Hull (see reference 5).

The radiation passed to the spectrometer through a 15-mil Al window in the evacuated target chamber. Electrons traveling in the direction of this window were deflected by an electron trap employing a permanent magnet. To account for the contribution of the radiation arising from normal background and from electron scattering in the chamber, measurements were made with the target foil in and out of the electron beam.

The spectrometer consisted of a $\frac{3}{8}$-inch diameter 12-inch long collimator, a 5-inch diameter 4-inch long NaI(Tl) crystal, a type K1198 Dumont 5-inch diameter photomultiplier tube, and lead shielding extending 12 inches in front, 3 inches on the sides, and $\frac{1}{2}$ inch in the back of the crystal housing. The pulse-height distribution produced by incident radiation was measured with a 12-channel analyzer having approximately 15-kilovolt window widths which were calibrated during runs with a motor-driven sliding pulser. The pulse-height response of this spectrometer to monoenergetic photons appears as a line shape with a low energy tail[3] which replaces the prominent Compton escape peak found with small crystals. This response was characterized by a matrix whose indices corresponded to pulse height and photon energy. Thus, a matrix element specified the counting rate at a given pulse height for photons of a given flux density and of a given energy. These matrix elements were found by interpolation between the response curves measured for the photons from sources of Co^{60}(1.17 Mev, 1.33 Mev),[4] Cs^{137} (0.662 Mev),[4] Hg^{203} (0.279 Mev),[4] and Cd^{109} (0.087 Mev).[4] The matrix determined a set of simultaneous linear equations relating any pulse-height distribution to the corresponding input photon spectrum. In the present case, the bremsstrahlung yielded pulse-height distributions which fell off rapidly with increasing pulse height so that a line-by-line solution of the simultaneous equations was permissible with the aid of a simple perturbation type calculation.

Measurements of the bremsstrahlung spectra were made at angles of 10°, 30°, and 90°, and yielded values of the differential cross section shown in Fig. 1. For comparison, the differential cross section integrated over electron angle, as given by Sauter[5] on the basis of the Born approximation, is shown by the solid lines. It is seen that (a) the prediction of the large intensity variation with angle θ (two orders of magnitude between 10° and 90°) is confirmed, (b) although the measured integrated intensity goes roughly as Z^2, the measured spectral shape is Z dependent, and (c) the theoretical curves appear to underestimate the measured cross sections.[6] Measurements at other angles and materials, and for 500-kev electrons are now in progress.

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Correlation of Spontaneous Fission Half-Lives

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EMPIRICAL correlations which can be used in predicting the properties of undiscovered elements and isotopes are of great practical value. Many such