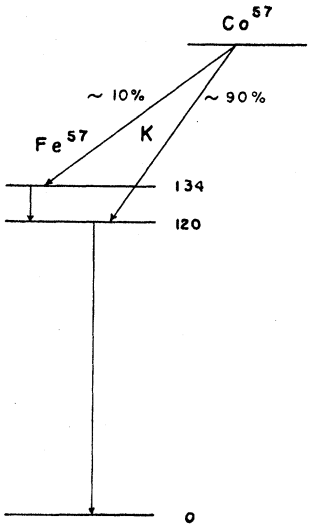

FIG. 1. Decay scheme of Co^{57}.

sented in Fig. 1. It differs from the one presented by Goldhaber and Hill[8] in that positron emission has been suppressed and the order of the two gamma rays reversed.

Experiments are in progress to determine the lifetime of the 120-kev state and the angular correlation of the two gamma rays.

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Nuclear Electric Quadrupole Moment of Na^{23}†

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THE hyperfine interaction constants of the $3\,^2P_{\frac{1}{2}}$ and $3\,^2P_{\frac{3}{2}}$ excited states of Na^{23} have been measured by the atomic beam resonance method proposed by Rabi.[1] In this method, the Na^{23} beam is excited by resonance radiation from a sodium discharge lamp, while a radio-frequency magnetic field is simultaneously applied. The rf changes the magnitude of the refocused beam when the rf corresponds to the separation of two hyperfine levels in the excited state. Since this change is small, high rf power and an intense light source are necessary. For the light source both Philips SO 60 W and General Electric NA-1 sodium lamps were used. From 10 to 20 percent of the atoms in the beam were excited, depending on the way the lamps were operated. Two continuously tunable triode oscillators were used to cover the rf range of 6 to 240 Mc/sec.

The small excited state rf effect also required a more elaborate detection system than is used in the usual atomic beam experiment. The rf field is square-wave modulated at 34 cps so that the refocused beam contains modulated excited state signal and unmodulated background. The atoms are ionized on the usual hot, oxidized, tungsten ribbon and deflected through a simple mass spectrometer onto the first dynode of an Allen type electron multiplier. The modulated portion of the output signal of the Allen tube is then amplified in a narrow band tuned amplifier. The signal is then rectified in a lock-in circuit, averaged in a long time constant *RC* circuit, and put on a recorder.

A typical set of experimental points for the $3\,^2P_{\frac{3}{2}}$ state at near-zero magnetic field is shown in Fig. 1. The narrow lines of the typical atomic beam resonance experiment are absent in this experiment. This is because the fundamental line width is here determined by the natural lifetime of the excited state, rather than by the atom in the rf field. The experimental points are fitted by means of two overlapping resonance curves of the form

$$\frac{h_{\mathrm{I}}}{(f-f_{\mathrm{I}})^2+g^2}+\frac{h_{\mathrm{II}}}{(f-f_{\mathrm{II}})^2+g^2},$$

where h_{I} and h_{II} are the heights of the individual resonances, f_{I} and f_{II} are the centers of the individual resonances, and g is their width. These five constants are determined by trial for a best fit. The results obtained in a series of five runs are given in Table I. The widths are in agreement with the results of Stephenson.[2] In addition, the $F=2$ to $F=1$ hyperfine separation in the

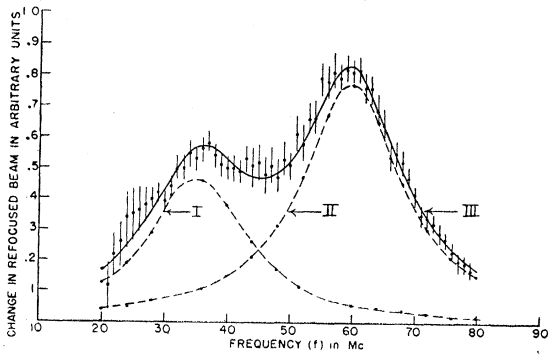

FIG. 1. Typical resonance curve for $3\,^2P_{\frac{3}{2}}$ state of Na^{23}, taken at 1.84-gauss static field. The dots with vertical probable error lines are the experimental points. Curves I and II are the individual resonance curves and curve III is their sum. The parameters of the curves are selected to give a best fit of curve III to the experimental points.

TABLE I. Constants obtained from the resonance curves of five different runs.

f_I, center of lower peak (Mc/sec)	f_{II}, center of upper peak (Mc/sec)	g, line width (Mc/sec)
35.0	58.5	9.75
35.5	59.8	9.80
35.4	59.8	9.80
36.0	60.2	9.75
35.8	60.5	9.90

$3\,^2P_{\frac{1}{2}}$ state was measured at near-zero magnetic field. This measurement gives a magnetic hyperfine interaction constant in the $3\,^2P_{\frac{1}{2}}$ state of $a_{\frac{1}{2}}=94.4\pm0.5$ Mc/sec.

In the $3\,^2P_{\frac{3}{2}}$ state, the three hyperfine level separations are given by

$$(3a_{\frac{3}{2}}+b) \quad \text{for} \quad F=3 \quad \text{to} \quad F=2,$$
$$(2a_{\frac{3}{2}}-b) \quad \text{for} \quad F=2 \quad \text{to} \quad F=1,$$
$$(a_{\frac{3}{2}}-b) \quad \text{for} \quad F=1 \quad \text{to} \quad F=0,$$

where $a_{\frac{3}{2}}$ and b are the magnetic dipole and electric quadrupole hyperfine interaction constants for the $3\,^2P_{\frac{3}{2}}$ state. Since the theoretical ratio of $(a_{\frac{1}{2}})/(a_{\frac{3}{2}})$ is 5 we can uniquely assign the two observed overlapping resonances to the 3–2 and 2–1 transitions. The weak 1–0 transition was not observed, so that there are two possible values of b, each giving a different value for the nuclear electric quadrupole moment, Q. It is difficult to assign a probable error to the values of b which one gets from the kind of curve-fitting one is compelled to use in evaluating this experiment. The average value of the two possible coefficients are $b=+2.58\pm0.18$ Mc/sec and $b=-21.6\pm0.5$ Mc/sec, where the error is taken to be the extreme of the deviation from the average. However if the peak positions of I and II from different runs are taken the limits become much wider. For this reason we do not trust the resultant values of b to better than about 10 percent. The corresponding values of Q are $Q=+0.11\times10^{-24}$ cm^2 and $Q=-0.91\times10^{-24}$ cm^2, without corrections of the Sternheimer type.

In conventional optical spectroscopy, further assignment can be made by the ratio of the intensities of lines. In our case a comparison of the experimental ratio with a simplified theoretical calculation of the ratio favors the assignment of the upper transition to the 3–2 transition. This gives a Q of $+0.11\times10^{-24}$ cm^2. However we do not feel that the experimental conditions of either the light source or the application of the rf are sufficiently definite to make this assignment with full confidence. These remarks apply equally to the results of Sagalyn[3] obtained by the double-resonance optical method. Current nuclear theory would find it very difficult to accept the value $Q=-0.91\times10^{-24}$ cm^2.

Full details will be published in an extended paper in this journal. We are now in the course of making similar measurements on rubidium. We wish to acknowledge the important contributions of Dr. Charles A. Lee and Dr. G. K. Woodgate who participated in the construction and operation of the early form of the apparatus.

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