moments for a number of even-even nuclei. The values so obtained are shown in Table I. Nuclei from Gd^{154} to W^{186} have been included in the table. It is probably true that pure rotational spectra exist for some nuclei at either end of the indicated region of A. However, there seems to be conflicting evidence in certain cases, and it is felt that all the available evidence points to pure rotational spectra in the region indicated above. The values of k are calculated from the number of nucleons in each case.

The present concept of a fractional mass (or charge) participating in nuclear rotations has a natural extension to the interpretation of the data on electrodynamic transitions between nuclear ground states and rotational levels. This extension follows as a consequence of the assumption that the mass and charge densities of nuclear matter are uniform. Hence, if it is assumed that only a certain fraction of the mass participates in collective motion, then for the sake of consistency it should be assumed that only the same fraction of the charge participates in the motion. This emphasizes the fact that the prescription proposed for the determination of the mass fraction in terms of the excess of particles or holes outside filled major shells must be interpreted as providing an estimate of only the magnitude of the fraction and not its character in the sense of a dependence upon the *particular kind* of particles outside the major shells in a given case.

Since both rates for radiative transitions[1] from and cross sections for Coulomb excitation[2] of nuclear rotational levels are proportional to the nuclear current, it is seen that the interpretation of the data relative to such processes will be explicitly dependent on the charge fraction participating in collective motion. It has been shown[3] that for the case of the uniformly-charged axially-symmetric rigid rotator considered in the present work, the values of Q_0 determined from the measured lifetimes of first-excited 2^+ states of even-even nuclei in the rare-earth region as given by Bohr and Mottelson[4] must be divided by k. It is expected that the same modification would hold in the determination of Q_0's from Coulomb-excitation cross-section data.

The intrinsic quadrupole moments obtained from transition data are shown in Table I. The values given in the second column as $Q_0(\mathrm{B-M})$, except those for the tungsten isotopes, are those listed on page 18 of Bohr and Mottelson's paper.[4] The values given for tungsten have been obtained with separated isotopes by McGowan and Stelson.[5] The numbers listed in the table have been obtained from both Coulomb-excitation cross-section data and from lifetime data.

It is of interest to point out that the precision of the measurement of the energy levels is of the order of a few percent and that of the Coulomb-excitation cross sections, considering the uncertainties in making absolute intensity measurements and the uncertainties in the values of total conversion coefficients, is of the order of 30%.

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Observation of Nuclear Magnetic Resonances via the Electron Spin Resonance Line

G. Feher
Bell Telephone Laboratories, Incorporated, Murray Hill, New Jersey
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The double-frequency resonance method reported recently in connection with a nuclear polarization scheme[1] has been extended to observe nuclear transitions and thereby determine hyperfine interactions and nuclear g values.

The method is illustrated for the simple case $I=\frac{1}{2}$, $J=\frac{1}{2}$, in which the hyperfine structure is resolved. The transitions induced by the microwave field of frequency ν_e are indicated by arrows in Fig. 1. The amplitude of the signal due to these transitions is proportional to the difference in population in levels A and A'. If we partially saturate this resonance the population difference will be diminished and the signal reduced. By inducing the nuclear transitions $h\nu_N$ (see Fig. 1), we may either equalize the populations in levels A and B (by saturating these transitions) or reverse the populations (by an adiabatic fast passage).

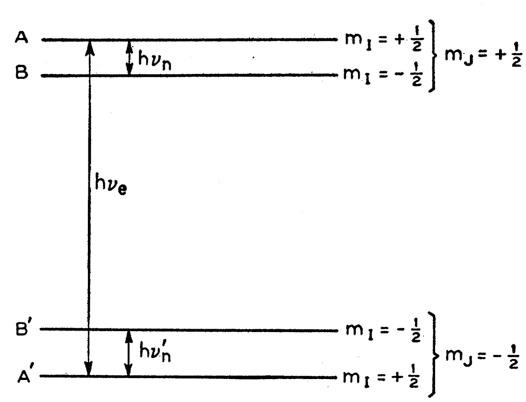

Fig. 1. Energy levels of a system with $I=\frac{1}{2}$, $J=\frac{1}{2}$. Arrows indicate transitions which were induced in the phosphorus-doped silicon sample.

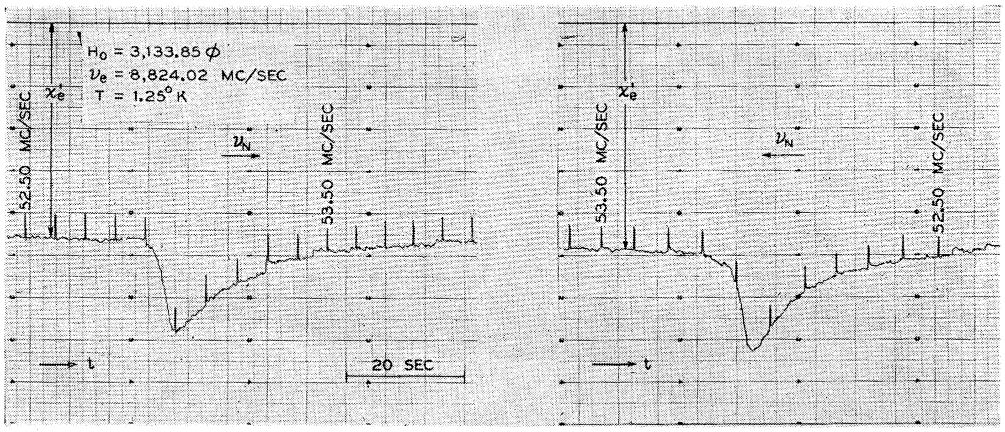

FIG. 2. Electron spin resonance signal in phosphorus-doped silicon. Small vertical lines on trace represent frequency markers of the rf field which is superimposed on the microwave field. A similar trace was obtained at a frequency 11.59 Mc/sec higher.

In either case the population difference in levels A and A' has been increased and thereby the electron spin resonance signal enhanced.

The experimental setup and the phosphorus-doped silicon sample were similar to the one described earlier[2] with the exception that 100-cps magnetic field modulation was used. The magnetic field was adjusted to correspond to the resonance condition of the low-field line ($m_I=+\frac{1}{2}$). Figure 2 is the recorder tracing of the electron spin resonance signal. It shows clearly the enhancement of the signal when the frequency corresponding to the nuclear transitions is being traversed. This enhancement decays with a characteristic time depending on the rate at which the levels A, A' are being saturated. This accounts for the observed asymmetry of the line. A similar line was observed at a frequency 11.59 ± 0.02 Mc/sec higher corresponding to nuclear transitions between levels A' and B' (see Fig. 1). From this frequency difference, one may easily calculate g_I for phosphorus [see reference 1, Eq. (2)]. The value obtained is $g_I=2.265\pm0.004$ which agrees with the accepted value[3] of 2.2632 ± 0.0004.

Since this method yields a value of g_I without having to know the wave function of the electron associated with the paramagnetic center, it may be used either to determine an unknown nuclear g_I or as an analytical tool to identify impurities.

The method is also applicable to uses in which the hyperfine interaction $a(\mathbf{I}\cdot\mathbf{J})$ is small in comparison to the electron line width and therefore no structure can be observed in a single-frequency spin resonance experiment. Such a case is, for example, lithium-doped silicon, in which Honig and Kip[4] first observed an unresolved electron spin resonance line. By performing the same experiment as in the phosphorus-doped silicon sample described before, we were able to observe an enhancement of the electron spin resonance line at the frequencies of 4.89 Mc/sec and 5.74 Mc/sec with an external magnetic field of 3217 oersteds. Since for this case $a(\mathbf{I}\cdot\mathbf{J})<g_I\mu_0H$, we expect the two frequencies $\nu_{1,2}$ to occur at

$$h\nu_{1,2}\simeq g_I\mu_0H\pm\tfrac{1}{2}a.$$

This yields for the hyperfine interaction constant $a=0.85\pm0.01$ Mc/sec as compared with the theoretical estimate of Kohn and Luttinger[5] of 0.5 Mc/sec. We also obtained lines arising from the interaction of the electron with the Si^{29} nuclei. They are presently being analyzed in more detail and may prove to be a convenient way of getting the electron wave functions at different lattice points.

Another system to which the double-resonance method has been applied is F centers in KCl. An unresolved line was first observed by Hutchison[6] and investigated in greater detail by Kip *et al.*[7] We were able to resolve different sets of lines which presumably arise from the interaction of the electron with the potassium and chlorine nuclei. A more detailed analysis is being prepared for publication.

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Gamma-Ray Branching Ratio of the 3.95-Mev Level in N^{14}

H. E. GOVE, A. E. LITHERLAND, E. ALMQVIST, AND D. A. BROMLEY

Chalk River Laboratory, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada

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IN the course of a study of He^3-induced reactions on C^{12},[1] the gamma-ray branching ratio of the 3.95-Mev level in N^{14} has been measured. The results of this

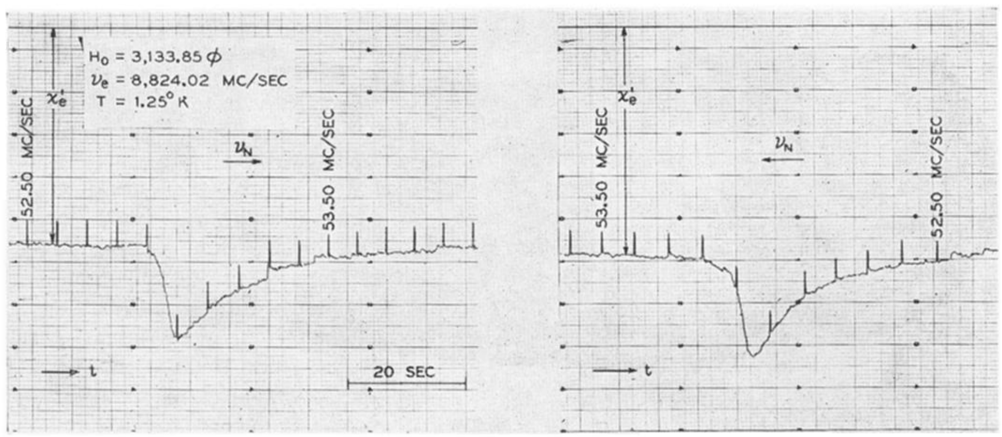

FIG. 2. Electron spin resonance signal in phosphorus-doped silicon. Small vertical lines on trace represent frequency markers of the rf field which is superimposed on the microwave field. A similar trace was obtained at a frequency 11.59 Mc/sec higher.