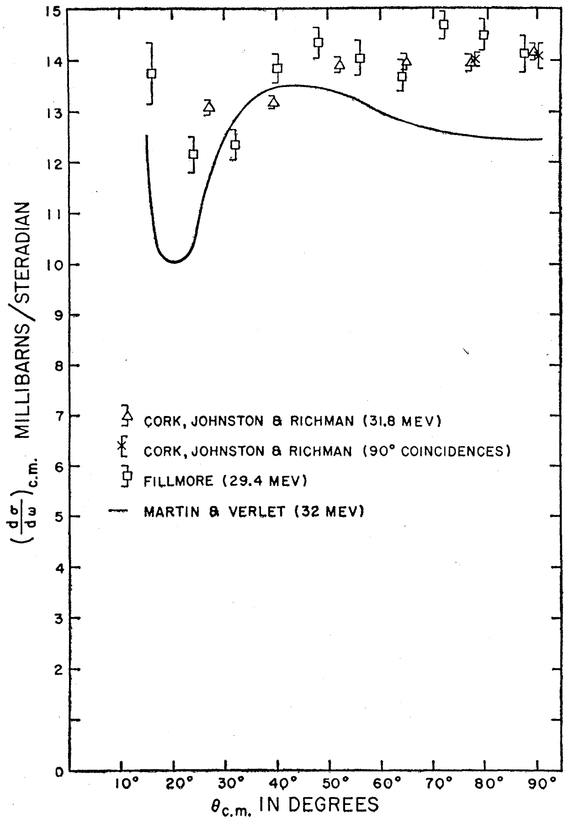

FIG. 1. The differential cross section for proton-proton scattering, normalized to 32.0 Mev assuming a $1/E$ dependence, and comparison with the calculated values of Martin and Verlet.

pendence. Also the calculated curve of Martin and Verlet is shown on the same graph.

The probable errors indicated are those assigned by the experimenters. The more recent data[5] are observed to be in better agreement with the calculated curve,[1] and the proportional counter data.[4]

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The Spin and Magnetic Moment of Ca^{43}

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THE magnetic resonance of Ca^{43} has been observed at a frequency of 2.85 Mc/sec in a magnetic field of 10 000 gauss, using a recording nuclear induction spectrometer somewhat similar to that described by Proctor.[1] The sample consisted of a 0.7-molar aqueous solution of $CaBr_2$, enriched to 68 percent Ca^{43}, mixed with a 4.5-molar aqueous solution of $MnCl_2$ containing a few percent D_2O. The D_2O provided a deutron magnetic resonance signal for reference and the Mn^{++} ions acted as a paramagnetic catalyst to shorten the relaxation time. The ratio of the resonance frequency of Ca^{43} to that of D in the same magnetic field has been observed to be

$$R=\nu(Ca^{43})/\nu(D)=0.43832\pm0.00004. \quad (1)$$

By comparing the sign of the Ca^{43} signal to that of the D signal it was furthermore observed that the magnetic moment of Ca^{43} is negative.

According to Bloch's phenomenological theory of nuclear induction,[2] the spin of a nucleus can be determined in principle by comparing its signal amplitude and width with the amplitude and width of the signal from a nucleus whose spin is known. By this means the spins of several nuclei have been measured by Proctor,[1] Alder and Yu,[3] and others. For slow passage conditions it can be shown that if the radiofrequency field H_1 is much smaller than the saturation value, and the modulation field H_s small compared to the line width, then the observed signal amplitude h is proportional to $\gamma^3W^{-2}NI(I+1)H_1H_s\omega^2$, where γ is the gyromagnetic ratio, W is the line width, N is the number of nuclei per unit volume, I is the spin, and ω is the Larmor frequency.

In the present case it was observed that the variation of the Ca^{43} signal amplitude with the magnitude of the radiofrequency field had the behavior predicted by Bloch's theory; a similar behavior was observed for the D signal amplitude. Slow passage conditions were achieved by shortening the relaxation times by the use of the Mn^{++} ions and by using a low spectrometer modulation frequency. The line shapes were normal, and there was no evidence of any structure which are due to chemical effects. Thus there is good evidence that the expression for the signal amplitude as given above is applicable to both the Ca^{43} and the D signals. For nine sets of data we have measured h and W for both the Ca^{43} and the D signals obtained for the same values of H_1, H_s, and ω. Using the above expression, we find

$$[I(Ca)][I(Ca)+1]=2\left[\frac{1}{R}\right]^3\left[\frac{W(Ca)}{W(D)}\right]^2\left[\frac{h(Ca)}{h(D)}\right]\left[\frac{N(D)}{N(Ca)}\right]=15.8\pm2,$$

from which we conclude that the spin of Ca^{43} is

$$I(Ca^{43})=7/2, \quad (2)$$

considering that the nearest other possible spin values of 5/2 and 9/2 give values of $I(I+1)$ well outside this measured value.

Using this spin value and the frequency ratio (1), we obtain for the magnetic moment of Ca^{43}, without diamagnetic correction,

$$\mu(Ca^{43})=-1.3152\pm0.0002 \text{ nm}, \quad (3)$$

where we have used in this calculation the ratio $\mu(D)/\mu(H)=0.307015$ as given by Mack,[4] and $\mu(H)=2.7925$ as determined by Bloch and Jeffries.[5]

This experiment assigns an $f_{7/2}$ orbit to the odd neutron in Ca^{43}, which is in agreement with the nuclear shell model proposed by Mayer[6] and Haxel, Jensen, and Suess.[7] It should also be pointed out that the values of the magnetic moment of Ca^{43} as predicted by the schemes of Schawlow and Townes,[8] and of Davidson,[9] which are -1.38 nm and -1.17 ± 0.12 nm, respectively, agree well with the above measured value.

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