ponent due to $Mg^{24}$ and a weak component $+0.095$ cm$^{-1}$ from the $Mg^{24}$ component. The 30-mm pattern showed the weak component resolved into two, the stronger of which had the higher frequency. The separations of these from the $Mg^{24}$ component are $+0.1021 \pm 0.0004$ and $+0.0786 \pm 0.0007$ cm$^{-1}$. The stronger is assigned to $Mg^{26}$ and the weaker is one of the two components expected from $Mg^{25}$. The 50-mm pattern indicated a faint component on the high frequency side of the strong component which in this pattern arises from an overlap of the $Mg^{24}$ and $Mg^{26}$ components in adjacent orders; but its position could not be accurately measured.

The ratio of the intensities of the $Mg^{26}$ component and the neighboring $Mg^{25}$ component, corrected for their mutual influence and the background due to $Mg^{24}$, was measured from the 30-mm pattern and is $1.7 \pm 0.2$. The assigned error is large because the background intensity due to $Mg^{24}$ is comparable to the intensity of both the $Mg^{25}$ and $Mg^{26}$ components. Using the known relative abundances[3] of the isotopes and the intensity formula, values of this ratio can be predicted for both positive and negative moments and various I values. For a negative moment and $I=1/2$, $3/2$, $5/2$, and $7/2$ the predicted values are 1.49, 1.78, 1.91, and 1.99, respectively. Positive values of the moment give ratios greater than 2.55. Thus the measured value confirms a negative magnetic moment. It is not sufficiently accurate to determine I, but is compatible with $I=5/2$.

If the center of gravity of the $Mg^{25}$ components is assumed to be midway between the $Mg^{24}$ and $Mg^{26}$ components the interval factor of $^2S_{1/2}$ of Mg II can be evaluated and used to calculate the magnetic moment. The position of the $Mg^{25}$ component, corrected for the influence of the $Mg^{26}$ component, relative to the center of gravity is $0.0274 \pm 0.0015$ cm$^{-1}$. For $I=5/2$ this separation gives $a_{3s}=0.0231$ cm$^{-1}$ when allowance is made for the small structure of $^2P_{3/2}$. $\mu(Mg^{25})=-0.93 \pm 0.05$ n.m. is obtained from $a_{3s}$ by the Goudsmit formula.[4] However, the uncertainty in $\mu$ would be increased to 10 percent if the assumed position of the center of gravity is in error by 0.001 cm$^{-1}$.

The values of the magnetic moment determined from the h.f.s. splittings of $^3S_1$ of Mg I and $^2S_{1/2}$ of Mg II agree within the assigned errors. The weighted mean is $-0.96 \pm 0.07$ nuclear magnetons. The Fermi-Segrè[5] correction has been applied and the effect of the finite size of the nucleus[6, 7] is negligible.

The spin and the negative sign of the magnetic moment agree with the predictions of the shell structure in nuclei.[8, 9] The magnitude of the magnetic moment falls near the average curve for similar nuclei in a Schmidt diagram,[8] but as for most of these nuclei it does not agree with the value predicted by an individual particle model.

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## Nuclear Moments of $_{39}Y^{89}$

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LINES in the first, second, and third spectra of yttrium have been examined for hyperfine structure,[1–4] but none has been observed. The only result obtained from these investigations was that the magnetic moment of $_{39}Y^{89}$ is small. From the observed half-width, 0.1 cm$^{-1}$, of the Y III resonance line 2817A ($5s\,^2S_{1/2}-5p\,^2P_{3/2}$) Wittke[3] estimated an upper limit of 0.05 cm$^{-1}$ for the h.f.s. splitting of $5s\,^2S_{1/2}$, and from this calculated $\mu \leq 0.1$ n.m., on the supposition that $I=\frac{1}{2}$.

In the present investigation, the Y III resonance line 2817A ($5s\,^2S_{1/2}-5p\,^2P_{3/2}$) has been resolved into two components. The observed intensity ratio is 3:1, and the fainter component is of lower frequency. Thus $I=\frac{1}{2}$, and the magnetic moment is negative. The magnetic moment calculated from the observed separation of the two components is $\mu=-0.14$ n.m.

The Y III spectrum was excited in the electrodeless discharge described by Crawford and Levinson.[5] $YCl_3$ was introduced into the quartz discharge tube. The tube was then evacuated, and argon admitted. The pressures used were in the range of 0.1 to 1.0 mm Hg at room temperature (26°C). Gaseous impurities in the discharge tube were removed by calcium shavings placed in a side branch. Graded seals connected the discharge tube to the pumping system, and liquid air traps placed between the stopcocks and the discharge tube prevented contamination by vapors from the stopcock grease. The discharge tube, with the exception of the windows, was immersed in liquid air. Even with liquid air cooling the Y III lines were easily excited.

The structure of 2817A was resolved with a 3-cm Fabry-Perot etalon, with aluminum coated plates. The etalon was placed between the collimator and the dispersing prism of the spectrograph, which had an $F/4$ off-axis paraboloidal mirror as the camera objective. The structure of the other resonance line of Y III could not be measured because an argon line was superimposed on it.

The effects of different excitation conditions and argon pressures on the half-intensity width and the intensity of the components were studied. It was possible to obtain half-widths of 0.05 cm$^{-1}$ with intensity adequate to give in a two-hour exposure a photographic density suitable for accurate intensity measurements. The plates were calibrated for intensity measurements by the step-slit continuous spectrum method. The intensity ratio of the two components was found to be independent of excitation conditions and argon pressures. Thus the structure observed must be h.f.s.

The separation of the components, when corrected for their small overlap as determined from the analysis of the intensity contours, is $0.060 \pm 0.005$ cm$^{-1}$. This separation is very nearly equal to the difference between the splittings of the $^2S_{1/2}$ and $^2P_{3/2}$ levels. A calculation shows that the splitting of the $^2P_{3/2}$ level is 1/15 that of the $^2S_{1/2}$ level. Therefore the $^2S_{1/2}$ splitting is $0.064 \pm 0.005$ cm$^{-1}$. The magnetic moment calculated from this separation by the Goudsmit formula,[6] with a Fermi-Segrè correction,[7] is $\mu=-0.14$ n.m. The correction for the finite size of the nucleus[8] is negligible compared to the experimental error in $\mu$.

The spin and the sign of the magnetic moment of $_{39}Y^{89}$ are consistent with the predictions of the single particle model[9–11] for a configuration in which 50 neutrons form closed shells and the last 5 protons are in the $3p$ shell. Thus one concludes that at $Z=39$ the $2s$ and $3p$ proton levels have not crossed. The magnitude of the magnetic moment of $_{39}Y^{89}$ is in fair agreement with that predicted for the single particle model, and is additional evidence that the observed and predicted magnetic moments are in much better agreement for nuclei with completed shells plus or minus one proton, or plus or minus one neutron than for other nuclei. $Pb^{207}$ and $Bi^{209}$ are the two outstanding exceptions and they are adjacent to the radioactive elements.

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