A Suggested Dependence of Nuclear Moments on Atomic Number

It is the purpose of this letter to point out *that for nuclei of odd mass number the magnitude of nuclear magnetic and mechanical moments appears to depend somewhat upon whether, Z, the atomic number, is even or odd.* All of the data in Goudsmit's[1] recent paper (entitled *Nuclear Magnetic Moments*) point to such a dependence. In his table[1] there are five nuclei for which Z is even; their magnetic moments vary from $+0.60$ down to -0.67. The fifteen nuclei with Z odd have magnetic moments ranging from $+0.9$ up to $+5.4$, while for eleven of these the values are greater than $+2.0$. Thus for these nuclei there is a definite difference, all the nuclei with Z even having small positive or negative magnetic moments, while nuclei with Z odd have magnetic moments which are all positive, and somewhat larger and more variable in magnitude.

This correlation suggested by Goudsmit's data[1] is supported by our own experimental results.[2] We have studied the neighboring pairs of nuclei Cb^{93} and Mo^{95}, also Ta^{181} and W^{183} which differ by one unit in Z, and by two units in mass number. We have found in each case the member of the pair with Z odd to have a very considerably larger magnetic moment than that with Z even.

For nuclei of odd mass number we have compiled a rather complete table of the experimentally determined I values. This table shows that I also depends on whether Z is even or odd. Nuclei with Z even have small I values, generally $\frac{1}{2}$ or $\frac{3}{2}\cdot h/2\pi$, whereas those with Z odd show much more variation, ranging from $\frac{1}{2}$ to at least $9/2$, with quite a number of nuclei[2] having $I \geqq 5/2$.

Since nuclear magnetic moments depend directly upon the value of I, then the smaller I values, found for nuclei with Z even, will in part account for the differences in magnetic moments to which reference has been made above. If, however, we compare the magnetic moments of nuclei having the same I value (virtually comparing nuclear g-factors) we find that nuclei with Z odd definitely have the larger magnetic moments; e.g., for $I=\frac{1}{2}$ the magnetic moments are,[1] for Z odd; Al^{27}, $+2.1$; Tl^{203} and Tl^{205}, $+1.8$; whereas for Z even; Cd^{111} and Cd^{113}, -0.67; Hg^{199}, $+0.55$; and Pb^{207}, $+0.60$.

A more complete discussion of the general field of nuclear moments will be published shortly.

Note: Since this letter was written a very interesting paper by Fermi and Segrè (Zeits. f. Physik **82**, 729 (1933)) on nuclear magnetic moments has appeared. His results are in excellent agreement with those of Goudsmit and they therefore lend considerable additional support to the generalizations suggested in this letter.

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[1] Goudsmit, Phys. Rev. **43**, 636 (1933).

[2] Grace and Ballard, and Grace and More, Bull. Am. Phys. Soc. **8**, No. 3, papers 2 and 3; Grace and McMillan, Bull. Am. Phys. Soc. **8**, No. 4, paper 54; Grace and White, Phys. Rev. **43**, 1039 (1933); and unpublished data.

Fine Structure of H^2 Alpha

Through the courtesy of Professor G. N. Lewis we were supplied with an amount of water containing equal parts of the two hydrogen isotopes for purposes of spectroscopic investigation. A large discharge tube of the modified Wood type entirely immersed in liquid air was used. The spectrum was photographed through an etalon interferometer with the first order of a 30 foot grating spectrograph for auxiliary dispersion. The lines $H^1\alpha$ and $H^2\alpha$ were widely separated, each showing its own system of interference fringes. With the interferometer separation used, namely 7.8 mm the fringe system of one main component of the fine structure was displaced with reference to that of the other main component by almost exactly one-half of a fringe. In the case of both isotopes the presence of a third component ($n=3\rightarrow2$, $j=\frac{1}{2}\rightarrow\frac{1}{2}$) at the indicated position is distinctly shown by dissymmetries in the microphotometer tracings. This effect is noticeably more evident in the case of the heavier isotope (see Fig. 1). A preliminary measure of the doublet separation corrected for the effect of the weaker components indicates strongly a value, corresponding on the basis of the present theory, to $1/\alpha=138$. This is distinctly greater than the value given by Birge[1] from other data. This discrepancy does not necessarily imply erroneous values for e and h but may arise from an incompleteness of the theory of fine structure. The similarity of the interference fringe systems for the two isotopes affords a very accurate method of determining the difference in wave-length between $H^1\alpha$ and $H^2\alpha$. From this value m, the mass of the electron, can be computed and combined with the known value of the Faraday to obtain e/m. Preliminary measurements yield a value for e/m smaller than 1.758×10^7 e.m.u.

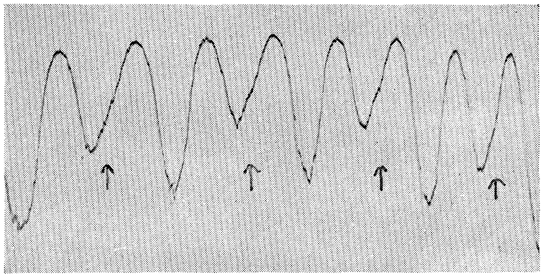

FIG. 1. Microphotometer trace of fringe system for $H^2\alpha$. Arrows indicate position of third component.

The authors wish to express their sincere appreciation of the generosity of Professor Lewis who suffered his own investigations to be somewhat delayed that $H^2{}_2O$ might be furnished for the present study.

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[1] Birge, Phys. Rev. **40**, 228 (1932); **40**, 319 (1932).

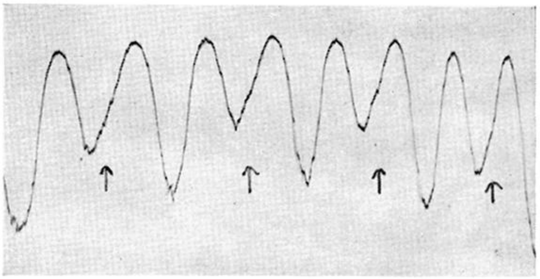

FIG. 1. Microphotometer trace of fringe system for $H^2\alpha$. Arrows indicate position of third component.