LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

The Nuclear Magnetic Moment of N^{14} *

The ${}_7N^{14}$ nucleus is one of the few which possess odd atomic number and even atomic weight. Like ${}_3Li^6$ and ${}_1H^2$, which are also in this class, its spin is known to be 1. It was suggested by some writers that the moment of ${}_7N^{14}$ as well as that of ${}_3Li^6$ should be equal to that of the deuteron, at least in first approximation. These predictions are fulfilled in the case of ${}_3Li^6$. However, Bacher,[1] as a result of a spectroscopic investigation in which he failed to find any hyperfine structure splitting of lines in the atomic spectrum, set an upper limit of 0.2 for the moment of N^{14}.

Accordingly, the new molecular beam method for the direct measurement of nuclear magnetic moments,[2] previously used[3] for the determination of the moments of Li^6, Li^7 and F^{19} has been applied to a determination of the moment of N^{14}. The method measures the precession frequency, ν, of a nucleus in a uniform magnetic field, H. The moment is obtained from the relation, $\nu = g\mu_0 H/h$ where $g = \mu/i$. The nuclear spin, i, of N^{14} is known[4] to be 1 from the alternating intensities observed in the band spectra of nitrogen.

There was a certain difficulty in finding a compound which contained nitrogen and an alkali atom and which could be vaporized without decomposition. The alkali atom in the molecule is necessary for detection by the method of surface ionization. The molecules finally used were NaCN, KCN and RbCN. Although free alkali atoms were observed in the beam and identified by means of the method of zero moments[5] a sufficient intensity of molecules was obtained for further experimentation. The atoms were not a source of disturbance because at high fields, in the deflecting magnets, they are thrown out of the beam entirely.

Apart from the resonance minimum for the alkali in question a minimum was observed which was common to all of the cyanides. The ratio of ν/H was constant with respect to applied magnetic field over a range from 2100 to 4400 gauss, for NaCN and KCN. The same ν/H minimum was observed in RbCN although in this case the agreement could not be accurately tested. This observed value of ν/H was constant within 1 percent. We attribute this common resonance minimum to N^{14}. It cannot be assigned to C^{12} since its spin is zero. C^{13} must be ruled out because the effect is too large, in view of the low abundance of this isotope. There remains a question whether it can be caused by the rotational moment of the molecule as a whole or to some group such as the CN group common to all the molecules. The former possibility can be ruled out because of the very different moments of inertia of the three molecules making it unlikely that they would all possess the same rotational gyromagnetic ratio. The assumption that the rotation of the CN group, as such (if such a possibility exists at all), has a moment which is the cause of this resonance is ruled out by the fact that ν/H is constant. This means complete decoupling of the hypothetical rotation from the rotation of the molecule as a whole which would be absurd at these low magnetic fields. Moreover, it is very difficult to make a reasonable model of such rotation which would have a Landé g high enough to account for the experimental results.

A further bit of evidence is obtained from the average over-all magnetic moment of the KCN molecule which was found to be about one nuclear magneton. We arrived at this value by observing the deflection of the beam in an inhomogeneous magnetic field. Since these experiments are performed at oven temperatures of about 1000°K the average rotational angular momentum of the molecule or any constituent such as CN is at least $17h/2\pi$. This rotation would result in a magnetic moment of $17 \times 0.4 \sim 7$ nuclear magnetons. It would, therefore, be very difficult to assign the resonance to any cause other than a nuclear moment.

The value which we find for $\mu(N^{14})$ is 0.400 ± 0.002 nuclear magneton. This is referred to our published value of 3.265 as the moment of Li^7 which will be our standard, since the ratios are, at present, determined more accurately than the absolute values.

Our value is twice as great as the upper limit assigned by Bacher. However, in view of uncertainties of the calculation of nuclear moments from his data, this fact may be of no further importance. It may be of considerable significance for the nuclear model that the value of $\mu(N^{14}) = 0.400$ agrees quite well with the results of theoretical considerations of Bethe and Rose[6] and Feenberg and Phillips.[7]

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4 Ornstein and Van Wijk, Zeits. f. Physik **49**, 315 (1928).
5 Cohen, Phys. Rev. **46**, 713 (1934).
6 Bethe and Rose, Phys. Rev. **51**, 205 (1937). See "*Note added in proof.*"
7 Feenberg and Phillips, Phys. Rev. **51**, 597 (1937).