# Nuclear Magnetic Resonance of $Ni^{61}$ in Metallic Nickel

L. J. BRUNER, J. I. BUDNICK, AND R. J. BLUME
*International Business Machines Watson Research Laboratory, Columbia University, New York, New York*
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The nuclear magnetic resonance of $Ni^{61}$ in unenriched metallic nickel has been observed. The results provide the first experimental measure of the internal field at the nucleus in nickel. The resonance occurs at a frequency of 26.02 Mc/sec at room temperature, yielding an estimate of 170 kilogauss for the internal field.

WE wish to report the observation of the nuclear magnetic resonance (nmr) of $Ni^{61}$ in unenriched nickel powder. These observations are similar to those previously reported by Portis and Gossard[1] on $Co^{59}$ in cobalt metal and by Gossard, Portis, and Sandle[2] on $Fe^{57}$ in 80% enriched iron. The nmr of $Fe^{57}$ in unenriched iron has also been observed by Robert and Winter[3] as well as in our laboratory.[4]

The $Ni^{61}$ resonance is observed at a frequency of 26.02 megacycles at a temperature of 298°K in high-purity (99.999%) Johnson-Matthey powder with the natural abundance (1.25%) of $Ni^{61}$. A typical recorder trace, exhibiting the approximate second derivative of the resonance absorption curve, is shown in Fig. 1. The linewidth at room temperature is about 50 kc/sec.

The resonant frequency has been measured at three fixed temperatures; the results are tabulated in Table I. The results contained in Table I cannot be fitted by an expression of the form

$$\nu(T)=\nu_0[1-(T/T_c)^2]^{\frac{1}{2}}, \quad (1)$$

which has proved adequate for the cobalt observation[1] in this temperature range. In Eq. (1), $T_c$ is the Curie temperature which for nickel is 631°K.

TABLE I. $Ni^{61}$ resonant frequencies at three different temperatures.

| Temperature | Frequency (Mc/sec) |
|---|---|
| 78°K | 28.21 |
| 193° | 27.54 |
| 298° | 26.02 |

The nuclear spin of $Ni^{61}$ is known to be $\frac{3}{2}$.[5] Using this, together with the $Ni^{61}$ moment of 0.30 nm as measured by Orton, Auzins, and Wertz,[6] we find the internal field at the nickel nucleus to be 170 kilogauss at room temperature. Further studies of the temperature dependence of the internal field are in progress.

## ACKNOWLEDGMENT

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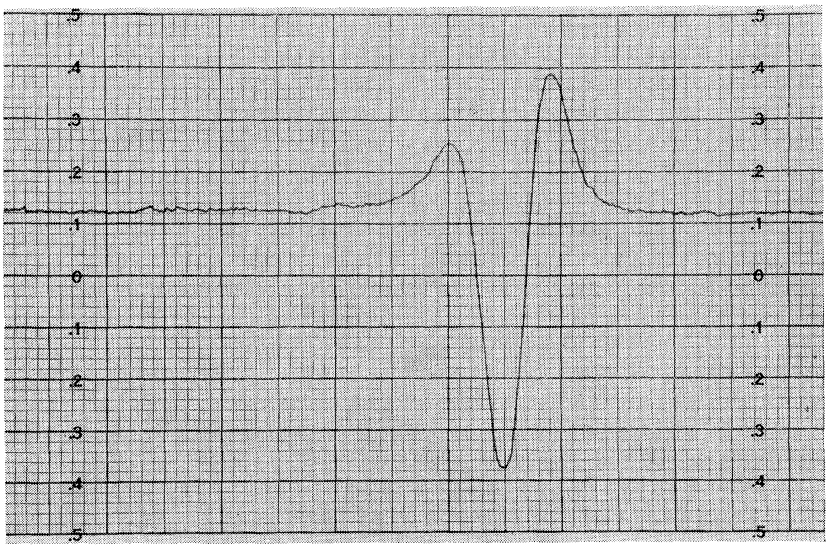
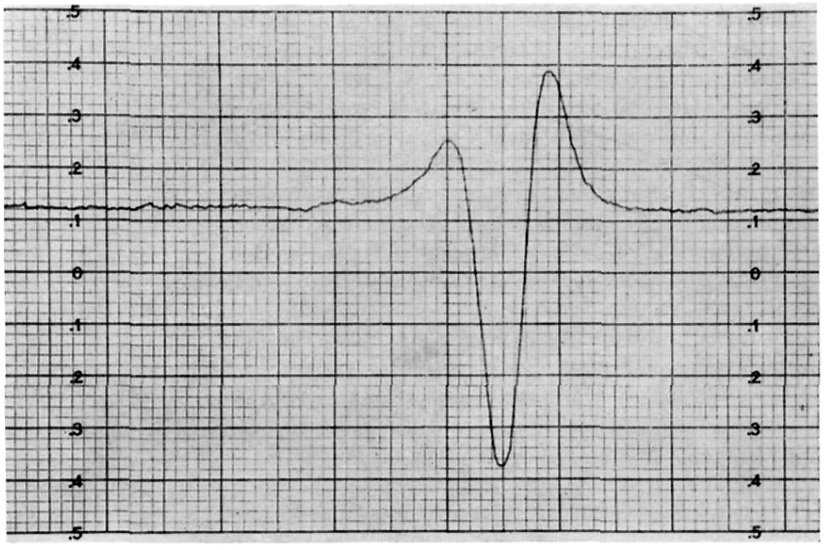


FIG. 1. The approximate second derivative of the absorption curve for the $Ni^{61}$ resonance.

[1] A. M. Portis and A. C. Gossard, Suppl. J. Appl. Phys. **31**, 205S (1960).
[2] A. M. Portis (private communication).
[3] C. Robert and J. -M. Winter, Compt. rend. **250**, 3831 (1960).
[4] Abstract submitted to the Sixth Annual American Institute of Electrical Engineers Symposium on Magnetism and Magnetic Material, New York, 1960 (unpublished).
[5] H. H. Woodbury and G. W. Ludwig, Phys. Rev. Letters **1**, 16 (1958).
[6] J. W. Orton, P. Auzins, and J. E. Wertz, Phys. Rev. **119**, 1691 (1960).

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