## Nuclear Magnetic Resonance of Ni<sup>61</sup> 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<sup>61</sup> 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.

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

The Ni<sup>61</sup> resonance is observed at a frequency of 26.02 megacycles at a temperature of 298°K in highpurity (99.999%) Johnson-Matthey powder with the natural abundance (1.25%) of Ni<sup>61</sup>. 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

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

| TABLE                   | Ni <sup>61</sup> resonant frequencies a | at three |  |  |  |  |
|-------------------------|---|----------|--|--|--|--|
| different temperatures. |   |          |  |  |  |  |

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

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

The nuclear spin of Ni<sup>61</sup> is known to be  $\frac{3}{2}$ .<sup>5</sup> Using this, together with the Ni<sup>61</sup> moment of 0.30 nm as measured by Orton, Auzins, and Wertz,<sup>6</sup> 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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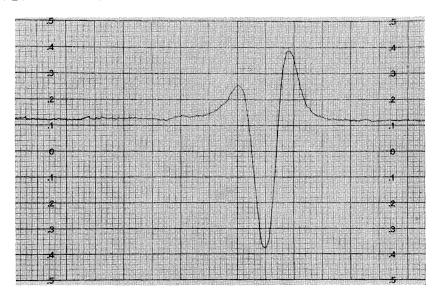


FIG. 1. The approximate second derivative of the absorption curve for the Ni<sup>61</sup> resonance.

<sup>1</sup> A. M. Portis and A. C. Gossard, Suppl. J. Appl. Phys. 31, 2058 (1960).

<sup>2</sup> A. M. Portis (private communication). <sup>3</sup> C. Robert and J. -M. Winter, Compt. rend. **250**, 3831 (1960).

<sup>4</sup>Abstract submitted to the Sixth Annual American Institute of Electrical Engineers Symposium on Magnetism and Magnetic Material, New York, 1960 (unpublished). <sup>5</sup> H. H. Woodbury and G. W. Ludwig, Phys. Rev. Letters 1, 16 (1958). <sup>6</sup> J. W. Orton, P. Auzins, and J. E. Wertz, Phys. Rev. 119, 1691 (1960).

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