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.

A Modified Arc Source for the Cyclotron

Encouraged by the success of Livingston *et al.*[1] and particularly of Allen[2] with arc ion sources in cyclotrons, we have tried a similar source in the 60-inch cyclotron here. The design is a modification of those recommended in the references given, but we believe that it is sufficiently different and simpler to merit a brief description. Fig. 1 shows a cross section of our source. The cone is turned from a solid block of copper; it has a $\frac{1}{4}$-inch hole in the top and is beveled at about 45°. The filament is a coil of 50-mil tungsten, with vertical leads that bend horizontally at the bottom, and are clamped in water-cooled blocks. Below the filament is a tungsten plate at the filament potential, to prevent the arc from striking downward. The arc runs with 1.5–2 amperes at about 100 volts drop, in a deuterium pressure estimated at about 10^{-2} mm Hg.

The performance of this source may be illustrated by some results of trials. These figures were collected from the data of operation over several weeks and may not be strictly comparable. In all cases the beam consisted of 16-Mev deuterons, and the oscillators were fed with single phase full wave rectified power. The peak voltage between dees was about 200 kv. Old filament source 14μA; arc source, $\frac{3}{16}''$ hole, not beveled, no feelers 5μA; arc source, $\frac{3}{16}''$ hole, beveled, no feelers 25μA; arc source, $\frac{1}{4}''$ hole, beveled, no feelers 52μA; arc source, $\frac{1}{4}''$ hole, beveled, feelers on 90μA. The introduction of the feelers reduced the amount of power needed to maintain the dee voltage, even though it increased the beam. This would seem to indicate that their function, in this case at least, is to give the ions from the source a better start rather than to pull more ions from the source.

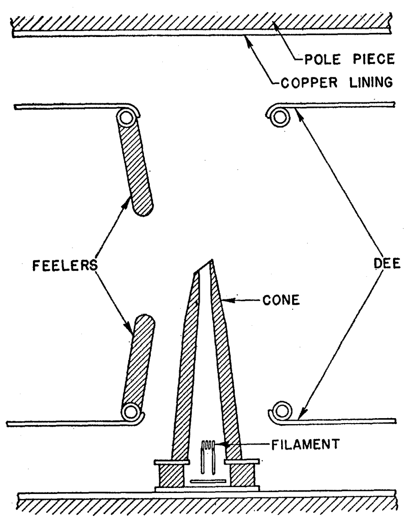

FIG. 1. Cross section of ion source in place in 60-inch cyclotron. The feelers are 2 inches wide in the direction along the dee gap. The pole pieces are 10 inches apart.

By operating the oscillators on three-phase power, an ion current increase of 2–3 times should be obtained, with the same maximum dee voltage and arc conditions.

The operating life of the 50-mil filament is found to be about 24 hours. We have now put in a 60-mil filament; since a 40-mil filament lasted about 4 hours, this should give a great increase in life.

EDWIN MCMILLAN
W. W. SALISBURY

William H. Crocker Radiation Laboratory,
University of California,
Berkeley, California,
October 2, 1939.

[1] M. Stanley Livingston, M. G. Holloway and C. P. Baker, Rev. Sci. Inst. 10, 63 (1939).
[2] Alexander Allen, J. Frank. Inst. Oct., 1939, and private communications.

The High Frequency Perpendicular Fundamental Vibration of the Ammonia Molecule

For some time it has been recognized that the high frequency perpendicular fundamental of ammonia (conventionally denoted as ν_2) has a value around 3400 cm^{-1}, but the exact location has proved difficult. In a recent paper[1] Barker has suggested the value 3415 cm^{-1} from a very careful investigation of certain combination bands, but particularly from a band at 4μ, which he interprets as $\nu_2-\nu_3$. The purpose of the present note is to point out that the interpretation of this combination band offered by Barker is open to question. The value it yields for ν_2 seems to be too low if we are to interpret the band at 2.2μ as $\nu_2+\nu_3$. The center of the latter band appears to be at 4450 cm^{-1} whereas Barker's value of ν_2 would make it fall at 4365 cm^{-1} or even lower. Again in the plot of the 3μ region, where a part of the ν_2 fundamental can be picked out, the maximum of intensity would appear to be much closer to 3450 cm^{-1} than to 3415 cm^{-1}. Further, a comparison of the values of ν_2 and ν_4 in the isotopic molecules NH_3 and ND_3 indicates that the value for ν_2 in NH_3 should be considerably nearer 3450 cm^{-1} than 3400 cm^{-1}. Since these three separate lines of evidence suggest a value for ν_2 near 3450 cm^{-1} we must find another interpretation of the band at 4μ, and there seems to be no reason why it should not be interpreted as $\nu_3+\nu_4$. An examination of the behavior of this band at low temperatures would perhaps be the best method of checking its assignment as a sum, rather than a difference, of two fundamentals.

The writer wishes to acknowledge the benefit of discussing this matter with Professor Barker.

G. B. B. M. SUTHERLAND*

Pembroke College,
Cambridge, England,
September 15, 1939.
* At present Leverhulme Research Fellow.

[1] E. F. Barker, Phys. Rev. **55**, 657 (1939).

Magnetic Anisotropy of Nickel at 20°K

The only experiments on ferromagnetic anisotropy that have been carried out below the temperature of liquid nitrogen are those of Honda, Masumoto and Shirakawa[1] on nickel in liquid hydrogen. Their results indicate a large increase in the anisotropy as the temperature is lowered from 77° to 20°K, the constant K_1 changing by a factor of about 5. On the other hand, Brukhatov and Kirensky[2] have found that in the temperature range from 77° to 350°K, the constant is given by the relation

$$K_1=K_0e^{-aT^2} \quad (1)$$

which predicts an increase of but 20 percent in going from 77° to 20°K. Accordingly we have undertaken, with the kind cooperation of Drs. H. A. Boorse and S. L. Quimby of Columbia University, to measure again the anisotropy constants at 77° and 20°K, using this time the more accurate method of torques.

The ratio of the constants was found to be about 1.2 (accuracy about 10 percent), as compared with the ratio 5 derived from the data of Honda, Masumoto and Shirakawa and 1.21 from the equation of Brukhatov and Kirensky. Our absolute values at 77°K and above are very close to those of Brukhatov and Kirensky. Thus our work extends the validity of this equation to lower temperatures (see Fig. 1) and shows that there is no unusual behavior in the ferromagnetic anisotropy at these low temperatures. This clarifies the theoretical situation since Van Vleck[3] in his discussion of the wave-mechanical theory of anisotropy, has not been able to find any basis for a difference in variation with temperature of the constants for iron and for nickel.

The crystal of nickel used was grown[4] in pure hydrogen from high purity nickel kindly supplied by Mr. E. Wise of the International Nickel Company. It was cut in the form of a disk with planes parallel to (100) and edges rounded to a semi-circle. The thickness was 0.29 cm, the largest diameter 1.38 cm. The liquid hydrogen was introduced into the Dewar flask surrounding the crystal through a straight Dewar tube of stainless steel connected directly to the bottom of the liquefier. The flask and crystal and torsion-measuring apparatus[5] were then removed to the electromagnet for measurement of the torque when the field was inclined at various angles to [011], the direction of easiest magnetization in the (100) plane. The highest field used was about 4000 oersteds. This was not sufficient

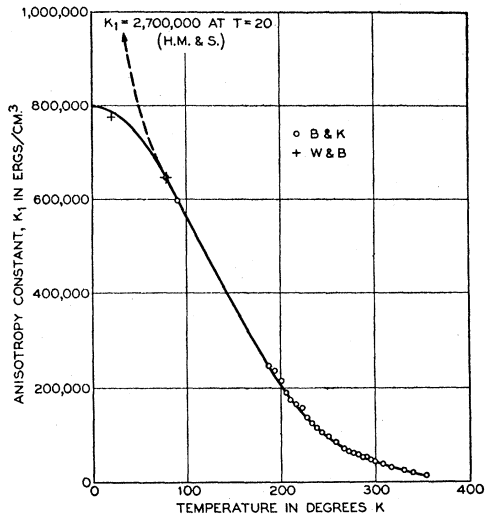

FIG. 1. Anisotropy constant of nickel as dependent on temperature. Data from 77° to 350°K, inclusive, by Brukhatov and Kirensky. Data at 77° and 20°K by the authors, adjusted slightly to fit the former data at 77°K. Curve calculated from Eq. (1) using $K=800{,}000$, $a=0.000034$.

to permit observation of the torque at saturation, but was so near this point that the ratio of the constants at 77° and 20°K could be determined with some accuracy. Saturation was later observed at 77°K in a field of about 5000 oersteds.

We wish to express our appreciation to Dr. Boorse and Dr. Quimby and others of the Cryogenic Laboratory of Columbia University, for supplying the liquid hydrogen.

H. J. WILLIAMS
R. M. BOZORTH

Bell Telephone Laboratories,
New York, New York,
September 25, 1939.

[1] K. Honda, H. Masumoto and Y. Shirakawa, Sci. Rep. Tohoku Imp. Univ. **24**, 391 (1935). The anisotropy constant was derived by one of us (R. M. B., J. App. Phys. **8**, 575 (1937)) from their magnetization curves for the [100] and [110] directions. A similar calculation by L. W. McKeehan (Phys. Rev. **52**, 18 (1937)) yielded an even higher value of K_1. Its value is somewhat uncertain on account of the extrapolation of the magnetization curves to saturation.
[2] N. L. Brukhatov and L. V. Kirensky, Soviet Phys. **12**, 602 (1937).
[3] J. H. Van Vleck, Phys. Rev. **52**, 1178 (1937).
[4] By Mr. O. L. Boothby, using the method described by P. P. Cioffi and O. L. Boothby, Phys. Rev. **55**, 673 (1939).
[5] Similar in design to that described by H. J. Williams, Rev. Sci. Inst. **8**, 56 (1937).

The Disintegration of Mesotrons

In order to test the hypothesis of the spontaneous decay of mesotrons we have compared the absorption of the mesotron component of cosmic radiation in air and in carbon.

The mesotrons were detected by the coincidences of three Geiger-Müller tubes arranged in a vertical plane. The counters were shielded with 10 cm of lead on each side to prevent coincidences from the air showers. Also, 12.7 cm of lead was placed between the counters in order to cut off the soft component.

The absorption in air was measured by counting coincidences at different heights from Chicago up to the top of Mt. Evans, Colorado, (4300 m). The absorption in carbon