# Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 1060.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

## Thermal Conductivity at Low Temperatures

IN continuation of our experiments on quartz and potassium chloride[1], Mr. Biermasz and I have determined the conduction of heat in quartz crystals of varying dimensions. (A complete account of this work will appear in *Physica.*) The object of the investigation was to study the dependence of the conductivity on the dimensions of the crystal[2]. It was found that both in the case of potassium chloride and silica (at temperatures 2·5°, 2·9° and 3·3° K.) the heat resistance is a definite function of the radius $R$; when $R$ tends to zero the resistance becomes infinite more quickly than $1/R^2$, or in other words, the 'specific' resistance becomes infinite. With increasing thickness, on the other hand, the specific resistance approaches a constant value asymptotically; for potassium chloride this value is almost reached for $2R \sim 1$ cm.; for silica this will be the case for $2R \sim 3$ cm.

It is not astonishing that such an asymptotic value is reached. If there were no scattering of the elastic waves at all, then it would be impossible to establish a temperature gradient in the crystal and the conductivity would be infinite[3]. In order to obtain a finite temperature gradient, one has to assume that the elastic waves are scattered, and with increasing cross-section of the rod the scattering by the surface of the cylinder will gradually become less and less important relative to the scattering in the bulk of the material. We will assume that the resistance is due to scattering by the surface, scattering by the mosaic structure and to scattering of the elastic waves by one another. Further investigations will be needed to show the part played by each of these factors separately.

It seems interesting to investigate the behaviour of thin rods of metal and to see whether a separation of electronic conduction and lattice conduction can be effected, and whether a correlation between these conductivities can be found.

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May 9.

[1] *Physica*, **5**, No. 4, 320 (1938).
[2] Peierls, *Ann. Phys.*, (3), **5**, 1055 (1929).
[3] "Vorträge über die Kin. Theorie der Materie", by Debye, 19 (1914).

## Neutron-Electron Interaction proposed by Kikuchi

IT is known that a Geiger-Müller counter operated near a source of fast neutrons gives a rather large number of counts. Kikuchi, Aoki and Husimi[1,2], working with a D-D source of neutrons, have postulated that these counts arise in part from a direct interaction of fast neutrons with electrons in the thin lead foil surrounding their counter. However, the recent discovery by Kallmann and Kuhn[3] that gamma-rays are emitted in the D-D reaction seems to offer a simple and more satisfactory explanation for the phenomena observed by Kikuchi and co-workers. Confirmatory evidence is the discovery by Bonner[4] of two groups of neutrons from the D-D reaction.

Even when the gamma-rays from a D-D source are absorbed with lead[5], or when a radium-beryllium source of neutrons is used with a sufficient thickness of lead to remove the primary gamma-rays from the source[6], a counting rate much in excess of the natural background of the counter is observed. We have shown that two thirds of the counts caused by a radium-beryllium source of fast neutrons, suitably enclosed in lead, can be accounted for by the gamma-rays excited in lead by the inelastic scattering of fast neutrons. An appreciable part of the remaining third will be due to recoil nuclei within the counter gas. Internal conversion of the gamma-rays produced in the lead foil surrounding the counter (and in the iron wall of the counter) can account for the remainder of the counts only if one assumes an average internal conversion coefficient as large as 15 per cent. In a study of the radiation accompanying thin, non-radioactive, gamma-ray sources, we find, however, that internal conversion coefficients of this magnitude do occur in the heavier elements for gamma-rays of moderate energy. Recent experiments by Alvarez[7] also lead to internal conversion coefficients larger than those previously expected.

Takeda[8] also studied the counts caused by the neutrons from a radium-beryllium source surrounded by a large block of lead. He concluded that less than half his observed counts could be accounted for by the gamma-rays excited in the lead block by the neutrons, and hence that the direct interaction of neutrons with electrons proposed by Kikuchi and co-workers was responsible for the remainder of the counts. However, he failed to correct for the decrease in the natural background of his counter caused by the test lead (placed above the counter) which he used to estimate the fraction of the counts which were due to gamma-rays excited in the lead block. When such a correction is made, the results of Takeda appear to be in agreement with our own.

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[1] Kikuchi, Aoki, Husimi, NATURE, **138**, 841 (1936).
[2] Kikuchi, Aoki, Husimi, *Proc. Phys.-Math. Soc. Japan*, **18**, 727 (1936); **19**, 734 (1937).
[3] Kallmann and Kuhn, *Naturwiss.*, **26**, 106 (1938).
[4] Bonner, *Bull. Amer. Phys. Soc.*, **13**, No. 2, 22 (1938).
[5] Gibson, Seaborg, Grahame, *Phys. Rev.*, **51**, 370 (1937).
[6] Seaborg, Gibson, Grahame, *Phys. Rev.*, **52**, 408 (1937).
[7] Alvarez, *Phys. Rev.*, **53**, 606 (1938).
[8] Takeda, *Proc. Phys.-Math. Soc. Japan*, **19**, 835 (1937).

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