ON THE GEOMETRICAL ARRANGEMENT IN HALL EFFECT MEASUREMENTS

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Summary

A discussion of the short circuiting effect of the current electrodes in Hall effect measurements is given for an arbitrary geometrical arrangement. It is shown that (for singly connected geometries) the correction to be applied is given by a universal function of only one parameter which is characteristic of the geometry and which can be determined by measurement. The theory is experimentally verified for a particular geometry by measurements on copper.

§ 1. Introduction. In 1948 Isenberg, Russell and Greene\(^1\) have given a theoretical treatment of the short circuiting effect of the current electrodes in the measurement of the Hall coefficient of metals and semiconductors. This theory, which was checked by experiments on cuprous oxide, only applies to the geometry shown in fig. 1a: a rectangular plate with the current contacts extending along two opposite edges. The theoretical ratio of the measured potential difference \(V_m = V_1 - V_2\) to the real Hall voltage \(V_H\) is shown in fig. 1c, curve a, as a function of the ratio between width \(w\) and length \(l\) of the sample.

It is seen, that for \(w/l < 0.25\) no correction is needed, but as pointed out in the work mentioned, the sensitivity may, for a given tolerable power dissipation in the sample, be increased by increasing \(w/l\) up to a certain limit; choosing \(w/l > 3\) gives no further increase in sensitivity. As the correction for the short circuiting effect will now be large, one has for such a procedure to rely upon the stability of the current contacts. In order to avoid this and to increase the sensitivity beyond the limit set by the edge electrode arrangement, Isenberg, Russell and Greene suggest the use of small probes as current electrodes. Without a detailed specification of
experimental conditions the authors report a few measurements showing that the ratio $V_m/V_H$ is very nearly 1 in this case.

Contrary to this fig. 1c, curve c, shows results obtained in this laboratory with the geometry of fig. 1b *). Here the current electrodes are copper pins, 2.2 mm in diameter, soldered to the plate at a centre distance of 40 mm as shown. The ratio $V_m/V_H$ deviates considerably from 1; this was first thought to be due to short circuiting currents circulating around the pins, and the sample was therefore cut along the lines S; this certainly increased $V_m/V_H$, but not to the value 1 (see curve b).

Fig. 1. The ratio $V_m/V_H$ for various geometries. Hatched areas indicate current electrodes. The Hall voltage is measured between points 1 and 2.

It is further seen that for $2w$ less than about 20 mm pin electrodes in this special case give rise to larger errors than edge electrodes, and as the power dissipation in the sample in the vicinity of the current electrodes will be larger than in the corresponding edge electrode arrangement, the use of pin contacts hence is not preferable. Yet the

*) The curve was first found (for copper) by O. Gram Jeppesen, to whom I am indebted for calling my attention to the problem, and was later reproduced by the author.