REBUTTAL ON "COMMENTS ON ZERO RESISTANCE IN A LONGITUDINAL MAGNETIC FIELD FOR GALLIUM SINGLE CRYSTALS···" BY J. A. MARCUS AND W. A. REED

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Considerations given in the paper by Yahia, Lee, and Fournier showing the inappropriateness of the explanations of Marcus and Reed for the observations in gallium are taken up once again in detail in this paper.

The question raised by Marcus and Reed[1] had been discussed briefly by Yahia, Lee, and Fournier.[2] At this point, it is important to go into this matter in detail. Figure 1 is a rough drawing of crystal holder and crystals showing the placement of potential probes and of current leads. The top two crystals, one on each side of the holder, are crystals a_2 and a_3. Note the current contacts covering the entire end faces of the crystals, a geometry favoring a uniform current distribution, in contradistinction to the measurements in chromium described by Marcus and Reed,[3] where point current contacts were used. The potential probes for both these crystals are in the b plane, the determination of this plane being made once before placing the crystals in the mount and again, after the measurements, by exposing the face from which the potential leads had been detached to the x-ray beam. The back-reflection Laue patterns were the same in both cases and corresponded to the known pattern for a set of planes orthogonal to the b axis. It is clear that: (1) The electrode configuration assumed by Marcus and Reed[1] is not the one of our experiment. In fairness to Professor Marcus, it must be pointed out that he was probably misled by a previous inaccurately drawn schematic of the electrode configuration. (2) The argument of Marcus and Reed[1] concerning a sheet of current flowing along the "path of least resistance" would give $\Delta V \neq 0$ precisely on the potential probes where Yahia, Lee, and Fournier measured $\Delta V = 0$. (3) The arguments of Marcus and Reed[1] also fail to account for the lack of generality and for the specific configuration for our $\Delta V = 0$ observations in gallium: Only for one orientation of current and field (but in three crystals) has this property been observed, although longitudinal magnetoresistance measurements have been made on seven crystals by Yahia et al., three with their length parallel to the a axis and two each with their lengths parallel to the b and the c axis. In particular, $\Delta V = 0$ would, on the "anisotropic magnetoconductivity and asymmetry of current contacts" hypothesis claimed by Marcus and Reed,[1] be observed, if at all, for $J \parallel a$ axis, potential probes in the c plane and for $J \parallel b$ axis, potential probes in the c plane. Our observations run contrary to both these predictions. The former of these predictions runs contrary to our observations described in the paper by Yahia, Lee, and Fournier[2] and in detail above, and the latter was discussed in the paper by Yahia, Lee, and Fournier[2] in the following terms: "for two of our crystals we have just such a configuration and find a saturating positive magnetoresistance." The plane of the potential probes for these latter two crystals was determined with some care as for the crystals a_2 and a_3.

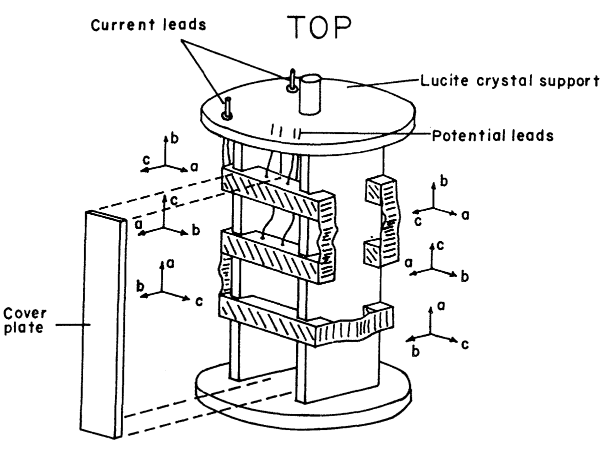

FIG. 1. Crystal holdes. Length of crystals, 15 mm; cross section, 2×2 mm^2; distance between potential probes, 6 mm.

[1]J. A. Marcus and W. A. Reed, preceding Letter [Phys. Rev. Letters 24, 503 (1970)].

[2]J. Yahia, C. Lee, and E. Fournier, Phys. Rev. Letters 23, 293 (1969).

[3]Footnote 2 of Ref. 1.