ELECTRON FOCUSSING PROPERTIES OF CROSSED ELECTRIC AND MAGNETIC FIELDS

BY

A. E. SHAW

Ryerson Physical Laboratory, University of Chicago, Chicago, Illinois

In magnetic deflection experiments for the determination of e/m for electrons, the difficulty of making an accurate measurement of the velocity of the electrons constitutes the principal uncertainty in the attainable precision of the determination. In 1929, Bartky and Dempster called attention to the remarkable focussing properties of crossed electric and magnetic fields and they deduced an equation for e/m which does not contain the velocity explicitly but involves simply the radius of curvature and the electric and magnetic fields.

The present work is an attempt to examine experimentally the focussing properties of crossed fields in order ultimately to make an accurate determination of e/m for electrons. Such a combination of fields which act simultaneously possesses the desirable property of focussing both in direction and velocity, if the variations are not too large. The method consists, essentially, of projecting a beam of electrons into a radial inverse first power electric field at the same time that a homogeneous magnetic field is established normal to the plane of the trajectory. With the proper combination of the two fields the electrons are brought to a focus 127° 17′ from the slit. A very fine wire is placed at this point in order to receive the electrons, and a maximum deflection of a galvanometer connected to the wire indicates symmetrical refocussing. When this occurs the radius of curvature of the beam is known from the geometry of the apparatus, and by measuring, on a potentiometer, the magnitudes of the electric and magnetic fields, e/m can be computed directly in terms of the electric and magnetic fields and the radius of curvature. Although the original equation for e/m does not contain the velocity explicitly, it is necessary that electrons of a suitable velocity be projected into the crossed fields. This velocity is adjusted to the proper value during the process of focussing. The sharpness of the focussing curves obtained thus far suggest that this combination of fields should permit of a determination of e/m with an accuracy of at least 1 in 2000.

One difficulty has arisen in the work due to the formation of polarized layers on the plates of the electric field. These layers operate to change the intensity of the electric field so that the intensity as measured externally will not be a true measure of the field actually deflecting the beam. It is possible, however, accurately to measure these extraneous potentials and work is in progress to develop a means of keeping them as constant as possible before a final determination of e/m is made.