

PROOF THAT IN FIELD ELECTRON AND ION MICROSCOPES THE ELECTRON/ION PATH IS INDEPENDENT OF THE CHARGE/MASS QUOTIENT

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In normal circumstances, the path taken by a charged particle (electron or ion) moving in an electromagnetic or electrostatic field depends on the charge/mass quotient (q/m). However, in the contexts of the operation of field electron and field ion microscopes and the materials-analysis technique of atom-probe tomography (APT), it has been known for 70 years (and has been repeatedly confirmed) that electrons and ions (whatever their mass) follow *essentially* the same paths when moving in the electrostatic field associated with a needle-like emitter (although in APT there are some very small path differences associated with surface atomic structure of the needle). The technique of APT would not work if this were not the case. This result has also been confirmed (by more than one author) by trajectory simulations using finite-element methods. However, no clear theoretical explanation of this result is available in the literature of these techniques.

This Poster reports an analytical theoretical explanation of the above results, using theory based on Coulomb's and Newton's Laws. Details will be outlined on the Poster. Briefly, trajectory independence of q/m is to be expected if: (a) the particles are moving in a purely electrostatic field; and (b) particles start from the same point in space; and (c) particles start with zero kinetic energy; and (d) final velocities are non-relativistic. The time taken to traverse a given path, however, does depend on the quotient q/m . These conditions apply to the field electron and field ion microscopes and APT, and to various other situations involving electrostatic fields.

An implication of this result is that (for a given emitter shape) the field electron and field ion microscopes have the same magnification. This equality of magnifications is a key part of the theory of a new method of measuring emission area on field electron emitters, proposed by T. Shuai et al. [1].

[1] T. Shuai et al., submitted for publication and under review.