AN EXTENSION TO THE CONVENTIONAL TOROIDAL MODEL OF THE BOSTICK PLASMOID

D. A. BUTTER
Lamp Research Laboratory, General Electric Company, Nela Park, Cleveland, Ohio, USA

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Time of arrival measurements of Bostick plasmoids to an electrostatic probe suggest that the plasmoid motion may be simulated by a uniformly expanding torus with one point fixed at the button source.

The earliest experiments which were made on plasmoids gave results which were interpreted as being indicative of a plasmoid being projected from its button source in the form of a small torus of plasma [1]. Extensions of this model enabled a qualitative explanation to be made of certain phenomena which were exhibited by plasmoids created in the presence of externally induced magnetic fields [2]. Later, it was shown that the assumption of a toroidal plasmoid, enabled a theoretical estimate to be made of the plasmoid mass in terms of the experimental parameters, and this estimate was shown to correlate fairly well with published results [3].

The investigation which is recorded below, was undertaken to examine directly the geometry assumed by a Bostick plasmoid in magnetic field free space by a method which is not recorded in the literature - namely by examining the plasmoid motion in the plane of the current discharge. The basic idea which initiated this particular experiment is as follows: let us suppose that for a given plasmoid v_1 is the velocity of the center of mass of the plasma relative to the button gun, and v_2 the velocity relative to the center of mass of an arbitrary point P on the plasma boundary (see fig. 1). Then, if the plasma is to grow as a torus, it clearly is necessary that $v_1 = v_2$ throughout the creation period of the plasmoid and also (by virtue of the inertia of the plasma) after the surge current has ceased to flow. It follows, therefore, that if the point P is inclined at an angle θ to the axis of symmetry of the button source, and is moving at a given velocity at the cessation of the surge current, it will continue to move at the same speed in the direction defined by θ.

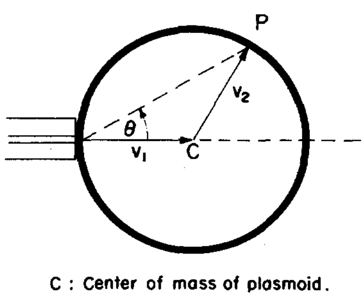

Fig. 1. Motion of a point on the periphery of an idealized toroidal plasmoid.

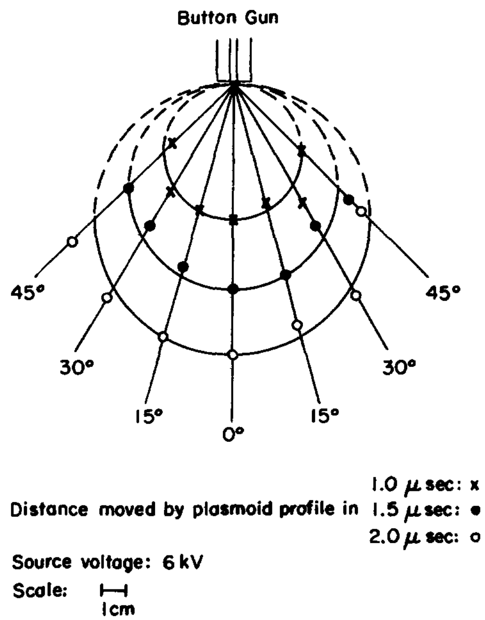

Fig. 2. Profile of a Bostick plasmoid in the plane of the current discharge.

The profile of the plasma front was found in the following manner: a 6 kV discharge of 1 μsec duration across a button gun was used to form plasmoids in vacuo (10^{-6} Torr). An electrostatic probe was moved along the polar lines 0^o, 15^o, 30^o, 45^o until a signal from the plasma was obtained in each case a) 1.0 μsec. b) 1.5 μsec and c) 2.0 μsec after the initiation of the current discharge. The corresponding distances between the probe and the button gun along the polar lines were measured and plotted on polar graph paper (see fig. 2). Circles then were drawn whose diameters equalled the furthest distance travelled by the plasma from the button gun (in each case this was found to be along the line $\theta = 0^o$). Fig. 2 reveals that these circles are a fairly satisfactory approximation to the measured profile. It is, moreover, hardly surprising that the profile of the plasmoid seems to have one point at the button gun fixed in space, because reference to our model in fig. 1 above, reveals that there is no motion of the plasma relative to the gun at the point defined by $\theta = \frac{1}{2}\pi$.

We conclude, therefore, that this particular experiment suggests that our plasmoid propogates itself as a uniformly expanding torus which has one point fixed at the button source.

This experiment was performed in the Physics Department of the University of Western Ontario, London, Canada.

References

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2. W.H.Bostick in Symposium of Electromagnetics and Fluid Dynamics of Gaseous Plasma, V.XI (Polytechnic Press, Brooklyn, New York, 1961).
3. D.A.Butter, Phys. Letters 28 (1968) 138.

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THE TEMPERATURE DEPENDENCE OF THE "CURIE POINT" FOR IRON OBSERVED IN THE CRITICAL SCATTERING OF NEUTRONS

K. BLINOWSKI
Institute of Nuclear Research, Świerk, Poland

and

R. CISZEWSKI
Institute of Physics, Technical University of Warsaw, Poland

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The small angle critical scattering of neutrons in iron was measured. The temperature shift of a maximum of scattered intensity has been discussed in the light of the latest theories.

The temperature and angular dependence of the intensity of critically scattered neutrons in iron was measured. Although many experiments of this kind were performed so far, there has been still a fully justified need for some more experimental data, especially for exact determination of the temperatures corresponding to the maximum intensities of the critically scattered neutrons with small wavelengths.

Earlier theories developed after Van Hove [1] identified always the temperature of the maximum of the intensity with the ferromagnetic Curie point.

According to the recent theory by Fisher and Burford [2] the maximum should be shifted on the temperature scale proportionally to the scattering vector in the power 1.55, starting from the zero scattering angle. On the other hand Kociński [3,4] points out that such a shift does not start from zero angle but appears for some larger value of the scattering vector $\kappa = 2\pi\theta/\lambda$, and increases with κ in a power higher than $\frac{3}{2}$.

The essential difference however, between first theories based on the Ornstein-Zernike type spin pair correlation function and Kociński's work lies in the basic approach to the problem which should consist in treating the scattering system as an inhomogeneous medium. Such an observation was already introduced in the pioneer