ON THE PARAMETERS WHICH CONTROL THE FORWARD VELOCITY OF A BOSTICK PLASMOID

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Received 18 November 1968

The forward velocity of Bostick plasmoids is shown experimentally to be proportional to the mean surge current through their button source.

One of the early experiments on plasmoids revealed that their forward velocity depended only upon the energy of the source capacitors, and hence upon the current through the button gun circuit [1]. Although this relationship was recognized clearly, it was deduced from measurements over a rather small range of interest and the result itself does not seem to have been regarded as being one of much significance. Again, no attempt apparently had been made to explain this result or to investigate its implications until recently, when it was shown theoretically that the plasmoid velocity was directly proportional to the mean current by using the assumption of a highly conducting toroidal plasmoid, and the analysis was extended to reveal that the number of ions in an arbitrary plasmoid could be estimated theoretically in terms of the experimental parameters [2].

In view of the encouraging correlation between theory and experiment, it was felt worthwhile to conduct an experiment to test directly whether the forward velocity of a Bostick plasmoid was proportional to the mean current. The experiment is shown schematically in fig. 1. A pair of electrodes is placed directly in front of a conventional button gun source in vacuo (2×10^{-6} Torr). The electrodes are in series with a battery and a 10 kΩ resistor. Plasmoid were formed, each by a single pulsed unidirectional current discharge of 1μ sec duration which was generated by source capacitor voltages ranging from 6 kV to 16 kV. When the conducting plasma flows between the electrodes of the probe, a current flows in the circuit of the probe and the potential drop across the resistor is recorded on an oscilloscope which is triggered at the instant of initiation of the unidirectional current pulse through the button gun. The probe was moved along the direction of the forward trajectory of the plasmoids and hence time of arrival measurements enabled plasmoid velocity to be deduced as a function of average surge current. Fig. 2 reveals that the forward velocity of these plasmoids is indeed proportional to the average surge current for the entire range over which measurements were made. This range was bounded a) above, by the limitations of the output of the power supply which charged the source capacitor in the button gun circuit and b) below, by the separation of the button gun electrodes (0.6 mm) across which a vacuum spark could not be formed by a potential drop less than 6 kV. Although the straight line which passes through the experimental points could be expected to pass

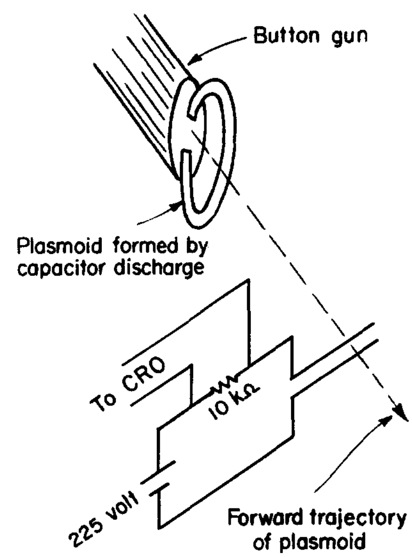

Fig. 1. Schematic diagram of apparatus used for measuring the forward velocity of a Bostick plasmoid.

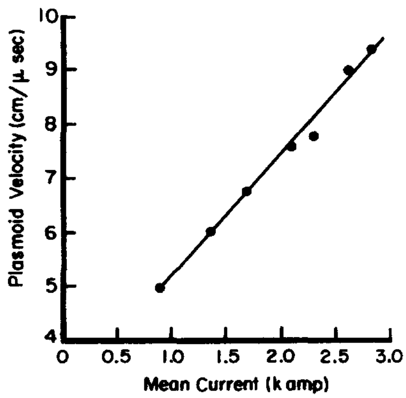

Fig. 2. Forward velocity of a Bostick plasmoid versus mean current.

through the origin, it should be remembered that theoretical work reveals that the forward velocity depends linearly on the mean surge current if the plasmoid is a torus [2]. Clearly, therefore, at low currents, the pinch fields may be too weak to retain the toroidal shape on which this linear relationship depends so that another mechanism may predominate.

We conclude, therefore, that the forward velocity of a Bostick plasmoid is proportional to the mean surge current over a wide range of interest. We also suggest, that in view of recent theoretical work [2], the mean surge current is a natural parameter by which plasmoid physics can be studied.

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

References

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CALCULATIONS PERTAINING TO THE THERMOPOWER OF COPPER *

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Received 18 November 1968

The KKR method has been used to calculate the electronic velocity in copper at over 20 000 points on the Fermi surface. The quantity $\int v_k \mathrm{d}S$ is found to be +1.80 and is compared to values previously determined by interpolation schemes.

The thermopower of metals appears to be particularly sensitive to changes in both the shape of the Fermi surface and the band structure in the immediate vicinity of the Fermi energy. Consequently, a theoretical investigation of the thermopower of any metal with complex band structure in the vicinity of the Fermi energy is in order. This letter reports preliminary results from such an investigation on metallic copper.

Copper is well suited for such a study for a variety of reasons. Experimentally, the Fermi surface of copper is well established. Numerous theoretical calculations performed on the band structure of copper have led to a calculated Fermi surface and E_k versus k behavior that has been quantitatively correlated with various experimental data [1-5]. Further, it has been observed that copper's thermopower is positive, except at very low temperatures. Finally, even though there is a hump - caused by phonon drag - in the thermopower curve up to about 200°K [6], above 200°K the thermopower varies fairly linearly with temperature, giving hope for a simple explanation for the thermopower in this temperature region. Under certain approximations, the theoretical electronic contribution to the thermopower may be written [7]

* Research sponsored by the U. S. Atomic Energy Commission under contract with the Union Carbide Corporation.