Pramāṇa, Vol. 15, No. 2, August 1980, pp. 117–136. © Printed in India.

On plasma-neutral gas interaction

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MS received 18 January 1980; revised 2 June 1980

Abstract. The paper emphasises the importance of plasma-neutral boundary layer in a wide variety of physical phenomena occurring in laboratory and cosmic plasmas. The interaction of a magnetised plasma stream penetrating a neutral gas cloud is discussed in the light of Alfvén's critical velocity and Varma's threshold velocity on the ionising interaction.

Interaction of a moving magnetised plasma with a stationary neutral gas has been studied and described. The device comprises of a plasma gun and an interaction region where neutral gas cloud is injected. The interaction region is provided with a transverse magnetic field of upto 1000 G. Several diagnostics deployed at the interaction region to make measurements on the macroscopic parameters of plasma and neutral gas are described. The parameters of discharge circuits are measured with high current and voltage probes.

An interaction between a magnetised plasma stream and a neutral gas cloud is demonstrated. It is shown that this interaction does not have Varma's threshold on their relative velocity. The Alfvén's critical velocity phenomenon is shown to depend on the integrated column neutral gas density that a plasma stream encounters while penetrating through it and not on the neutral gas density in the range of $10^{17}-10^{21}$ m^{-3}.

Keywords. Plasma; neutral gas; interaction; critical velocity; plasma gun; diagnostics.

1. Introduction

In recent years, a great deal of interest has arisen in a wide variety of physical phenomena whose description requires an understanding of the interaction at the contact surface of magnetised or unmagnetised plasma with neutral gas. Tokamaks of future generation will have a gas blanket enveloping the magnetised plasma body to insulate it from surrounding walls (Lehnert 1975). In the pellet method of refuelling a fusion reactor, a layer of gas and cold plasma develops by ablation and thereby the remaining part of the pellet is protected from the fusion plasma energy flux (Verboom and Rem 1973). Coensgen *et al* (1975) demonstrated an improved confinement of the plasma in a mirror device by end-plugging it with a cloud of neutral gas. In all these problems, it is the particle and the energy transport properties of the plasma which are affected by excitation or suppression of plasma collective processes at the plasma-neutral gas boundary layer.

Since the first quantitative model for the solar wind-comet interaction was proposed by Biermann *et al* (1967), many investigations have suggested that the production of suprathermal electrons, structures in the cometary tail and cometary plasma transport into the tail region have in their explanations an intimate connection with plasma-neutral gas interaction (Danielsson and Kasai 1968; Kubo *et al* 1971; Biermann 1971;