a very weak echo at a frequency of approximately 1.1 ω_c. The frequency for this echo was also independent of electron density. These observations are currently under further study.

This experiment supports the velocity dependent collision model of cyclotron echo generation and demonstrates that energy and momentum relaxation processes and diffusion can be studied in a purely Coulomb plasma using this technique.

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BEAM-PLASMA INSTABILITY IN THE HOLLOW CATHODE DISCHARGE

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A new point of view is suggested that considers the hollow cathode effect as an expression of the plasma instabilities that arise when two antiparallel electronic beams are interacting in the plasma ("double-beam instability").

The studies concerning the mechanism of the glow discharge in a hollow cathode geometry agree about the existence of two classes of electrons in the glow: the group of fast primary electrons accelerated in the cathode fall region and the group of their filiation in the plasma. Consequently we may consider the negative glow of a hollow cathode discharge as a thermal plasma through which are travelling two beams of relatively few but energetic electrons originating in the two cathodic dark spaces. Such a beam-plasma model of the hollow cathode discharge agrees with the point of view according to which in a hollow cathode discharge, most of the excitation and ionization processes are occurring in the negative glow plasma [1, 2] .

A beam of electrons may excite in certain conditions in the plasma through which it is travelling, longitudinal waves with a phase velocity rougly equal to the mean velocity of the electrons of the beam. If two antiparallel electron beams are travelling through the plasma the oscillation pattern that results is a standing wave [3, 4]. We assume that oscillations are generated in the same manner in the negative plasma of a hollow cathode discharge, by the two streams of fast electrons emerging from the cathodic dark spaces.

The "diffusion" of the distribution function of the electron velocities [5], as an effect of the wave-electron interaction, explains the preferential excitation of the metal atoms sputtered by the cathode as compared to the excitation of gas atoms [6, 7].

The fact that plasma-beam instabilities result in a strong increase of the ionization and excitation probabilities of gas atoms in a plasma in magnetic field was emphasized also by Karchenko [8]. Such an abrupt increase of the ionization probabilities explains the hollow cathode effect

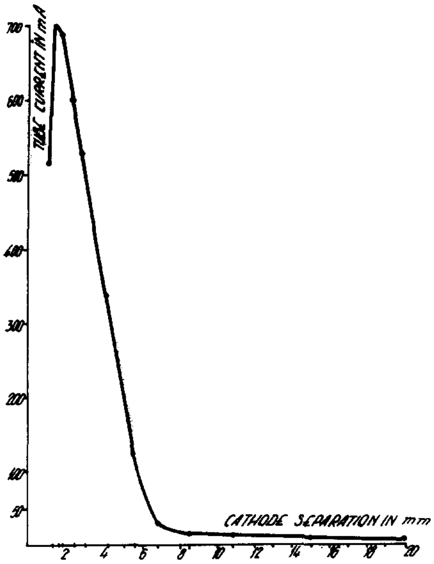

Fig. 1. Current intensity as a function of intercathode spacing at constant potential (320 V) and pressure (3 mmHg) in a hollow cathode discharge in neon gas.

current jumps at critical p or D values (fig. 1). The $I_{V,D\ \mathrm{const}} = f(p)$ curves obtained in the hollow cathode discharge agree entirely with the results of Etievant [3] who observes jumps of electronic densities at given pressure values in a two beam-plasma system. In the same manner as in the hollow cathode discharge, the current intensity jumps reported by Etievant are accompanied by an important enhancement of the plasma radiation.

The existence of critical domains of the beam parameters (I, V), gas pressure and magnetic field, in which instabilities are able to grow, is well-known, particularly in the case of plasma-beam instabilities. This explains entirely the critical influence of the same parameters on the hollow cathode effect.

We have measured the $I = f(V)$ dependence in hollow cathode effect conditions in neon at p = 2.2 mmHg, for various values of the intercathode spacing (fig. 2). For each D value, there is a given discharge potential (i.e. a given energy of the electrons of the beam) that allows the instability to develop and as a consquence the current to grow abruptly. The hatched domain in fig. 2 represents the zone of instability.

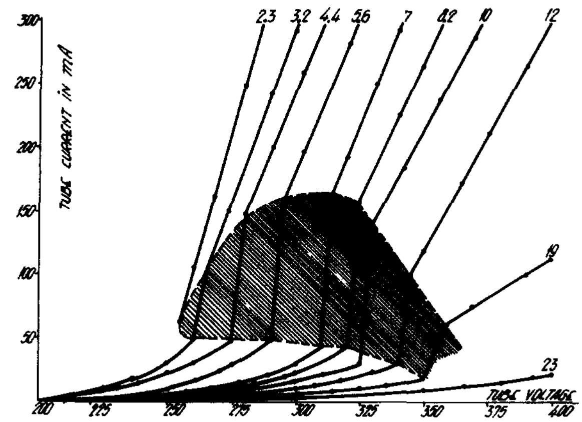

Fig. 2. Current intensity versus potential at constant pressure (2.2 mmHg) and various intercathode spacings in a hollow cathode discharge in neon gas. The domain of instability i.e. of increased ionization efficiency is hatched.

The hollow cathode effect is a very convenient means to study plasma-beam interactions due to the fact that the experimental device is of extreme simplicity and above all because it offers a possibility to extend the study of two beam instabilities to the domain of higher pressures (of several mmHg) where the devices with electronic gun do not work.

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