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Electron energy distribution function (0–40 eV range) in helium in transverse hollow-cathode discharge used for lasers

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Abstract. We present results of measurements of the electron energy distribution function (EEDF) in the range of 0–40 eV for the plasma of a transverse hollow-cathode discharge in helium as used in laser technology. The measurement technique employs the second derivative of the electric probe current–voltage characteristic. The results show that the EEDF for the transverse hollow-cathode discharge is neither Maxwellian nor Druyvesteynian and the influence of some elementary processes on the shape of the EEDF is discernible. The presence of the EEDF maximum at 26 eV is believed to suggest the importance of recombination in atomic processes occurring inside a hollow cathode.

1. Introduction

Many kinds of laser discharge tubes with cylindrical hollow cathodes have been used to obtain lasing in helium–metal vapour mixtures. They may, however, be systematised by distinguishing between two principle types of electric discharge occurring in a hollow cathode, namely, the transverse and the longitudinal discharge. Positioning of the hollow cathode and anode with respect to each other determines the type of the electric discharge in a particular configuration.

The transverse discharge exhibits an axial and radial symmetry of motion of the electric charge carriers, electrons and ions (figure 1).

In the longitudinal discharge, electrons leaving the cathode surface move towards the anode along the hollow cathode axis. Therefore the discharge properties vary along the cathode axis (Mizeraczyk 1983).

The electrical and optical properties of the transverse and longitudinal discharges are different. It is necessary to be familiar with them if the hollow cathode is to be used in practice as a source of spectral or laser lines. A spectacular example of the consequence of differences between properties of both discharges concerns simultaneous lasing at the three basic lines: blue, green and red. This lasing may be achieved with relative ease in the longitudinal hollow cathode in He–Cd mixtures and is difficult to obtain in the transverse discharge (Fujii *et al* 1980).

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