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ASYMMETRY OF THE BALMER H_β LINE IN THE LOW DC MAGNETIC FIELD

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1. INTRODUCTION

The hydrogen Balmer H_β line is frequvently used for plasma electron density determination. This spectral line profile emitted from plasmas is asymmetric and red shifted (see for example Wiese et al., 1972). However, theoretical calculations, see for example Keple and Griem, (1968) and Vidal et al., (1973), give symmetrical and unshifted hydrogen line profiles. There are many experimental determinations of the H_β line profile. These experiments treated separately the peak of the profile (Helbig and Nick, 1981; Mijatović et al., 1987; Halenka, 1988), the widths of the line profile at 1/2, 1/4 and 1/8 of the line maxima (Wiese et al., 1972), the line wings (Bengtson et al., 1976) and the H_β line shifts (Wiese et al., 1972, Mijatović et al., 1991).

Here we present experimental results of the asymmetry of the whole H_β profile in presence of the low d.c. magnetic field. These results are compared with our measurements obtained in absence of the magnetic field.

2. EXPERIMENTAL

The plasma was produced in a small, magnetically driven T-tube with an internal diameter of 27 mm and supplied with a reflector. It has been generally accepted (Kolb, 1957; Pavlov and Prasad, 1968) that plasmas produced in small electromagnetic T-tubes are quite homogeneous, both radially and axially, behind the reflected shock front. The tube was energized by using a 4 μF capacitor bank charged to 20 kV. The filling gas was hydrogen at a pressure of 300 Pa. In this experiment we used a constant d.c. magnetic field of 0.5 T produced by an electromagnet supplied by a 3-phase bridge rectifier. A hole drilled along the axis through one of the poles, allow us to perform observations of radiation emitted parallel to the magnetic field lines. Spectral intensity measurements were performed simultaneously along two directions of observation, parallel and perpendicular to the magnetic field lines using two monochromators. The measurements in the presence and in the absence a magnetic field, were performed without changing the monochromator wavelength setting, so that comparisons of the line profiles obtained in presence and absence of magnetic field became more reliable. The point of observation was 15 mm in front of the reflector. The photomultiplier signals were recorded by an oscilloscope equipped with a 35 mm camera. The details about experimental procedure are given in Mijatović et al., (1995).

The electron densities in the range from 2×10^{23} m^{-3} to 8×10^{23} m^{-3} were determined from the H_β line halfwidth (Vidal et al., 1973). Electron temperatures in range from 20000 K to 34000 K were determined from the line-to-continuum intensity ratios of the H_β line (Griem, 1964).

3. RESULTS AND DISCUSSION

All recorded H_β profiles emitted from the plasma in presence and absence of the magnetic field show the well known asymmetries. Furthermore, we found a difference in the profiles recorded with the magnetic field compared to those recorded without of the field only when observation was made along the magnetic field lines. A comparison of two simultaneosly recorded H_β profiles in the presence and absence of d.c. magnetic field, observed along the magnetic field lines is shown in Fig. 1. The magnetic field caused a small additional red shift of the whole H_β profile. We also found a small asymmetry increase of the profile in the presence of the magnetic field.

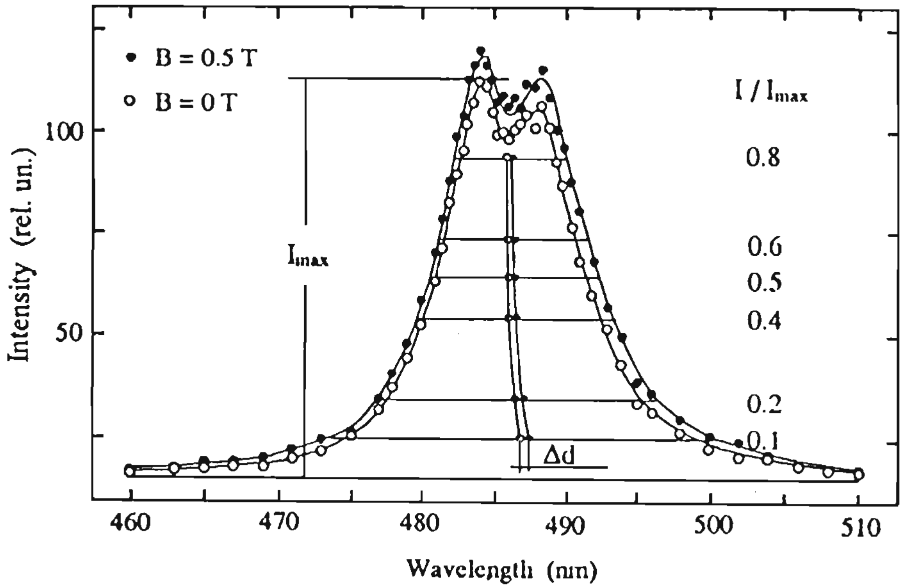

Fig. 1 The H_β profile recorded in the presence and the absence of the d.c. magnetic field.

We measured the positions of the center of the line on 0.8, 0.6, 0.5, 0.4, 0.2 and 0.1 of the maximum H_β profile (I/Imax, using the relevant profile) which is illustrated in Fig. 1. Line drawn through obtained central points is not straight line due to the asymmetry of the line. Difference between central points for corresponding line profiles with and without presence of the magnetic field represents additional red shift caused by external magnetic field. The measured additional shifts Δd for different electron densities are shown in Fig. 2. In order to obtain the best fit we used the linear least square fitting procedure. In this procedure we included the zero point also. The observed additional red shift increase with electron density increase.

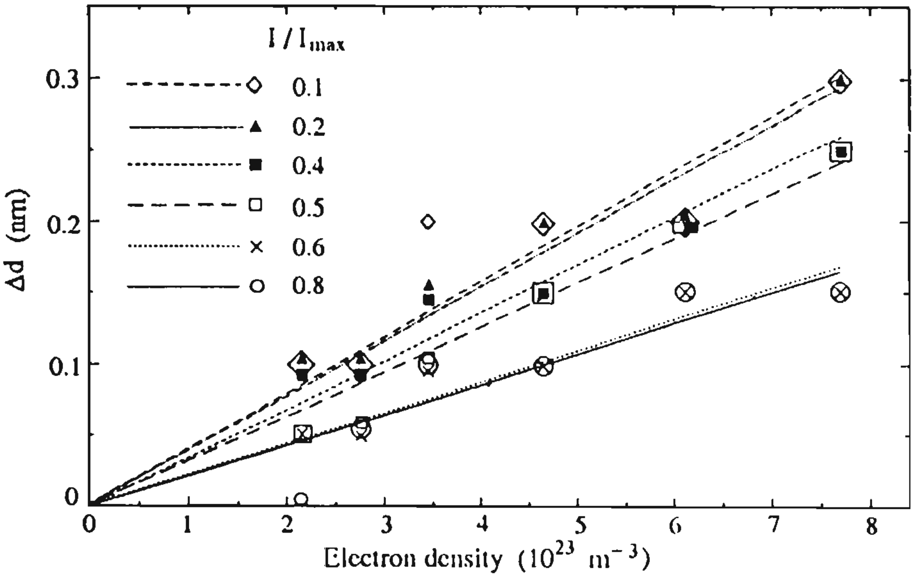

Fig. 2 Additional red shifts measured at different positions of the H_β line profile.

These results are in agreement with our previous results (Pavlov et. al., 1988; Mijatović et al., 1995; Djurović et al., 1995). The additional red shifts noticed in presence of the small external d.c. magnetic field could be explained by appearence of additional electric field. The charged particles electrons and ions in the moving plasma in the T-tube are separated by the magnetic field. This separation of charged particles causes an additional anisotropic electric field perpendicular to plasma flow velocity and field directions. The Zeman effect in this case was negligible as we reported earlier (Mijatović et. al., 1995).

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