Characterization of the divertor region during the formation of strong radiation in the JT-60U tokamak

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In magnetic fusion devices, it is important to mitigate significantly the heat load exhausted from the confined plasmas. To achieve this, the peripheral plasma such as divertor plasma requires to be cooled sufficiently, for instance, by radiation of impurities. It has been found that the line-radiation from C^{3+} is one of the dominant energy loss channels in the divertor region of tokamaks equipped with carbon walls such as JT-60U [1]. For the purpose of determining the radiative power of the impurities from spectral line intensities, plasma electron temperature and density are required and should be checked with independent methods. Under detachment conditions, usually a strong toroidally symmetric radiation (or a MARFE) forms in JT-60U [1-2]. During this process, where the peak of this strong radiation moves from the inner divertor leg (plate) towards the X-point, the intensity ratio of the C IV 2s-3p line (λ=31.24 nm) to the C IV 2s-2p line (λ=154.82 nm) remains constant, indicating a constant electron temperature. This suggests that the radiation peak moves towards the X-point while keeping similar plasma properties such as the radiative species having the highest ionization stage (C^{3+}). In this paper we will investigate the divertor plasma of JT-60U during the MARFE formation using two spectroscopic methods. The electron temperature is determined using carbon line intensities [1-2] and the electron density is deduced by fitting the C IV n=6-7 (λ=772.6 nm) line with calculated Stark-Doppler broadened line profiles [3]. The analysis of carbon spectra measured along viewing lines crossing the MARFE allows the deduction of electron densities N_e and temperatures T_e in the ranges 1-7x10^{20} m^{-3} and 1-10 eV respectively. It will be shown that fitting C IV n=6-7 spectra measured along viewing chords crossing the MARFE core requires at least two couples (N_e, T_e), suggesting that the C IV n=6-7 line emission comes from more than one single homogeneous plasma layer.

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