verification of balmer-alpha spectroscopy interpretation method for sol plasma with account of divertor stray light using the predictive modelling data for iter

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The development of the H-alpha high-resolution spectroscopy (HRS) for the scrape-off layer (SOL) plasma in the main vacuum chamber in ITER faced a serious problem caused by a divertor stray light (DSL) produced by diffuse and/or multiple mirror reflection of intense light emitted in the divertor. The verification of some essential properties of the theoretical model proposed for H-alpha diagnostics in ITER is carried out in [1] using the recent experimental data from the tokamak JET with ITER-like wall (JET-ILW). The model is aimed at reconstruction of the density of neutral hydrogen in the SOL, and its isotopic ratio, by solving a multiparametric inverse problem with allowance for: (i) a strong DSL in the signal measured on the line of sights inside the main chamber, (ii) a significant deviation of the velocity distribution function of neutral atoms in the SOL from a Maxwellian, (iii) the data of direct observation of the divertor.

In this paper, which extends [2], the accuracy assessment of the model [1] is done in the frame of the so-called synthetic diagnostics, in which the "phantom" experimental data are generated using the results of predictive numerical modelling of the basic plasma parameters and the corresponding measured values. Synthetic diagnostics allows to compare the "true" values with the ones reconstructed from the "phantom" experimental data. The verification is carried out using the data from predictive modeling of the flat-top of Q=10 inductive operation of ITER, calculated by the SOLPS4.3 (B2-EIRENE) code [3-5] (with modification [6]).

We evaluate the accuracy of: (i) the fitting of Balmer-alpha line shapes of hydrogen isotopes in the SOL in the case of a significant line shape asymmetry caused by an inward flux of the fast atoms (here the model [7] is used); (ii) the fitting of the DSL spectrum using the HRS data from the limited number (about ten) of the lines of sights of direct observation of the divertor, which covers the area of the divertor uniformly (with respect to major radius coordinate in the poloidal cross section); (iii) recovering of partial contributions (to the spectra measured on the SOL-directed line of sights inside the main chamber) of the inner and the outer emitting layers in the SOL, as well as of the DSL; (iv) recovering of partial contributions of deuterium and tritium atoms to the spectra measured on the SOL-directed lines of sights inside the main chamber. We estimate the maximum value of the DSL’s fraction in the measured signal, which limits the range where it is possible to reconstruct the parameters of neutral atoms of hydrogen isotopes in the SOL from the Balmer-alpha lines spectra.

References

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