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Simulation and experimental study of separatrix reconstruction by visible light in EAST

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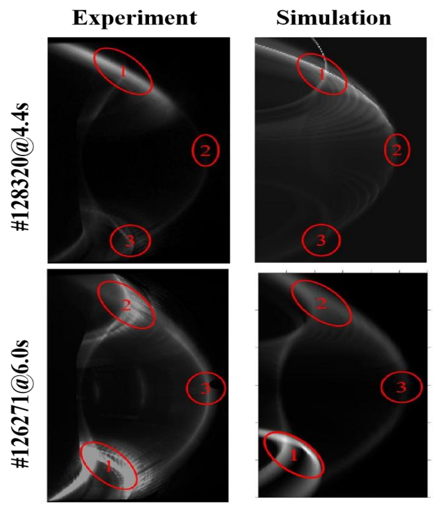
One of the critical factors in tokamak experimental control is the precise identification of the separatrix position. The magnetic equilibrium reconstruction (EFIT) using signals obtained from magnetic probes has become the primary approach for plasma boundary reconstruction. However, the EFIT reconstruction has uncertainties. For example, local magnetic field variations within the vacuum vessel can affect magnetic probe signals. In future fusion reactors, magnetic probes will be exposed to neutron irradiation, leading to a higher probability of probe damage.

Reconstructing the separatrix position based on visible light emission positions (OFIT)[1], as an absolute measurement method, has promising application prospects in future tokamak devices since its signals remain unaffected by complex electromagnetic environments. Although OFIT has been implemented in devices such as TCV[2] and EAST[3], discrepancies still exist between the separatrix positions obtained from OFIT and EFIT. In this work, a CCD camera equipped with a 545–550 nm filter was installed on EAST. The OFIT was employed to reconstruct the separatrix positions for a lithium-coated wall (#126271) and lithium powder injection (#128320) discharge experiments. The SOLPS-ITER was used to simulate the corresponding experiments, and the simulated boundary plasma parameters and luminous distributions showed agreement with experimental observations and as shown in Fig.1. Simulation results reveal that the visible light emission is primarily contributed by Li^{+1} excitation reactions (Li II). The radial distribution in the upstream SOL and the position of maximum emission intensity are determined by the radial profiles of n_e, T_e and n_{Li+1}. The position of maximum emission intensity shifts farther away from the interface as $T_{e,sep}$ increases. Further analysis examined light emission characteristics at different wavelengths (e.g. B III ~424.5 nm, Dα ~656.1 nm). As Fig.2 shown, the lower n_{B+2} near the separatrix lead maximum emission position of B III appears farther from the separatrix than that of Li II. Meanwhile, D primarily accumulates in the far SOL region, emitting light predominantly at the outermost boundary. This work contributes to optimizing the OFIT method for existing devices and provides a theoretical foundation for its application in future fusion reactor devices.

References
[1] G. Hommen, M. de Baar, P. Nuij, G. McArdle, R. Akers M S 2011 *Rev. Sci. Instrum.* **81** 113504
[2] G. Hommen, M. de Baar, B.P. Duval, Y. Andrebe H B Le 2014 *Nucl. Fusion* **54** 073018
[3] Chen M et al 2025 *Nucl. Fusion* **65** 016027



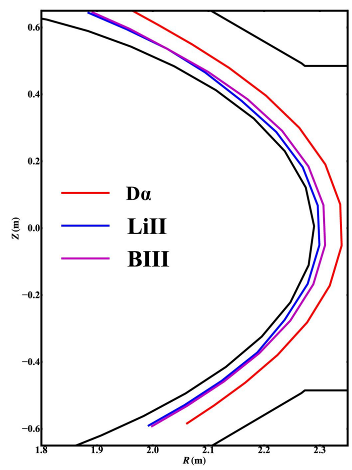


Figure 1. Simulation reconstruction agreement with experimental CCD observations of visible light distribution

Figure 2. Identification of the separatrixposition corresponds to characteristic wavelengths of different particles