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On the Possibility of Monitoring Liquid Metal Plasma-Facing Components via Emission by Computer Vision

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Liquid metal (LM) has been conceptualized for use as plasma-facing component (PFC) in future fusion devices [1]. Being accessible to self-repairing and self-replenishment, thanks to the nature of the liquid phase, has been attractive for being applied in future long-run but less-maintenance fusion devices. This encourages the promotion of such research field throughout the years [2-5]. Despite this, the direct observation of LM PFC with optical emission spectroscopic (OES) diagnostics towards the testing site has been found difficult. Fortunately, it is still possible to have at least a visible digital camera to monitor the LM PFC in some devices, e.g. EAST. In EAST [6-7], it has been discovered that the line emission of lithium (Li) was strong, emphasizing the intensive interaction of Li species with plasma electrons. Even though the direct OES diagnostics is none, the reconstruction of line emission by image processing, together with the survey OES diagnostics can show the emission trends of LM vapor interacting with electrons. The initial sample line spectra of lithium (Li) and tin (Sn) can be plotted using information from literature, e.g. the relative line intensities by NIST' s Handbook of Basic Atomic Spectroscopic Data [8]. This sample line spectra can be decomposed to a few important eigenbases with respect to sample line emission wavelength [9], keeping the significant emission trends. The amplitude factor for each eigenbasis can be estimated by the RGB information of digital images after performing the transformation to the CIE1931 xyz color space. With this, the trends of the reconstructing line emission are compared to the survey OES diagnostics. This method allows qualitatively investigating LM behavior at edge plasmas and conceptualizes the possible monitoring tools for LM PFCs used in future fusion devices.

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