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Quantification of Radiating Species in the DIII-D Divertor in the Transition to Detachment Using Extreme Ultraviolet Spectroscopy

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Experimental observations of extreme ultraviolet resonance emissions in the divertor of DIII-D are used to quantitatively account for radiated power from molecular, atomic and ionized plasma constituents through the transition to detachment. Deuterium emission is found to be the primary emitter near the target scrape-off layer regions while the main impurity in DIII-D, carbon, is found to dominate the X-point region up the divertor legs. In an attached divertor, C emissions peak inboard of the strike point, while with a detached target, their emission region elongates radially. A relative lack of observed Lyman-Werner bands suggests that radiated power from molecules is minimal even with Te,OSP=1-2eV. Species-resolved measurements are necessary to understand a shortfall in radiated power as modeled with 2D fluid codes on multiple tokamaks. The spectrometer fielded for this purpose is a SPRED (Survey, Poor Resolution, Extended Domain) observing the 100-1700Å region. A broad grating provides views of C II, III, and IV resonance emission lines as well as the D Lyman-α line, together accounting for >80% of the power radiated in the divertor. The divertor SPRED (DivSPRED) is mounted with a vertical line of sight into the machine coincident with boundary diagnostics including divertor Thomson scattering.

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