Bayesian tomography of soft X-ray emissivity on the WEST tokamak

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Abstract

Reconstruction of spatially resolved soft X-ray (SXR) profiles from line integral measurements is a powerful method to investigate the magnetic equilibrium, fast magnetohydrodynamic activity and impurity concentrations in nuclear fusion plasmas. In this work, a Bayesian tomographic technique has been applied to the SXR diagnostic at the WEST tokamak. The reconstruction is a challenging task due to the limited number of measurement channels and signal noise. With a view to real-time impurity control, we use a Gaussian process to model the emissivity field, with added flexibility to take into account the varying length scales from the plasma core towards the edge. Under the assumption of normally distributed measurement noise, the posterior distribution becomes available in closed form. Furthermore, the hyperparameters of the model are inferred by maximizing the posterior, for an optimal trade-off between model complexity and data fit. The method has been successfully applied to synthetic data and will be implemented for the measurement campaign at WEST starting later this year.

Keywords: Bayesian tomography, Gaussian processes, Soft X-ray, Tokamak