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Bayesian inference and Gaussian Process for fusion diagnostic data analysis

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International Thermal Nuclear Reactor (ITER) will be equipped with a large array of diagnostics and produce a huge amount of data characterized by redundant, complementarity and complex errors. A prominent challenge for ITER as well as other fusion devices, is how to make the best use of such a large amount of data to obtain as much useful information as possible while meeting the requirements of accuracy, computation speed and reliability assessment against data and model uncertainty for specific tasks such as physics study and real-time control. In this talk, we will give a brief review of the recent developments and applications of advanced data analysis techniques based on Bayesian inference [1] and Gaussian Process [2], including Non-stationary Gaussian Process Tomography (NSGPT) method for tomographic reconstruction [3] and Gaussian Process Regression (GPR) for plasma parameter profile inference [4], as well as others. By contrast, these statistical methods possess advantages of uncertainty quantification for reliability assessment and high flexibility in incorporating domain knowledge into the prior model for improved inference. We will introduce briefly the Bayesian approach to an integrated analysis of multiple sources of data from heterogeneous diagnostics, by which improved reliability and consistency of the results can be obtained via the synergistic effect. This study is expected to provide instructive reference not only for magnetically confined fusion research but also for other fields where advanced analysis techniques are essential.

References
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