Prediction and feature extraction of radiative collapse in LHD using machine learning and sparse modeling

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The feature of radiative collapse has been extracted from high-density plasma experiments in Large Helical Device (LHD) using a sparse modeling technique, and the machine-learning predictor of radiative collapse has been developed based on the extracted feature.

Radiative collapse is one of the causes of high-density fusion plasma termination and it limits plasma density. In stellarator-heliotron plasma, it is the main cause of plasma termination and it limits the operational parameter region, such as electron temperature and density. The best known empirical density limit in stellarator-heliotron plasma is Sudo limit [1], which provides a comprehensive physics picture. However, there are many more parameters than in the Sudo scaling involved in the physics of radiative collapse and density limit. With regard to disruption prediction in tokamaks, data-driven approaches have been attempted.

In the present study, a model to predict the occurrence of radiative collapse has been constructed based on a support vector machine (SVM), which is one of the simplest machine learning techniques. To improve the performance of the model and find out the essential physical background of radiative collapse, plasma parameters to train the model were selected by exhaustive search (ES) technique, which is one of the sparse modeling techniques [2]. Finally, the performance of the predictor has been evaluated using experiment data in LHD.

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References

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