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Estimation of the magnetic field mode structure of EIC event applying data assimilation method in LHD

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It is known that MHD instability driven by energetic particles called EIC is excited in high ion temperature mode with high power perpendicular NBI heating in LHD [1]. The EIC has been observed by measuring temperature fluctuations and local magnetic field fluctuations, but the overall structure of the EIC is not well understood.

In this study, we introduce a data assimilation method based on the drift kinetics analysis code GNET-TD in a three-dimensional magnetic field configuration to reproduce the magnetic field fluctuation structure of the EIC. Data assimilation is the technique for determining the optimal state of a dynamic system by combining observation data with a numerical model. We use Ensemble Kalman Filter (EnKF) as a sequential data assimilation method to estimate the structure of magnetic field fluctuations from the observed experiment data. EnKF is successfully introduced to an integrated transport simulation [2].

We use two types of measurements, FIDA (Fast-ion Dα) and neutron emission rate measurements during the EIC as observation data for data assimilation. FIDA measures the Doppler-shifted light emitted as a result of the charge exchange reaction between fast ions and beam neutrals and estimates the velocity and position information of the fast ions. For simulating FIDA signals, we used FIDASIM code [3] which was developed as a neutral beam and fast-ion diagnostic modeling suite.

[1] X.D. Du et al., Phys. Rev. Lett. 114, 155003 (2015).
[2] Y. Morishita et al., Nucl. Fusion 60, 056001 (2020).
[3] B. Geiger et al., Plasma Phys. Control. Fusion 62, 105008 (2020).

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