Understanding and Predicting Intrinsic Rotation in Fusion Plasmas

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Objectives

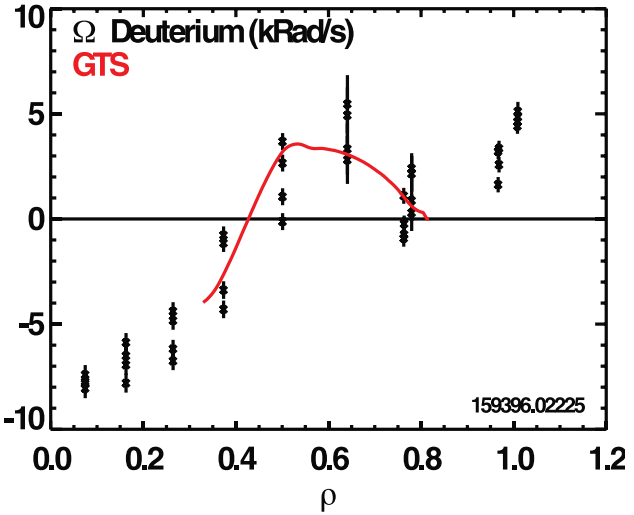
- Study plasma self-generated intrinsic rotation in fusion experiments and develop and validate first-principles-based predictive model
- Develope physics understanding needed for rotation profile control and optimization
- Challenges of this study:
  - Requires to take into account comprehensive global physics for momentum transport calculation

Impact

- ITER may have to rely on plasma self-generated intrinsic rotation for controlling macroscopic stability and reducing turbulent transport.
- Understanding and predicting intrinsic rotation profile structures of tokamak experiments is critically important and present great challenge and outstanding opportunity to test the physics of turbulence driving intrinsic rotation and validate first-principles-based models.
- Contribute to needs for rotation control & optimization

Accomplishments

- A major effort involving a strong collaboration with experiments made on developing physical understanding and a first-principles-based model for predicting profile structure and parametric scaling of intrinsic rotation in tokamak experiments including ITER.
- For the first time turbulent fluctuation-driven residual stress is shown to account for both shape and magnitude of observed intrinsic toroidal rotation profiles in DIII-D ECH plasmas.
- Applied the validated model to studying the characteristic dependence of global rotation profile structure in the multi-dimensional parametric space covering turbulence type, q-profile structure (magnetic shear and q-value), collisionality and up-down asymmetry in magnetic geometry etc.
- Studied turbulence effects on modifying neoclassical poloidal rotation.
- This work contributes two papers for IAEA FEC 2016 including one oral presentation, and an invited talk for APS 2016.



Predicted intrinsic rotation in comparison with experimentally measured main ion toroidal rotation in a DIII-D ECH discharge.

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