

Seminar

Institute for Plasma Research

Title: Role of Microinstability eigenmodes in magnetic confinement fusion devices

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Abstract

Microinstability eigenmodes in magnetic confinement fusion devices are extended along the field line and can nonlinearly interact with themselves at rational surfaces in a process called self-interaction. It can lead to the formation of fine-scale radial corrugations on the pressure profiles, drive zonal flows via a new mechanism that is different from the usual modulational instability, and can have significant impact on turbulent transport flux. An important consequence of self-interaction is a system-size effect that can lead to worse than gyro-Bohm scaling. These effects are validated using gyrokinetic simulations in both conventional tokamaks dominated by Ion Temperature Gradient (ITG) and high beta spherical tokamaks dominated by electromagnetic microtearing turbulence.

Analytic work in the linear limit indicates that in presence of a fine-scale pressure corrugation caused by self-interaction, an eigenmode splitting occurs, leading to higher growth rate. However, in a nonlinear system, profile-shearing associated with the pressure corrugation is found to dominate and decrease turbulent transport. This is particularly relevant for Electron Temperature Gradient (ETG) transport in the pedestal.

While experimental evidence do exist for these results, they are few. Given that these fine-scale pressure corrugations are only a few ion larmor radii in radial width, they are often not well-resolved by diagnostics during experimental measurements. Furthermore, usually the experimental data is smoothed before it is used as an input for both gyrokinetic and in reduced turbulence models such as quasi linear models in integrated modelling simulations. Neglecting fine-scale corrugations in transport models may lead to a systematic over-prediction of turbulent fluxes.

About the Speaker:

Ajay C. J. completed his PhD at the Swiss Plasma Centre, EPFL, Switzerland in 2020, followed by two post-docs at the University of Warwick in UK, and the Dutch Institute for Fundamental Energy Research (DIFFER) in Netherlands. Currently he is a research fellow at the Fusion theory group in Nanyang Technological University (NTU), Singapore. His research primarily focuses on plasma turbulence theory and gyrokinetic simulations. He also works on theory-experimental validation, integrated modelling and developing AI surrogate models for transport prediction.
