Introducing GENE-X: A full-f gyrokinetic code for the Edge and Scrape-Off Layer

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Abstract: Understanding and predicting the effects of plasma turbulence in the Scrape-Off Layer of a tokamak is a crucial step in the optimisation of confinement for future fusion power plants. Our goal is to develop a new gyrokinetic code, called GENE-X, to study SOL turbulence. The Scrape-Off Layer poses several significant problems for gyrokinetic codes. Fluctuations of the plasma in the Scrape-Off Layer are known to be stronger than in the core. As such, nonlinear effects originating from the coupling between fluctuations become important, i.e. a full-f treatment of the underlying equations is necessary. Furthermore, the poloidal magnetic field vanishes at the X-Point of a tokamak – which introduces a coordinate singularity in the commonly used flux-aligned coordinates. We solve this problem by implementing the flux-coordinate independent approach described in [1, 2]. In this talk, we present a careful derivation of the flux-coordinate independent coordinate system and describe the algorithms used. Moreover, we show results of simulations with GENE-X in regions of closed field lines and give an outlook on how to expand the code to open field line regions by introducing sheath boundary conditions.

1. F. Hariri et al., Computer Physics Communications, 184:2419 – 2429, 2013

2. A. Stegmeir et al., Computer Physics Communications, 198:139 – 153, 2016