Outline

- Introduction
- Benchmark M3D-K with NOVA using model equilibrium in MHD limit
- M3D-K simulation of beam-driven Alfven modes in DIII-D

  -- fixed beam injection speed

  -- beam injection speed scan
- Conclusions

Introduction

- In this work, we have carried out hybrid simulations of beam-driven Alfven modes in DIII-D plasmas using a kinetic/MHD hybrid code M3D-K;
- The goal is to validate M3D-K code;
- We find that the beam-driven mode is sensitive to beam distribution function, particularly the beam injection speed.
- Depending on value of injection speed, we find two types of beam-driven modes can be excited, one is RSAE and the other is an EPM-like mode with lower frequency and larger mode-peak-radius.

Benchmark M3D-K with NOVA using model equilibrium in MHD limit

- The n=2 mode is simulated using M3D-K code in MHD limit via an artificial antenna;
- The calculated mode structure and mode frequency agree with NOVA results.

M3D-K simulation of beam-driven Alfven modes in DIII-D: fixed beam speed case

- Beam is described by a slowing-down distribution with peaked pitch angle function;
- The calculated n=2 mode is a RSAE in agreement with NOVA in MHD limit;
- However, the beam-driven mode is different from RSAE with a larger mode-peak-radius. The mode frequency is NOT sensitive to q_{min}.

M3D-K simulation of beam-driven Alfven modes in DIII-D: beam speed scan

- A beam speed scan reveal sensitive dependence of the driven mode on beam distribution function;
- There exist a beam injection speed threshold. When the beam speed exceeds this threshold, a RSAE is excited. Otherwise, an EPM-like mode is excited with lower mode frequency and larger mode-peak-radius.

Conclusions

- In this work, we have carried out hybrid simulations of beam-driven Alfven modes in DIII-D plasmas using a kinetic/MHD hybrid code M3D-K for code validation.
- Depending on value of injection speed, two types of beam-driven modes can be excited, one is RSAE and the other is an EPM-like mode with lower frequency and larger mode-peak-radius.
- Our results show the importance of using realistic energetic particle distribution function for code validation.

Beam distribution function

$$f = \frac{1}{v^3 + v_{\text{crit}}^3} \exp\left[- \frac{P_\phi}{e\Delta\Psi} - \left(\frac{\Lambda - \Lambda_0}{\Delta\Lambda}\right)^2 \right]$$

Λ_0=0.3, $\Delta\Lambda$=0.3