Simulations of Energetic Particle-Driven Modes In Spherical Tokamaks*

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The energetic particle-driven MHD modes in STs are studied using hybrid model of the M3D code[1]. In the hybrid model, the plasma is divided into the bulk part and the energetic particle component. The bulk plasma is treated as a single fluid and the energetic particles are described by gyrokinetic particles. Previously we had shown the results of nonlinear saturation of TAE[2], energetic particle stabilization of internal kink modes and excitation of fishbone[1], and nonlinear saturation of fishbone in a circular tokamak[3]. In this work, the hybrid code has been extended to full 3D geometry using unstructured mesh[4] in poloidal planes and finite difference in toroidal direction. This new capability has been applied to study fast ion-driven MHD modes in spherical tokamaks such as NSTX. Results from hybrid simulations of a NBI-heated NSTX plasma show unstable TAEs with its frequencies consistent with the experimental observations. The effects of fluid compression on a fast ion-driven n=1 mode is studied by varying the ratio of the specific heat coefficient Γ. At $\Gamma = 0$ (i.e., zero sound speed), an n=1 TAE mode is found. However, At $\Gamma = 5/3$, the mode frequency of the $n = 1$ unstable mode is reduced to about 1/5 of the TAE frequency. This new mode is located below the beta-induced continuum gap near the center of the plasma and can thus be called Beta-included Alfven eigenmode (BAE). Details of the results will be presented.

References

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*In collaboration with J. Breslau, J. Chen, E. Fredrickson, S. Jardin, H. Strauss, L. Sugiyama, W. Park. Supported by DOE DE-AC02-76-CHO-3073.