Zonal Flow Driven By High-Energy Particle during Nonlinear MHD Evolution of CHS Fishbone Instability

S. Ohshima, A. Fujisawa, A. Shimizu, H. Nakano, K. Matsuoka, S. Okamura,
CHS-group
o-shima@nifs.ac.jp
National Institute for Fusion Science
Oroshi-cho, Toki, Japan 509-5292

In magnetic confined plasma, structure of the radial electric field determines the property of the plasma confinement, since the electric field causes the transition to the H-mode, regulation of the plasma turbulence and the transport, and so on. One of the factors to determine the electric field is the orbit loss of high energy particles. One of the modern issues is the enhanced loss caused by the interaction between the energetic particles and the MHD modes, such as TAE, fishbone, etc. Here, a question arises whether the enhanced loss of the energetic particle such a nonlinear interaction would result in the electric field variation which affects the property of the plasma confinement or not.

In compact helical system (CHS), temporal evolution of the electric field and density are investigated for an energetic particle driven instability, called CHS fishbone, using twin heavy ion beam probes. The results demonstrate that the oscillating symmetric electric field which has a zonal structure is really generated by energetic particle losses synchronized with the MHD mode frequency. This is a finding of a new kind of zonal flow, which is driven by an energetic particle driven instability.

The sheared electric field found in the CHS experiment is too small to affect the turbulence, however, the resultant shear of electric field could reach a sufficiently large level to reduce the turbulence transport in future burning plasma. This paper presents the nonlinear evolution of the energetic particle driven instability and the zonal electric field accompanied with the instability.