Excitation of Alfven Eigenmodes and Improvement of Plasma Confinement for the existence of “off-axis sawteeth” in EAST

Ming Xu, Hailin Zhao, Liqing Xu, Guoqiang Zhong, et al.
Institute of Plasma Physics, Chinese Academy of Sciences
mxu@ipp.ac.cn

ABSTRACT
• Series of Alfven Eigenmodes are excited during the so-called “off-axis sawteeth” (OAS) oscillation, and the internal transport barrier of electron temperature (e-ITB) is formed accordingly, e.g., the excitation of Reversed Shear Alfven Eigenmodes (RSAEs) is an important indicator for the formation of e-ITB.
• A new mode with plasma rotation frequency is featured by BAAE (or BAAE-like) instability, which has similar features as the pairs of BAES-RSAEs.
• The plasma confinement is improved for the establishment of ITB, and the confinement can be improved further for the suppression of instabilities.

BACKGROUND
• The development of plasma scenarios with ITBs and reversed magnetic shear (RMS) are promising for future tokamak devices, and the RSAEs are easily excited for the configuration of RMS[1-2].
• The collapse of OAS is triggered by the magnetic reconnection of double tearing modes (DTM) [4], which is damaged to the confinement of energetic ions and plasma stored energy.
• The BAAE-like instability [3] is observed near the position of q_min at the modest beta in DIII-D, which is more important for the understanding of “Sea” of Alfven Eigenmodes.
• The plasma confinement can be improved through the suppression of Alfven Eigenmodes or plasma turbulence.

Experimental Results
Establishment of e-ITB
The pairs of BAES-RSAEs are established periodically during the OAS oscillation (Fig.1), and the loss of energetic ions density (or electron temperature) in core region is triggered by the collapse of OAS (Fig.2).

Excitation of BAAE-like instability
The BAAE-like instabilities are reproduced in EAST during the OAS oscillation (Fig.3), and the frequency sweeps upward with the decreasing of q_min. The BAAE-like is featured by the plasma rotation frequency, and the mode structure is m/n=4/4 (Fig.4), where the constraint condition of q_min = 1 is considered.

Improvement of confinement by considering of OAS
• The H-mode is achieved when the beam of NBI is switched on as shown in Fig.5, and the plasma confinement is improved for P_{NB} ≈ 4MW.
• The ITB is established for the case with OAS at t = 3.13 s, and the confinement is improved further at t = 3.83 s.
• The instability with frequencies f_1, f_2, f_3 are suppressed for the increasing of plasma rotation.

CONCLUSION
• The OAS in EAST can be established by the combination of LHCD and off-axis ECRH, which has strong relationship with the core concentration of high-Z impurity density, and the DTM is formed accordingly.
• Series of Alfven Eigenmodes are easily excited during the OAS oscillation when the source of energetic ions is injected, e.g., BAES, RSAEs, BAAE-like.
• The ITB is established easily for high power of NBI under the condition of OAS, and the confinement can be further improved through suppression of Alfven instability or turbulence transport.

REFERENCES