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

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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.

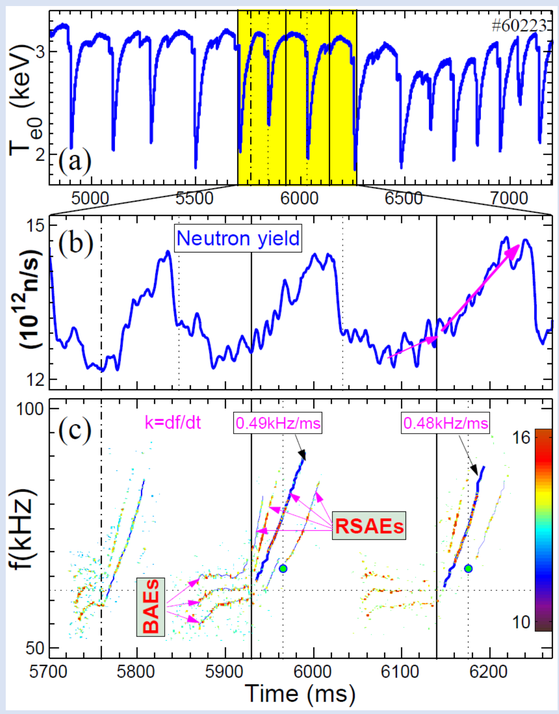

Fig.1. The pairs of BAEs-RSAEs are excited during OAS oscillation, and the energetic ions portion is modulated accordingly.

Fig.2. The loss of energetic ions density and T_e in core region are triggered by the collapse of OAS.

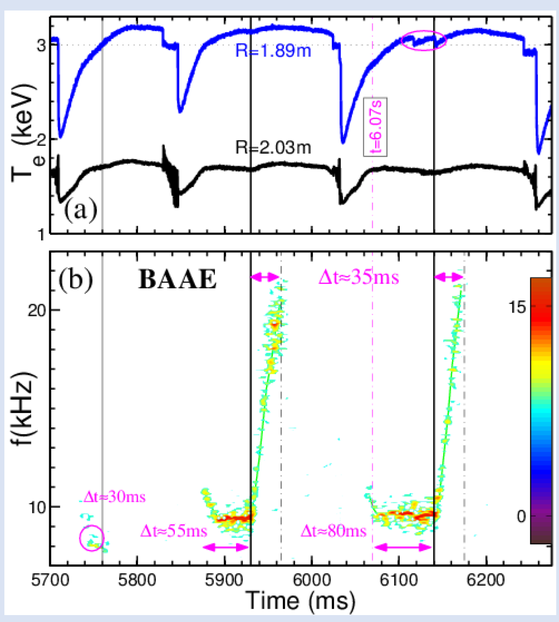

Fig.3. The excitation of BAAE-like during OAS oscillation.

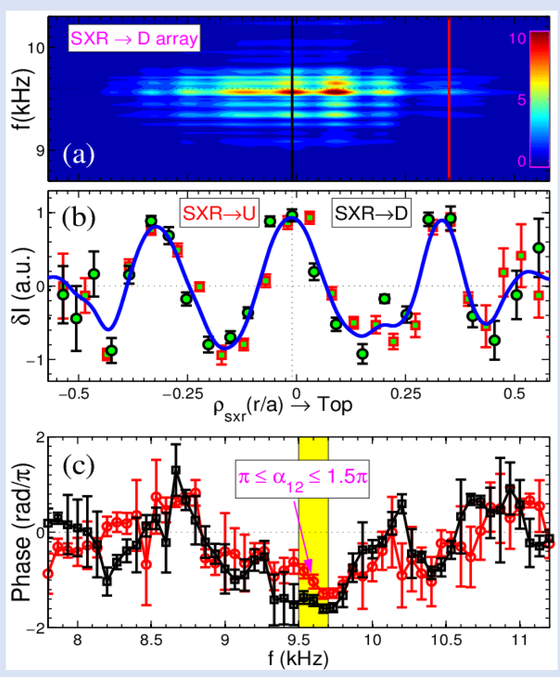

Fig.4. the structure (m/n=4/4) of BAAE-like measured by SXR arrays.

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 is 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 $P_{NB} \approx 4MW$.
- 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.

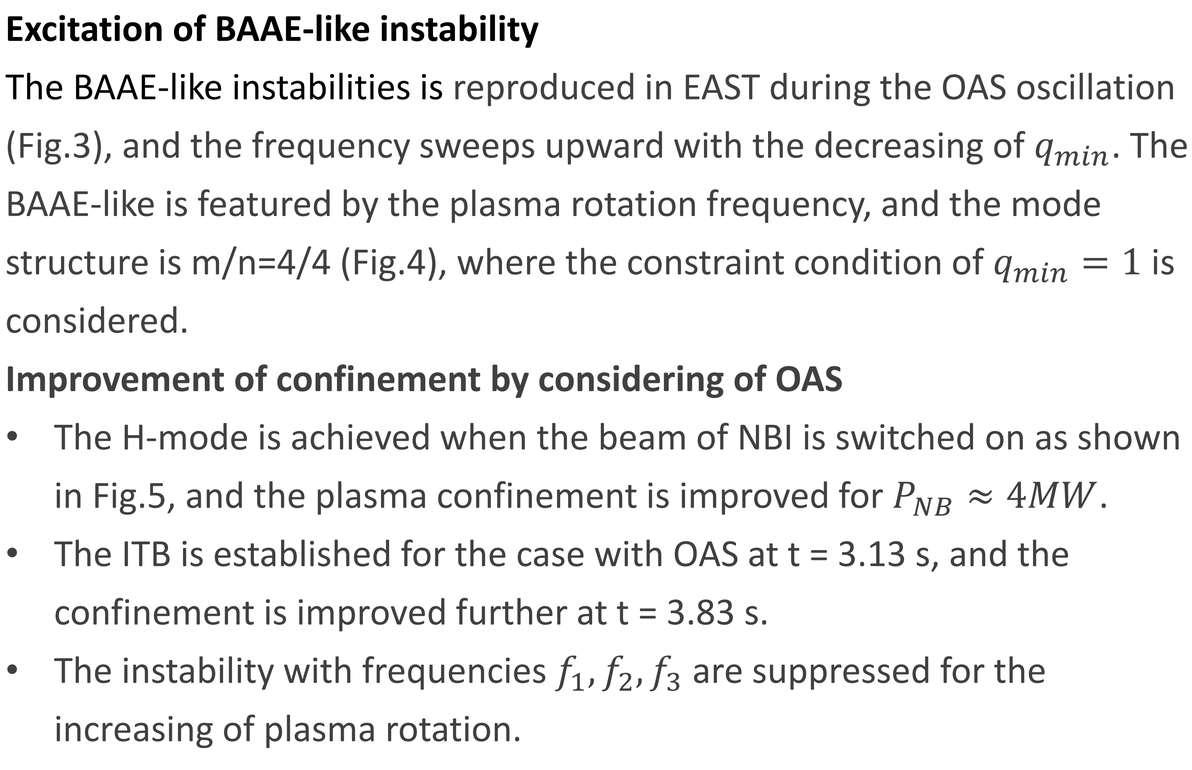

Fig.5. The plasma confinement is improved successively as shown in the left figure, and series of Alfven Eigenmodes are shown in the right for the existence of OAS ($t \leq 3s$).

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.

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