2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Study of quasi-coherent modes in KSTAR ECH and ohmic plasmas

Woochang Lee[1], J. A. Lee[2], S. H. Ko[1], D. J. Lee[3], J. M. Kwon[1], G. S. Yun[2], H. K. Park[3]
[1] National Fusion Research Institute (NFRI)
[2] Department of Physics, Pohang University of Science and Technology (POSTECH)
[3] Department of Physics, Ulsan National Institute of Science and Technology (UNIST)
e-mail (speaker): wclee@nfri.re.kr

Quasi-coherent modes (QCM), known as a type of the trapped electron mode (TEM) turbulence [1, 2], have been measured in the outboard core region of low-collisionality low-confinement (L-mode) discharges ohmically heated or electron cyclotron resonant heating (ECH) assisted in the KSTAR machine [3], and their characteristics have been studied. Note that QCM can be easily recognized by its unique quasi-coherency of $\Delta f/2 \lesssim f_{peak} \lesssim \Delta f$ from the spectrum of density fluctuations, where Δf is the bandwidth and f_{peak} is the peak frequency. Figure 1 shows a QCM with $f_{peak} \approx 40$ kHz measured at a core region of an ECH discharge #16481. Density fluctuations measured by the multichannel microwave imaging reflectometer (MIR) [4] revealed that QCMs with the peak frequencies in the range of 20–60 kHz occur or strengthen with an increase of the electron temperature to ion temperature ratio, whereas weaken or are fully suppressed by increased density (and collisionality). Toroidal rotation shear, which is strongly related to the density, also seems to stabilize the QCMs. Linear gyrokinetic simulations with the GYRO code indicated that TEM is the most unstable mode at low-density phases where the QCMs were observed for both the ECH and ohmic discharges. On the other hand, at high-density phases where the QCMs were fully suppressed, the most unstable mode is the ion temperature gradient (ITG) mode for the ECH discharges but still TEM for the ohmic plasmas.

In the ECH discharges, it was found that the direction of the core intrinsic toroidal rotation is gradually reversed from the co-current to counter-current direction (and the QCMs are suppressed) as the line-averaged density increases, which can be explained by the transition of dominant micro-turbulence (TEM to ITG). However, in the ohmic discharges, the acceleration of the core toroidal rotation is not fully explained by the TEM-ITG transition since the core toroidal rotation at the low-density phase (where QCM were observed) was in the counter-current direction. Furthermore, the core toroidal rotation was accelerated to the counter-current direction even though the line-averaged density slightly decreases.

In ECH discharges with slightly different parameters, QCMs often appeared shortly after ECH injection but sometimes were not observed even in the discharges with similar plasma parameters before the the ECH injection. In these discharges, plasma parameters such as the electron and ion temperatures, electron density, and toroidal rotation velocity revealed different responses to the ECH injection. We are investigating the different responses to the ECH injection for the two cases with and without QCM focusing on whether the different responses are due to QCM or the QCM appearance is affected by small differences in the parameters. A preliminary result will be reported.

This work was supported by Ministry of Science, ICT and Future Planning of Korea under the KSTAR project and the National Research Foundation of Korea under contract Nos. NRF-2014M1A7A1A03029865 and NRF-2017M1A7A1A03064231.

References

[1] H. Arnichand *et al*, Nucl. Fusion 54, 123017 (2014).
[2] H. Arnichand *et al*, Nucl. Fusion 55, 093021 (2015).
[3] J. A. Lee *et al*, Phys. Plasmas 25, 022513 (2018).
[4] W. Lee *et al*, Nucl. Fusion 54, 023012 (2014).

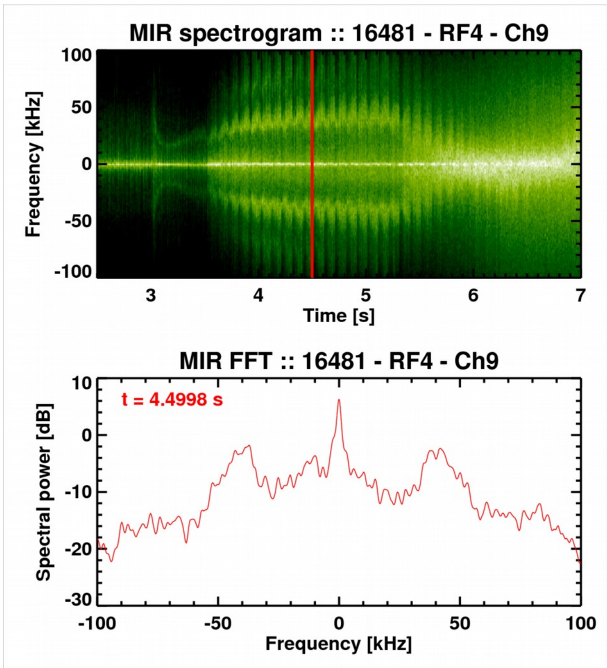

Figure 1. (Upper) Spectrogram of a MIR channel for a discharge #16481 shows that a QCM is driven by ECH injection at t = 3.0 s and is suppressed by rapidly increased density from 5.3 s [1]. (Lower) Spectrum at t = 4.5 s shows a clear QCM with $f_{peak} \approx 40$ kHz.