# Quantitative analysis of zonal flow influence in trapped electron modes through triad energy transfer

Jiheon Song[1], Jungpyo Lee[1,3] Emily Belli[2] and Jeff Candy[2]

[1]Hanyang University, Korea, [2]General Atomics, USA, [3]Princeton Plasma Physics Laboratory, USA

jhsong48@hanyang.ac.kr

Abstract

Magnetically confined plasma shows anomalous transport by micro-scale turbulence modes such as ion temperature gradient mode and trapped electron gradient mode (TEM). There are different results regarding whether zonal flow is involved as a saturation mechanism [1,2], and weak zonal flow (ZF) saturation appears depending on the electron profile [3]. In this study, we quantitatively compared the contribution of saturation to ZF in TEM by carefully changing resolution and electron profile. We used the gyrokinetic code CGYRO [4], which simulates the microinstabilities in a local flux tube. The free energy transfer and zonal flow production rate were examined. The results of the simulations revealed that fine resolution is essential to capture the correct zonal flow coupling. When the simulation was conducted at a finer resolution than previous studies, the energy transfer from the electron channel to ZF increased, resulting in a shift from weak ZF TEM to strong ZF saturation. Although it has been proposed that the contribution of trapped electrons to ZF excitation is insignificant [5], the simulation results indicate significant zonal flow production from the electron channel and clearly show that trapped electrons on the velocity grid are coupled to ZF. These results were obtained because recent advances in computing power have enabled higher resolutions to be achieved. These quantitative results could contribute to the validation of reduced models which rely on zonal flow saturation for TEM.

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea (No. RS-2024-00401407).

**References**

[1] F. Merz and F. Jenko Phys. Rev. Lett. 100, 035005 (2008).

[2] Y. Xiao and Z. Lin Phys. Rev. Lett. 103, 085004 (2009).

[3] D. R. Ernst et al, Phys. Plasmas 16, 055906 (2009).

[4] J. Candy, Journal of Comp. Phys. 324, 73-93 (2016).

[5] H. Chen and L. Chen Phys. Rev. Lett. 128, 025003 (2022).