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# Experimental Study of the Magnetic Braking Torque by Non-Axisymmetric Magnetic Perturbations in Different Plasma Collisionality Regimes on KSTAR

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Although tokamaks confine plasmas with an axisymmetric toroidal magnetic field, there is always a slight non-axisymmetric magnetic perturbations (NAMPs) resulted from the misalignment of the toroidal magnetic field coils or ripple error fields due to the finite number of toroidal magnetic field coils. NAMPs can also appear due to MHD activities (internal kink modes, tearing modes, etc.) or external magnetic perturbations such as resonant magnetic fields (RMPs), which can be applied for either active control or suppression of the edge localized modes (ELMs) in H-mode plasmas. It is well known from several tokamak experiments that the application of NAMPs or MHD activities can significantly slow down the plasma rotation. Strong braking of the toroidal rotation by the externally applied n = 1 non-resonant magnetic perturbations has been frequently observed in the KSTAR tokamak. Recent experiments in the KSTAR tokamak have shown that n = 2 non-resonant magnetic perturbations can also damp the toroidal rotation. In this paper, a comprehensive investigation of the several experiments dedicated on the toroidal rotation braking by the external magnetic perturbations is carried out. The braking torque due to the magnetic perturbations are determined from the momentum transport equation with the measured toroidal rotation profiles by the charge exchange spectroscopy and X-ray imaging crystal spectroscopy diagnostics of high temporal resolution up to 10 ms. The neoclassical toroidal viscosity theory is considered to explain the magnetic braking of the toroidal rotation. The dependencies of the magnetic braking torque on the plasma collisionality and rotation are also discussed.

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**Author:** Dr LEE, Hyungho (National Fusion Research Institute)

**Co-authors:** Dr HAN, Hyunsun (Nuclear Fusion Research Institute, Korea); Dr SEOL, JaeChun (National Fusion Research Institute); Dr KIM, Jayhyun (National Fusion Research Institute); Ms YOO, Jeongwon (University of Science and Technology); Dr KWAK, Jong-Gu (National Fusion Research Institute); Dr YOU, Kwangil (National Fusion Research Institute); Dr TERZOLO, Laurent (National Fusion Research Institute); Dr LEE, Sang Gon (National Fusion Research Institute)

**Presenter:** Dr LEE, Hyungho (National Fusion Research Institute)

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