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Numerical Diagnostics of Non-Diffusive Transport Process by Use of Turbulence Diagnostic Simulator

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Hysteresis in the flux-gradient relation (similar to what has been revealed by the dynamical response to the heating modulation [S. Inagaki, et al., Nucl. Fusion 53 (2013) 113006.]) is found in the global nonlinear turbulence simulation for the first time. Here we report (i) the abrupt increase of the heat flux after the gradual change of the flux and pressure gradient on the onset of the additional heating, and (ii) the simultaneous response of the flux associated with the radial width of fluctuations and their nonlinear couplings, which spreads the pressure response from core to edge with a speed of ten times faster than the diffusion velocity. The nonlinear simulation demonstrated the counter-clockwise hysteresis in the flux-gradient relation contrary to the experimental observation. This result implies the possibility that variety of hysteresis responses will be observed in fusion plasmas, and it is necessary to extend the approach from local to global nonlinear simulations with new degrees of freedom.

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Primary author: Dr KASUYA, Naohiro (Kyushu University)

Co-authors: Prof. ITOH, Kimitaka (NIFS); Dr SASAKI, Makoto (Kyushu University); Dr YAGI, Masatoshi (JAEA); Prof. ITOH, Sanae (Research Institute for Applied Mechanics, Kyushu University); Dr INAGAKI, Shigeru (Kyushu University)

Presenter: Dr KASUYA, Naohiro (Kyushu University)

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