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Physics overview of transport study in the Large Helical Device

Kenichi Nagaoka[1,2], Tokihiko Tokuzawa[1,3], Katsumi Ida[1,3], Motoshi Goto[1,3], Shu Nishimoto[2], Motoki Nakata[1,3], Masahiro Kobayashi[1,3]
[1] National Institute for Fusion Science, [2] Nagoya University, [3] The Graduate University of Advanced Science (SOKENDAI)
e-mail : nagaoka@nifs.ac.jp

Magnetically confined fusion plasma experiments have a high potential to contribute to a variety of physics research fields as well as fusion science due to a unique capability of extremely non-equilibrium state and strong nonlinearities. Moreover, great capability in diagnostics is another advantage of plasma experiment, such as profile measurement of temperature, density, velocity, and their fluctuation measurements, those are much more difficult in normal fluid experiments. Various experimental studies on transport related phenomena have been conducted in the Large Helical Device with distinguished diagnostics. Recent progress will be reviewed from the scientific viewpoints.

1. The zonal flow effect, which is a reduction of turbulent transport due to zonal flow excited by turbulence, was successfully evaluated in experiment with synthetic technique. And it is also demonstrated that the zonal flow effect can be controlled via change of geodesic curvature of the magnetic field [1], which will contribute the turbulent transport optimization in next generation stellarator study and the development of external control technique of self-organized fusion burning plasmas.

2. The interaction between low-k turbulence and high-k turbulence was observed [2], which attract much attention from viewpoint of multi-scale coupling physics, which is a common interest in space and fusion plasmas and intensively studied with large simulations with supercomputers [3].

3. The deformation of distribution function of ions was observed, and the Landau damping process induced by MHD activities is identified, which is important for alpha channeling physics in fusion and is closely related to the particle acceleration in space.

4. Non-mixture state was observed in multi-ion-species plasmas, which indicated that turbulence may induce particle transport only for specified ion species [4]. This phenomenon is significantly important in fusion burning plasmas both in the core of stars and laboratory.

5. The asymmetry measurement in parallel and perpendicular temperature was successfully demonstrated with the same technique with the next generation diagnostics for solar corona, contributing solar plasma physics as well as edge plasma modeling study in fusion [5].

Other progresses will be also presented in the conference. It will be emphasized that fusion-oriented research with general physics viewpoint can produce rich scientific outcome when we have good connections with scientists in other fields.

References

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