## §7. Studies on Wave Analysis and Electric Field in Toroidal Plasmas

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Radial electric field has been experimentally observed in toroidal plasma confinement devices such as tokamaks, stellarator and heliotron/ torsatrons. These experimental observations may provide the database for an understanding of the physics associated with radial electric field, i.e., the electric field is believed to play important roles in the suppression and/or enhancement of various types of microinstabilities, the neoclassical and anomalous transports, and consequential confinement improvement such as H-mode. Although a large number of database for the effect of radial electric field has been accumulated experimentally and theoretically, the physics involved has not been completely understood. To deepen understanding of these phenomena, the cooperative mechanism among electric field and physical processes involved, namely, loss of energetic particles, neoclassical and anomalous transports , heating and so on should be clarified.

Various theoretical models related to the electric field generation process and its influence on the stability and transport have been proposed. Also, much attention has been paid on how to control the electric field and consequently the confinement improvement. Several approaches to the active control of electric field have been discussed, by adjusting the ion and/or electron loss channel due to the selective NBI and/or ECH heating, biasing and so on. It should be noted that recent considerableprogress on the measurement echniques (CXS,HIBP etc.) may realize the detailed analysis of adial electric profile and confinement characteristics in the whole plasma region.

This is the over view of theoretical and experimental studies on the electric field generation process and its influence on the stability and transport in toroidal plasmas, which has been done past ten years. We first survey the wave analytical techniques for linear plasma waves on the basis of both fluid and kinetic descriptions. Particularly, the WKB analysis based on both the second order differential equation and the integral equation in wave number space(k-space). are discussed. This analytical method is applied to study the effect of electric field on typical microinstabilities such as drift waves in an inhomogeneous plasma. The reduction of anomalous transport due to sheared rotation(gradient of electric field) is also discussed.

Theoretical modeling on the electric field generation in toroidal plasma are surveyed , and recent and past year's plasma rotation experiments are revisited. The present topics have been done under close collaborations and stimulating discussions with my colleague , Drs. K. Itoh, J. Todoroki and many theory and experimental group members.

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