Production and Maintenance of High Beta Spherical Tokamak Plasmas using a New Method

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【 Outline of survey 】

The objective of this research is to develop a new method of generating and maintaining an " ultra-high-beta spherical tokamak (ST) plasma ". Beta is defined as the ratio of the plasma pressure and the confining magnetic field pressure, and is an important parameter to quantify the efficiency of magnetic plasma confinement. Attainment of a stable high-beta plasma enables realization of a compact fusion reactor and leads to greatly improved economic competitiveness. Specifically, we aim at developing a new method of producing an ultra-high-beta ST plasma without using the center solenoid (CS) located at the center of the torus, utilizing energy conversion from the magnetic field to plasma particles by magnetic field reconnection, which accompany merging of plasmas generated by coils located outside the vacuum vessel. In addition, we aim at maintaining a high-beta ST plasma using advanced radiofrequency (RF) methods. Existing equipments are fully utilized to achieve these goals. The ultra-high-beta ST plasma formation method utilizing rapid plasma heating accompanying plasma merging is developed on TS-4. The high-beta plasma maintenance method utilizing heating and current drive by RF such as the HHFW (high-harmonic fast wave) is developed on TST-2. The results of these research elements are combined to demonstrate maintenance by RF of an ultra-high-beta ST plasma formed by plasma merging, and application of this method to a fusion reactor is examined.

【 Expected results 】

This research will clarify the maximum beta achievable in ST plasmas formed by a new plasma merging method using induction by two pairs of plasma generation coils located outside the vacuum vessel. It will also clarify how long the high-beta ST plasma lifetime can be extended by RF heating or current drive. Success of this method should lead to generation and maintenance of high-beta plasma with high purity, since the absence of electrodes or conducting shell should prevent contamination by impurities

【 References by the principal researcher 】

[1] " Initial results from the TST-2 spherical tokamak," Y. Takase, A. Ejiri, N. Kasuya, T. Mashiko, S. Shiraiwa, et al., Nucl. Fusion **41**, 1543-1550 (2001).

[2] " Plasma Current Start-up, Ramp-up, and Achievement of Advanced Tokamak Plasmas without the Use of Ohmic Heating Solenoid in JT-60U," Y. Takase, T. Fukuda, X. Gao, M. Gryaznevich, S. Ide, et al., J. Plasma Fusion Res. **78**, 719-721 (2002).

【 Term of project 】 F Y 2004 — 2008

【 Budget allocation 】 83,600,000 yen

【 Homepage address 】 http://fusion.k.u-tokyo.ac.jp/kakenhi-e.html