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High-Temperature Plasma Dynamics and Structure Formation Based on Magnetic Field Diversity

Kazunobu Nagasaki

Institute of Advanced Energy, Kyoto University

In high-temperature plasmas such as magnetic confinement fusion plasmas, various "structure formations" occur, which are commonly observed in nature, and these structural formations can cause a transition to a new confinement state. The key to understanding the onset mechanism of this structure formation is the dynamics of turbulence and energetic particles in the plasma. Fluid-like and particle-like behaviors coexist, resulting in characteristics that are remarkably different from those of neutral fluids, such as (1) strong nonlinear coupling between the confining magnetic field and the plasma via the electromagnetic force, and (2) wave-particle resonance interaction with high-energy particles far from the thermal equilibrium state, such as alpha particles produced by nuclear fusion reactions. The complex interplay of these phenomena results in the formation of a macroscopic intrinsic flow from a turbulent state with microscopic vortices, creating a kind of "structure" in high-temperature plasmas. On the other hand, recent experimental results have revealed that these structure formation phenomena can be controlled by the three-dimensional structure of the magnetic field configuration that confines the high-temperature plasma.

For tackling this issue, we have launched an international program called “PLADyS”, Advanced Core-to-Core Network for High-Temperature PLAsma Dynamics and Structure Formation Based on Magnetic Field Diversity, financially supported by the Japan Society for the Promotion of Science (JSPS). It aims to establish an "International Research Center Consortium on Ultra-High Temperature Plasma Dynamics and Structure Formation" with Kyoto University as the primary research center, Max Planck Institute for Plasma Physics (Germany), University of Wisconsin-Madison (USA), and Southwest Jiaotong University (China) as the research centers in their respective countries. The program includes developing research program of multi-scale structure formation Human resource development, Personnel exchange (young researchers, students), remote international collaboration experiments, International and domestic seminars, summer school and lectures.

As part of these activities, we would hold the symposium entitled “High-temperature plasma dynamics and structure formation based on magnetic field diversity”. The symposium program is as follows,

S4-1. Introduction
Kazunobu Nagasaki (Kyoto Univ., Japan)

S4-2. "First observation of plasma healing via helical equilibrium in tokamak disruptions"
Xiaodi Du (GA, USA)

S4-3. "Dynamics of energetic particle-driven oscillatory zonal flow in toroidal plasmas"
Takeshi Ido (Kyushu Univ., Japan)

S4-4. "Effects of toroidal plasma current on divertor power depositions on Wendelstein 7-X"
Yu Gao（Max-Planck Institute for Plasma Physics, Germany）

S4-5. "Explosive magnetic energy release on the Sun and accreting young stars"
Shinsuke Takasao (Osaka Univ., Japan)

S4-6. Discussion

The topics include not only experimental studies on dynamic phenomena in high-temperature fusion plasmas but also the astrophysics in the Sun and stars related to the magnetic field. We expect that the symposium will provide us deeper understanding of the structural formation commonly observed in nature.

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