【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Mathematics/Physics)

Title of Project： Plasma Turbulence Observation System (PLATOS) for puzzling out the principles of structural formation and functional expression in turbulent plasmas

Akihide Fujisawa
(Kyushu University, Research Institute for Applied Mechanics, Professor)

Research Project Number：17H06089　Researcher Number：60222262
Research Area：Physics
Keyword：plasma, turbulence, structural formation, function expression, tomography, cross-scale couplings, turbulence localization

【Purpose and Background of the Research】

Plasma is ubiquitous, as it is said that visible matters of 99% in the universe are in plasma state. It is turbulence that determines the structure and dynamics of plasma. Particularly, the turbulence has been extensively studied in the research of magnetically confined plasmas aiming at nuclear fusion, since it is a key to determine the plasma properties. Thanks to these efforts, a new paradigm has been proposed recently, that is, the couplings between disparate scale fluctuations and structure produces a global scale correlation to determine plasma properties. The purpose of the project is, being based on the paradigm, to clarify the structural formation and function expression of turbulent plasmas.

【Research Methods】

In the project, a never-existing device, named **plasma turbulence observatory (PLATO),** is constructed to focus on the physics of turbulent plasmas and its understanding experimentally (see Fig.1). The device is the first device to measure the entire cross-sections of turbulent plasma with a spatial resolution of microscale of Lamor radius. The device makes it possible to investigate the reality of **cross-scale couplings and turbulence localization,** and finally to explore the principles of structural formation and function expression.

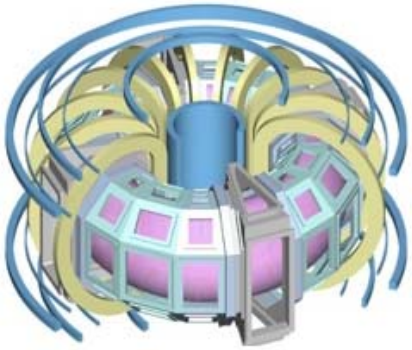

Fig.1 A conceptual view of PLATO

The plasma turbulence tomography, using plasma emissions, is the major diagnostic method that has shown the ability of turbulence measurement in a prototype installed on a linear cylindrical device in the previous project on grant-in-aid for scientific research (see Fig. 2). Moreover, in addition to the tomography, PLATO uses **heavy ion beam probes** (HIBP) and microwaves diagnostics with superior abilities in local and fine measurements. The HIBP ability of simultaneous detection of density, electric field, and magnetic field, is utilized, and turbulence studies are performed in the synthetic manner of these diagnostics.

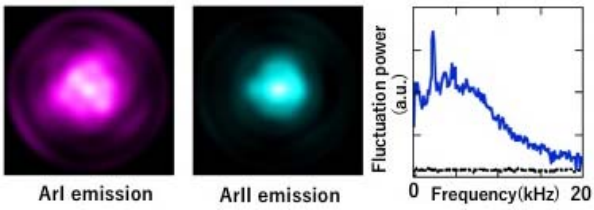

Fig. 2. .Plasma emission and a fluctuation power spectrum obtained with the prototype of plasma tomography on a linear device

【Expected Research Achievements and Scientific Significance】

Torus is a natural shape for magnetic field, and the studies of plasma in such magnetic field structure are important for understanding phenomena in nature and the universe, for example, solar tachocline, transport around accretion disk of a backhole, and so on. Moreover, it is a common subject for physics, chemistry, social science, *etc.*, how fluctuations should govern the structural formation and function expression in a non-equilibrium system. Finally, the project, pursuing the law of *panta rhei*, complementarily to research of elementary particles, has significance for physics of non-equilibrium that provides natural recognition and future technologies.

【Publications Relevant to the Project】

・A. Fujisawa, Nuclear Fusion **49** (2009) 013001.
・A. Fujisawa, Y. Nagashima, S. Inagaki et al., Plasma Phys. Control. Fusion **58** (2016) 025005.

【Term of Project】 FY2017-2021

【Budget Allocation】 448,600 Thousand Yen

【Homepage Address and Other Contact Information】

http://tokusui.riam.kyushu-u.ac.jp/PLATO_project/index.html