【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)

Title of Project : 2D Imaging Study of High Power Heating / Acceleration of High Magnetic Field Reconnection for its Physics and Application

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Research Project Number : 15H05750 Researcher Number : 30214191
Research Area : Plasma Sciences
Keyword : Magnetic reconnection, High-field plasma merging, Ion and electron heating/ Acceleration, 2D image comparison

【Purpose and Background of the Research】

The magnetic reconnection is known to heat and accelerate plasma within a short reconnection time. We will form small but high-field merging tokamak plasmas with heating/ acceleration power much larger than heat loss. Based on our own ideas, we will complete 2D imaging diagnostics and will make detailed comparison of 2D images among laboratory experiment, solar observation and particle simulations to elucidate its unsolved energy conversion mechanisms, especially ion and electron heating/ acceleration by outflow, inductive/ electrostatic electric field, shock, wave, surfing effect and turbulence etc. We will develop common interpretations of reconnection heating and acceleration for laboratory experiments, solar observations and simulations and will finally find the first application of huge reconnection heating.

【Research Methods】

Using downsized coils and upgraded capacitor banks, we will form two small but high magnetic field tokamak plasmas to merge them together, realizing reconnection heating power much higher than heat loss for our clear-cut reconnection heating experiment. We will develop 2D imaging diagnostics: 2D ion Doppler tomography, 2D Thomson scattering, 2D magnetic/ electrostatic probes for ion/ electron temperatures and densities, magnetic and electric fields. They will enable us to test the proposed reconnection heating/ acceleration mechanisms, to conclude relationship among A) MHD, B) two-fluid and C) kinetic interpretations. Detailed comparison of 2D images from experiments, solar observation and simulations will solved key energy conversion characteristics: A) huge ion heating energy up to 20% of magnetic energy, B) localized electron heating and C) formation of high energy particles.

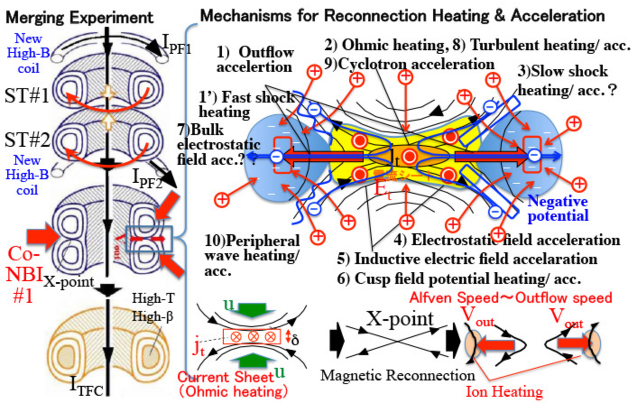

Figure 1 Torus plasma merging experiment (left) for the purpose of elucidating possible mechanisms for reconnection heating and acceleration (right).

【Expected Research Achievements and Scientific Significance】

Based on our B^2 scaling of reconnection heating, we can realize the first clear-cut reconnection heating experiment with heating power >> heat loss. All of its key parameters will be measured in 2D for the first time. They will enable us to test/ evaluate the proposed reconnection heating and acceleration mechanisms in the real plasmas. Detailed interdisciplinary comparison of 2D images from experiments, solar observations and simulations will solve common key physics: huge ion heating, localized electron heating and high energy particle, finally revealing common interpretations of reconnection heating/ acceleration that bridge large parameter gaps among those plasmas. We will explore applications of the huge reconnection heating/ acceleration at first to fusion plasma startup/heating.

【Publications Relevant to the Project】

・Y. Ono et. al., Plasma Phys. Controlled Fusion 54, 124039 (2012)
・Y. Ono et al. Physical Review Letters 107, 185001 (2011),
・Y, Ono, Parity 28, 14, (2013).

【Term of Project】 FY2015-2019

【Budget Allocation】 153,900 Thousand Yen

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