§1. Collaborative Research of Magnetic Reconnection among Laboratory, Observation and Simulation

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In fiscal year 2013, we promoted the proposed style of collaborative plasma research of magnetic reconnection among laboratory experiment, solar and magnetosphere observation and theory/ simulation by starting several joint research groups composed of Hinode solar satellite team, laboratory experiments at Univ. Tokyo, NIFS simulation team and NIFS diagnostic team, JAERI simulation team, AIST NBI team. We summarized our three year's activities in J. Plasma Fusion Res. 2013, No. 11-12, "Overview and Prospect - Frontier Researches in Magnetic Reconnection –" (by Y. Ono et al) [1] and also in Astronomical Herald 2013 No.6 (by N. Nishizuka) [2] related with the joint experiment on light bridge by TS laboratory experiment and Hinode solar observations. We made about 10 invited talks and published about 20 journal papers related with this collaboration program.

As shown in Fig.1, our Hinode-TS joint research team studied the plasmoid ejection phenomenon in solar chromosphere using solar satellites: Yohko/ Hinode and aspheromak/ tokamak plasma ejections in TS-2 experiment. We observed the plasmoid ejections consistently in solar observation and in laboratory experiments. Its key issues are that plasma pile-up inside the current sheet causes the ejection of plasmoid as well as large increase in reconnection speed. Figure 1(left) clearly shows that growth of plasmoid causes finally its ejection. Figure 1 (right) also shows similar growth and ejection of plasmoid with closed magnetic flux, causing large increase in reconnection speed and magnetic energy dissipation. The jet turned out to be the reconnection outflow whose the speed is as high as poloidal Alfven speed. This outflow jet causes the ion heating in the downstream area over 20 eV. This laboratory experiment of plasmoid ejection leading us to our publication of J. Plasma Fusion Res. 2013, No. 11-12.

NIFS-TS team investigated the cause and mechanism for reconnection heating by using both of particle (PIC) simulations code developed by NIFS and TS merging/ reconnection experiment in Univ. Tokyo. Causes and mechanisms for reconnection heating have been studied using the PIC simulation with the driven-type boundary condition (developed by Horiuchi) similar to the laboratory merging experiment[3]. The parallel acceleration was found to accelerate ions widely not only inside the current sheet but also outside, causing large ion heating of reconnection. The magnetized electrons form the negative potential well in the downstream, also accelerating unmagnetized ions. The heating model of reconnection is now under development in collaboration between laboratory and simulation groups. TS-NIFS-AIST-MAST joint team also studied the significant reconnection heating of ions and electrons up to 1.2keV in the MAST experiment, exploring high-power heating/ startup of tokamak plasmas [3]. Those results will be presented as the Fusion Energy 2014 and the COSPAR 2014 conferences.

[1] Y. Ono et al., "Overview and Prospect - Frontier Researches in Magnetic Reconnection - " J. Plasma Fusion Res. Vol.89, No.11 (2013), 753.
[2] N. Nishizuka, Y. Ono et al, Astrophys. J., 756, 152, (2012).
[3] Y Ono et al., Plasma Phys. Cont. Fus. 54, 124039, (2012).

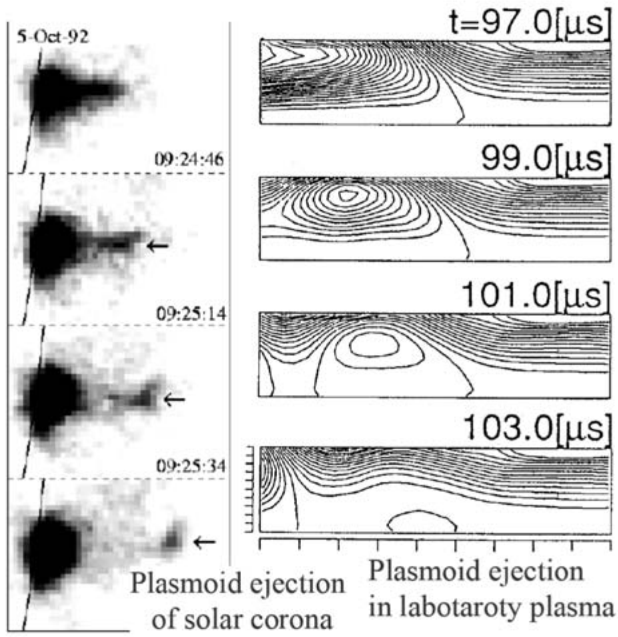

Fig. 1 Plasmoid ejections in solar flare (left: X-ray image) and in laboratory experiment (right: poloidal flux contours).