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

Ono, Y., Inomoto, M., Yamada, T., Hoshino, M. (Univ. Tokyo, Dept. Advanced Energy), Horiuchi, R., Nagayama, Y.,
Sakakita, H., Hirano, Y. (AIST), Tsuneta, S., Nishizuka, N., Shimizu, T. (NAOJ)

In fiscal year 2011, we successfully completed a new 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,

Especially, Hinode-TS joint team demonstrated the significant reconnection heating of ions and electrons over 1keV and TS-3(Japan) measured ion heating in the reconnection downsteam and electron heating inside the current sheet using their 2-D images. Based on these new results, we made 20 invited talks (IPELS etc.) and 40 publications (Phys. Rev. Lett., Physic Plasmas etc.). Joint experiments in TS and Hinode solved magnetic fluctuation inside current sheet and also the plasmoid ejection as a fast reconnection mechanism, leading us to the plasmoid symposium in Plasma Conference 2011.

As shown in Fig.1, our Hinode-TS joint research team also simulated the light-bridge phenomenon in solar chromosphere using toroidal plasma and center solenoid fux in TS-4 devices and investigated the dynamics of plasma ejections, heating and wave generation triggered by component reconnection in the chromosphere. The light-bridge type configuration in Fig. 1(b) revealed bi-directional outflows with the speed of 4 km/s at maximum, ion heating in the downstream area over 30 eV and magnetic fluctuations mainly at 5-10 microsecond period. We succeeded in qualitatively reproducing chromospheric jets, but quantitatively we still have some differences between observations and experiments such as jet velocity, total energy and wave frequency.

The Joint team of AIST, U. Tokyo, U. Wisconsin and Nihon Univ. started a joint NBI experiment to artificially inject plasma flow in the high-beta tokamak plasma equilibria. We experimentally tests plasma stability under plasma flow and found significant reduction of magnetic fluctuation due to the beam.

We also found the cause and mechanism for reconnection heating using detailed 2-D ion/ electron temperature measurement of merging tokamaks in TS-3 device. We found the magnetic reconnection heats plasma ions in the downstream of reconnection and electrons at X-point inside the current sheet. These results were published in Phys. Rev. Lett.

In Nov., our main papers in MR2010 were published successfully in Physics of Plasma, Special Issue. As for young scientist's activitires, we used young scientists and students as main leaders of our joint research program, after our careful schooling in each institutes. Our program of overseas education activated a varieties of researches of young scientists, causing their winning prizes, such as IEEJ, Plasma Conference 2011 etc.

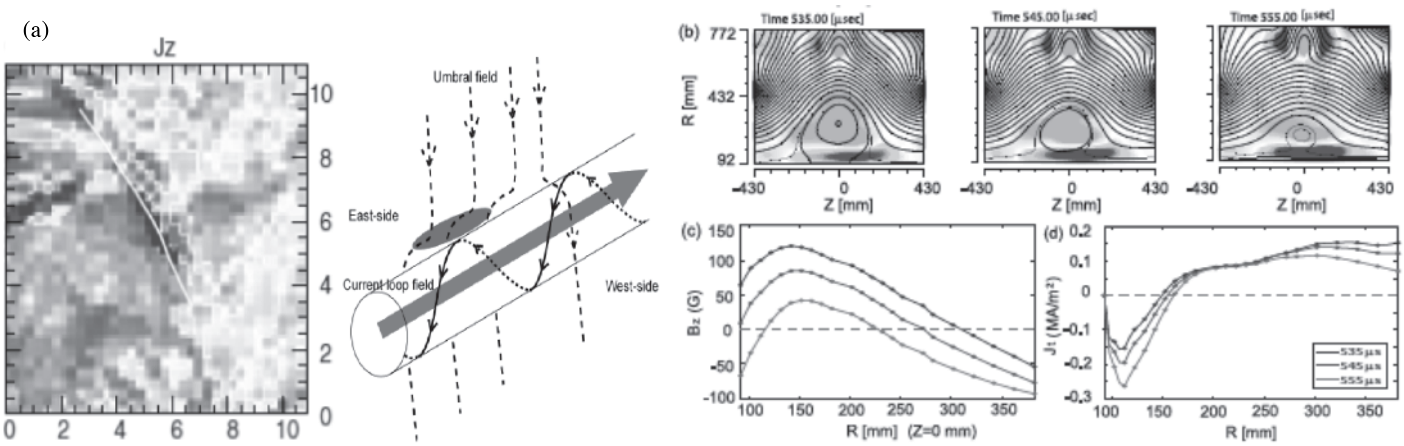

Fig. 1 (a) Light-Bridge phenomenon observed at a sun spot (left) and its most-probable field-line structure (right). (b) Snapshot images of spheromak and OH field. Thick contours show magnetic field lines at regular intervals and thin contours are complementary to emphasize reconnecting field lines. Color bar indicates toroidal current density measured by the 2D magnetic probes. (c) The radial profile of *Bz* component and (d) the toroidal current *Jt* on the mid-plane