

FY2013

JSPS Core-to-Core Program
-Strategic Research Networks-
Research Report

Project No.	22001
Research Theme	Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas
Duration of Project	2010.4. 1 – 2015.3.31
Core Institution in Japan	Graduate School of Frontier Sciences, University of Tokyo

Implementing Organizations

Country	Japan
Core Institution	Graduate School of Frontier Sciences, University of Tokyo
Co-Chair (name and title)	Yasushi ONO, Professor
Number of Cooperating Institutions	5
Cooperating Institutions	Advanced Industrial Science and Technology National Astronomical Observatory of Japan Japan Aerospace Exploration Agency National Institute for Fusion Sciences Kyoto University

Country	United States of America
Core Institution	Princeton Plasma Physics Laboratory, Princeton University
Co-Chair (name and title)	Hantao JI, Principal Research Physicist
Number of Cooperating Institutions	9
Cooperating Institutions	University of Wisconsin University of Washington University of Chicago Swarthmore College University of New Hampshire University of Alabama Stanford University George Mason University University of California, Los Angeles
Matching Fund	COE Project: Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas (CMSO)

Country	Italy
Core Institution	Padova University
Co-Chair (name and title)	MARTIN Piero, Professor
Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	Research on the Self-Organization of Magnetic Field in Laboratory Plasmas

Country	United Kingdom
Core Institution	Culham Laboratory
Co-Chair (name and title)	GRYAZNEVICH Mikhail, Principal Research Physicist
Number of Cooperating Institutions	1
Cooperating Institutions	University of London
Matching Fund	Tokamak Science

Country	Bundesrepublik Deutschland
Core Institution	Max Planck Institute for Solar System Research
Co-Chair (name and title)	SOLANKI Sami K., Principal Research Physicist
Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	Base research funds

Country	Spain
Core Institution	Instituto de Astrofísica de Canarias
Co-Chair (name and title)	TRUJILLO BUENO Javier, Professor

Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	Base research funds

Result of Program Implementation

In fiscal year 2013, our CMSO (Center for Magnetic Self-Organization) group hosted 153 foreign researchers and sent 30 research staffs/ students to MAST (UK), MRX (US), MST (US), RFX (Italy) groups and two solar observation groups for joint studies of magnetic reconnection and self-organization and solar/ space observations. For magnetic reconnection study, we sent 9 members to the world largest reconnection experiment: MAST including 4 long-term trips and installed the 2D Doppler ion temperature diagnostics. We made clear 1) the ion heating in the downstream and electron heating at the X-point during reconnection and 2) their interaction forming triple peaked temperature profiles of ions and electrons after reconnection. We also sent 2 members for long term to MRX to measure 3) magnetic and electrostatic fluctuations inside the current sheet and to check 4) the guide field effect on the negative potential well in the downstream. The UTST (U. Tokyo) found 5) the high-energy electrons localized at X-point inside the current sheet. For self-organization study, we sent 3 and 2 members to MST and RFX for 6) the extended active control of plasma self-organization using pellet injection, inductive electric field and Neutral Beam Injection (NBI). We found 8) formation of new helical equilibrium together with 9) the suppression of magnetic self-organization. As for On-site self-organization study, we started 10) multi-wavelength observations of solar coronal/ chromosphere activities by Hinode and IRIS satellites. We developed 11) a new style of spectroscopic data analyses from those satellites together with Max Planck Institute and Instituto de Astrofísica de Canarias and extended 12) the laboratory-simulation of light-bridge to the plasmoid formation. As for our seminars, we hosted two important conferences: IPELS2013 at Nagano and Hinode7 at Gifu to review the advanced researches of magnetic self-organizations. The IPELS with attendees over 100 focused on the interrelationship between laboratory experiments, solar/magnetosphere/astrophysical observations and the Hinode7 with attendees over 200 did on the magnetic self-organization in the sun. These activities promoted the joint research of magnetic self-organization among laboratory experiment, observation and theory in Japan, US and Europe, recently also in Asia.

Achievements in FY2013 (Self Review)

In fiscal year 2013, our CMSO team successfully hosted two core meetings: IPELS 2013 for general magnetic self-organization and Hinode 7 for on-site solar self-organization and one plasma school for graduate and undergraduate students. Our collaborative plasma research among laboratory experiment, extended astrophysical/ solar observations and theory/simulation took an initiative in those meetings as a new trend of plasma researches. The number of attendees were over 100 in IPELS, over 200 in Hinode and over 100 in the school. Our three core meetings: MR, IPELS and Hinode are already the top quality meetings in the field of reconnection, self-organization and solar observations, respectively. We also successfully published major papers of our MR2012 conference (at Princeton 2012) as a special issue "Advances in Magnetic Reconnection Research in Space and Laboratory Plasmas -Part II) of Physics of Plasmas (Vol. 20, No. 6). This special issue is the second one after the first special issue (Physics of Plasmas Vol. 18, No. 11) from major papers from MR2010.

As for joint researches, the MAST(UK)-TS(UTokyo) collaboration successfully measured 2D contours of ion and electron temperatures: the ion heating in the downstream and electron heating at the X-point during reconnection and their triple peaked temperature after reconnection by using the system of 2D Doppler tomography spectroscopy moved from U. Tokyo. The laboratory-simulation collaboration successfully controlled magnetic reconnection/ self-organization in MST using NBI and ice pellet injection. On-site self-organization study of the sun started the multi-wavelength observations, a new style of spectroscopic data analyses and extended the laboratory-simulation of light-bridge into that of plasmoid formation. Based those results, we wrote several invited/ selected papers such as a IAEA FEC2014 paper in addition to 20 invited talks (MR, IAEA etc.) and over 70 publications (Astrophys. J., Phys. Plasmas etc.). As one of the most outstanding progress, we COE members wrote a series of tutorial papers "Overview and Prospect-Frontier Researches in Magnetic Reconnection-" (94 pages) in J. Plasma Fusion Res. Vol.89, No.11 and 12 (2013), as a summary of our recent reconnection researches. We are also requested to publish a tutorial paper of our solar simulation experiments such as the solar light-bridge and the plasmoid in the Astronomical Herald as a new type of joint solar physics research after reported in several newspapers.

As for young scientist's activities, our international and interdisciplinary joint-researches encouraged young students and scientists to study abroad. Our young CMSO Seminars and organized schooling system help them to make successfully the international and interdisciplinary joint-research, causing their winning prizes IEEJ. The plasma schools significantly contributed to the interdisciplinary plasma education for undergraduate. young graduate students and also to extending our international and interdisciplinary joint-researches to the other Asian countries because of over 40 plasma school attendees from China, Korea and Taiwan.

Future Plan (Measures toward Achieving Research Objectives)

In the fiscal year 2014, our primary research subjects will be 1) to find the kinetic interpretation of magnetic reconnection and self-organization, which turned out to be the key last year and also 2) to complete merging/ reconnection heating of torus plasmas as the first application study. We will conclude 3) the whole energy conversion process of reconnection and 4) major fast reconnection mechanisms as a key process of self-organization and finally 5) to bridge the magnetic reconnection to the magnetic self-organization through formation of magnetic configurations. We, interdisciplinary CMSO team will make detailed comparisons of reconnection and self-organization among experiments, solar/ space observations and theory/ PIC simulations to conclude their kinetic/ MHD interpretations. The application study of reconnection and astrophysical observations are new frontiers for reconnection/self-organization research, leading us to new styles of collaboration and workshop. It is also important to make active control of reconnection and self-organization in TS, MST(US) and RFX(Italy) using neutral beams, pellet/ gas injection and induction. As for seminars, we will host the MR2014 conference for interdisciplinary reconnection research also for extension of reconnection to self-organization. The Hinode 8 workshops will solve wider one-site problems of solar and astrophysical self-organizations finally for interpreting self-organization by reconnection. We are planning to have the Young CMSO Seminar for three times for education of young scientists and students and will encourage them to study abroad timely in the most suitable research team of magnetic self-organization.