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FY2014

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	Advancecd 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 Laboraotry 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 2014, our CMSO (Center for Magnetic Self-Organization) group hosted 86 foreign researchers and sent 43 research staffs/ students to NSTX (US), MRX (US), MST (US), MAST (UK), RFX (Italy) groups and two solar-diagnostics groups for new measurements of solar reconnection and self-organization. For magnetic reconnection study, we sent two members both to the world largest reconnection experiments: NSTX and MAST including two long-term trips for their Doctor thesis. In NSTX, we developed 1) the first fusion reactor study using merging/ reconnection heating as effective plasma startup and found a new type of economic high-beta ST reactor design with low magnetic field and moderate reactor size. In MAST, we compared the heating characteristics of on and electrons with PIC simulation results developed by NIFS, Japan. Both agrees that the downstream heating of ions by reconnection outflow and the strong heating of electrons inside the current sheet but the localized electron heating at the X-point was observed only in MAST probably due to some other electron acceleration mechanism. We also sent one members to MRX to solve the guide field effect on the negative potential well formation in the downstream. The UTST (U. Tokyo) hosted about three members from MRX and MST to solve how the bright HeII plasma light emission with the high-energy electrons is formed inside the current sheet and the strong ion heating in the downstream. For self-organization study, we sent four and two members to MST and RFX to study the most effective Neutral Beam Injection (NBI) for the active control of plasma self-organization. We studied the threshold energy to suppress magnetic self-organization using helical eqilibria. As for On-site self-organization study, we sent one members to Instituto de Astrofísica de Canarias to study the most advanced measurements of chromosphere magnetic field using non LTE radiation transport by Hida (Kyoto) and Canary Island observatory. We also sent another members to the Max-Plank Institutes for the high resolution measurement of solar coronas and its application. We also studied the laboratory-simulation experiment of the jet during the light-bridge formation, finally publishing a new review paper of the Astronomical Herald 2014. As for our seminars, we hosted two important conferences: MR2014 at Univ. Tokyo and Hinode8 at Portland, US to review the most recent researches of solar magnetic self-organizations. The MR2014 with attendees over 90 focused on the reconnection study by laboratory experiments, solar/magnetosphere/astrophysical observations and the Hinode 8 with attendees over 210 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. We also sent three members to Asian plasma school to give lectures of interdisciplinary plasma physics for the purpose of extending our CMSO activities to Asia.

Achievements in FY2014(Self Review)

In fiscal year 2014, our CMSO team successfully hosted the core meetings: MR2014 for general magnetic reconnection physics and its tutorial for graduate students and also had Hinode 8 in US for on-site physics of solar self-organization. The number of attendees were over 90 in MR2014 and over 200 in Hinode. Thoughout five year's activities, we successfully upgraded our interdiciplinary research of magnetic reconnection/ selforganization from a new trend into one of the main streams in plasma physics, because our three core-meetings: MR, IPELS and Hinode are already the top meetings in the field of reconnection, self-organization and solar observations, respectively. We are now correcting major 10 papers of our MR2014 conference to publish them as a special issue "Advances in Magnetic Reconnection Research in Space and Laboratory Plasmas -Part III) of Physics of Plasmas. This special issue is the third one after the first special issue I (Physics of Plasmas Vol. 18, No. 11) from major papers from MR2010 and the second special issue II (Physics of Plasmas Vol. 18, No. 6).

As for joint researches, the NSTX(UK)-TS(UTokyo) collaboration successfully designed the first spherical tokamak (ST) reactor with reconnection heating together with its new type of design with low magnetic field and reasonably large size. The MAST(UK)-TS(UTokyo) collaboration was extended to comparison of its ion heating in the downstream and electron heating at the X-point with PIC simulation results made in NIFS. Both agree the down-stream heating of ions but its localized electron heating at the X-point and the electrostatic potential well formation in the downstream needs more detailed comparison. The neutral beam injection to RFP plasma was further studied to find out its suppression mechanism of magnetic selforganization in MST. We studied the threshold energy to suppress magnetic self-organization using helical eqilibria. On-site self-organization study summarized high resolution measurements of solar coronas and the most advanced solar plasma diagnostics. The Kyoto) and Canary Island observatory developed the magnetic measurements of chromosphere using non LTE radiation transport and Hanre effect. The laboratory-simulation of solar plasma demonstrated plasma jet formation in the light-bridge and published its review paper the Astromical Herald. We started the new simulation experiment of plasmoid formation, finding impulsive increase in reconnection speed by the plasamoid ejection. Based those results, we wrote several invited/ selected papers such as a Physics of Plasma invited paper in addition to 15 invited talks (MR, IAEA etc.) and over 70 publications (Astrophys. J., Phys. Plasmas etc.).

As for young scientist's activities, our international and interdisciplinary joint-researches encouraged young students and scientists to study abroad. More than two Doctor course students wrote their thesis using the joint research with the NSTX team in US and with the MAST team in UK. Our MR2014 meeting had a special tutorial session for young scientists and its international and interdisciprinary exchanges of young scientists finally cause winning several prizes: IEEJ Award for Young Scientists, Hinode 8 Student Poster Award and Young Scientist's Award of Plasma Conference 2014, Dean's Award of Univ. Tokyo etc. We are also extending our interdisciplinary plasma education to East Asia countries by sending our members to the forth East Asian Plasma School in China.

Future Plan (Measures toward Achieving Research Objectives)

The last year for the five year's program of Core-to-Core 22001