JSPS Core-to-Core Program
FY2014 Implementation Plan (Project No. 23002)

Research Theme Non-equilibrium dynamics of soft matter and information

Duration of Project 1 April, 2011～ 31 March, 2016 (60 months)

Core Institution in Japan (Co-Chair) Graduate School of Science, Kyoto University
(Prof. Shin-ichi Sasa)

Implementing Organizations

○ **Japan**

Japan	Core Institution	Graduate School of Science, Kyoto University	
	Co-Chair (name and title)	Shin-ichi Sasa, Professor	
	Cooperating Institutions	Univ. of Tokyo, Kyoto Univ., Tohoku Univ., Ochanomizu Univ., Chiba Univ., Kyushu Univ., Tokyo Metropolitan Univ., Waseda Univ., Nagoya Univ., Osaka Univ., Tokyo Institute of Technology	Number of Cooperating Institutions: 11

○ **Partner Countries**

Germany	Core Institution	Heinrich-Heine University Dusseldorf	
	Co-Chair (name and title)	Hartmut Loewen,Professor	
	Cooperating Institutions	Max-Planck Institute Mainz, Heidelberg University, University of Konstanz, Fritz Haber Institute, University of Stuttgart, Ludwig-Maximilians University of Munich, University of Magdeburg, University of Bayreuth, Physikalisch-Technische Bundesanstalt, Forschungszentrum Jülich, University of Göttingen, Institute of Materials Physics in Space, Technische Universität Berlin	Number of Cooperating Institutions: 13

France	Core Institution	Atomic Energy Commision	
	Co-Chair (name and title)	Hugues Chate, Senior Scientist	
	Cooperating Institutions	École Normale Supérieure, LPTMS, ESPCI, Institut Curie, Université Paris 6, Université Paris 7	Number of Cooperating Institutions: 6

Objectives of Research Exchange (including the five years after the project finishes)

By performing the Integrated Action Initiative Project, to elucidate a rich variety of behaviors that soft matters exhibit has turned out to be really significant. Thus, our basic concept is to develop researches of systematic understanding of structure fluctuation and dynamics of soft matters. On the other hand, through the communication of the project, it has been recognized that information theoretical quantities naturally appear in the law of non-equilibrium fluctuations and that theoretical techniques for analyzing glassy dynamics are also useful in information sciences. In the Strategic Research Network Project, the research topics of information are explicitly placed on one side in addition to the topics of soft matters on the other side, and then these apparently unrelated topics are combined by researches with key concepts of non-equilibrium fluctuation and dynamics. As a result, new aspects in physics will be opened up.

During five years after the Strategic Research Network Project, a design principle of soft matters that exchange information will be constructed on the basis of the fundamental law of physics. This is obviously related to more general subjects on the physical description of biological functions. Toward the understanding of them, the long term project will progress with the synergy of matter and information by non-equilibrium.

Results to the present

In order to perform collaboration works, 16 researchers visited Germany and French. Three seminars were conducted as the result of discussions mainly among the coordinators. These aim at having a wider communication than the personal collaborations. Concretely, the seminar entitled with “Joint seminar on statistical physics” was held from October 21 to October 24 at Kyoto, the seminar “Engineering chemical complexity ” was held from June 10 to June 13 at Rostock-Warnemunde , Germany, and the seminar with “Information statistical dynamics” was held from September 30 to October 11 at Les Houches, France. In researchers’ communication, young researchers such as graduate students stayed for a long term, where the purpose is the education of graduate students through the experience of collaboration works.

Some achievements in the research are summarized as 43 papers (including unpublished 17 papers) on soft matter dynamics of liquid crystals and colloids, slow dynamics of glassy systems, active dynamics of self-propelling particles, and dynamics related to information processing. Thirteen presentations in international workshops and eleven presentations in domestic symposiums were done, respectively. Here, it is noted that many researchers have presentations without explicit mentioning their grants and that the total number of members’ presentations on the topics of this program is 112. Another important achievement than publications is the success in the announcement of this program. In particular, participants from Asian countries expressed strong interest in the research program connecting soft matter with information. This is important for the establishment of the research center.

Summary of FY 2014 Exchange Plan

Joint Research

There are four groups, each of which addresses the joint research plan.

First, the soft matter group studies the cross coupling between internal degrees of freedom and transportation phenomena for various soft matters, theoretically and experimentally, with respecting features of three countries.

Second, slow dynamics group extracts a universal picture behind colloids, super-cooled liquids, and spin glasses with the key word slow dynamics as well as understanding of each phenomenon.

Third, the active dynamics group, theoretically and experimentally, studies nano-machines working at the single molecule level, active matter such as living cells, active colloids, granular matter, synchronization, waves, and pattern formation of chemical reactions, from the viewpoint of active dynamics.

Finally, the information dynamics group develops a statistical mechanical method for information processing, formulates non-equilibrium dynamics including information exchange, and considers rare-event sampling from non-equilibrium statistical mechanics.

Seminar

Seminars are planned in France and Japan.

First, on August 26 – September 4, Cargese, France, "Spin glasses: An old tool for new problems" is planned. A spin glass theory, which emerged from the study of disordered magnetic materials, is now applied to a wide class of complex problems from life sciences and information sciences. In the seminar, participants will exchange the novel concepts and techniques that are recently discovered and also discuss new area of the application. As a result, interdisciplinary researches connecting soft-matter and information will be developed further.

Second, on February 8 -21, in Kyoto, Japan, the meeting on active matter and non-equilibrium fluctuation is planned with aiming at increasing communication among young researchers in France, Germany and Japan. This meeting consists of tutorial lectures, the intensive workshop, and presentation by young researchers. Senior researchers as well as Ph. D students from France, Germany and Japan will be mixed in a well-balanced manner.

Researcher Exchanges

In order to develop the communication initiated so far and start new collaborations, Ph D students and young researchers visit France and Germany for 530 days as a whole. In particular, five students and eleven students, who stay in Germany and France over the one month, are the kernel of the communication among countries.