

**JSPS Core-to-Core Program**  
**FY2015 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,	Number of Cooperating Institutions  13

France	Core Institution	Atomic Energy Commission	
	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

Here, I describe the results in the term from 2014.4 to 2015.3.

In order to perform collaboration works, 20 researchers visited Germany and French. Two 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 “Frontiers of Statistical Mechanics: from Non-equilibrium Fluctuation to Active Matter” was held from February 4 to February 17 at Kyoto, and the seminar with “Spin Glasses: An old tool for new problems” was held from August 25 to September 6 at Cargese, 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 50 papers (including unpublished 14 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. Fifty one presentations in international workshops and domestic symposiums were done. 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 142. Another important achievement than publications is the success in the informal communication among young researchers who participate in the two seminars. This will play an important role on the establishment of the research center.

## Summary of FY 2015 Exchange Plan

### **Joint Research**

In the last year of this program, we intentionally attempt to publish papers as the result of communication among members in the three countries. Furthermore, the members discuss the way how to continue the cooperative system on the basis of the review our achievement. Joint research is basically done by the continuation in the last two years. That is, 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**

First, on June 22 – June 26, Munchen, Germany, toward understanding of the interface between chemical reaction and non-equilibrium dynamics, which includes self-organized phenomena of active matters and cells, control and design of complex chemical systems from macroscopic chemical reactors to one molecule reaction is focused on.

Second, on August 11 -14, in Kyoto, Japan, the meeting on non-equilibrium physics of glassy materials is planned. Core members of this program present their achievements and confirm the results to the present. We also have discussion on the cooperative system after this program.

### **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 477 days as a whole. In particular, four students and nine students, who stay in Germany and France over the one month, are the kernel of the communication among countries.