JSPS Core-to-Core Program
FY2013 Implementation Plan (Project No.:２１００２)

Research Theme Establishing an International Collaboration Platform for Strangeness Nuclear Physics by Electron Beams

Duration of Project 2011/4/1~2014/3/31 (36 months)

Core Institution in Japan (Co-Chair) Graduate School of Science, Tohoku University
(Hirokazu Tamura)

Implementing Organizations

○ **Japan**

Japan	Core Institution	Graduate School of Science, Tohoku University	
	Co-Chair (name and title)	Hirokazu TAMURA (Professor)	
	Cooperating Institutions	Research Center for Electron Photon Science, Tohoku University; High-energy Accelerator Research Organization; Yamagata University, Osaka Electro-Communication University, RIKEN Nishina Accelerator Center; Advanced Science Research Center, Japan Atomic Energy Agency	Number of Cooperating Institutions: 6

○ **Partner Countries**

USA	Core Institution	Thomas Jefferson National Accelerator Facility (JLab)	
	Co-Chair (name and title)	Liguang Tang, Staff Scientist (Professor, Hampton Univ.)	
	Cooperating Institutions	Hampton University, Florida International University, University of Puerto Rico	Number of Cooperating Institutions: 3

Germany	Core Institution	Institute for Nuclear Physics, Mainz University	
	Co-Chair (name and title)	Josef POCHODZALLA (Director, Professor)	
	Cooperating Institutions	Giessen University	Number of Cooperating Institutions: 1

Italy	Core Institution	INFN Rome	
	Co-Chair (name and title)	Franco GARIBALDI (Professor)	
	Cooperating Institutions	INFN Bari, Universita di Torino, INFN Torino	Number of Cooperating Institutions

			3

Czech	Core Institution	Nuclear Physics Institute, Academy of Science of Czech	
	Co-Chair (name and title)	Petr BYDZOVSKY (Staff Scientist)	
	Cooperating Institutions		Number of Cooperating Institutions
			0

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

Based on the international collaboration of the hypernuclear spectroscopy with electron beams, Tohoku University drove two collaborative researches with Jefferson Lab (USA), Mainz University (Germany), INFN Rome (Italy) and theoretical division of NPI (Czech): namely, 1) spectroscopic study of Lambda hypernuclei with electron beams and 2) study of the strangeness nuclear physics with photon and electron beams.

Using analysis results of JLab experiments, a new experiment setup was designed and serious simulation works were performed. The collaboration is preparing a new proposal which includes various research projects from the elementary process to heavy hypernuclear spectroscopy at JLab in 12GeV era.

Concurrently with design works for future programs, existing resources at Mainz University are fully utilized to establish a novel experimental technique, decay pion spectroscopy of electric-produced hypernuclei. It was tested at the MAMI-C electron machine at the Mainz University. We are now trying to establish the principle of the experiment. With the upgraded Kaos spectrometer, a study of the electro-production of strangeness with liquid hydrogen target was carried out.

With flexible beamtimes at Mainz, feasibility study and pilot experiments were performed to establish and extend the hypernuclear study with electron beams. At future JLab, with the excellent beam and spectrometers, full potential of these research techniques will be explored.

At ELPH-Tohoku, a research of the photo-production of strangeness is also in progress. The activities are now extended to MAMI-C, Mainz under this core-to-core program. Understanding of the elementary process will help the analysis of Lambda hypernuclear electro-production mechanism. Based on the establishing international research network, new information about the detailed structure of Lambda hypernuclei and Lambda-Nucleon interaction will be obtained and our knowledge about the baryon force will be deepened.

Results to the present

Our first reliable measurement of the binding energy of $^{7}_{\Lambda}$He hypernucleus triggered lots of discussion about the Charge Symmetry Breaking (CSB) effect of the Lambda-Nucleon interaction.

International conferences at ECT*, Trento, at JLab, Newport News and at Barcelona, Spain were organized under this program. The international school for strangeness nuclear physics (SNP school 2012 and 2013) were successfully performed at Tokai and Sendai, Japan. Based on these activities, a new proposal of new hypernuclear programs in 12GeV era at JLab was prepared. At Mainz, a series of the feasibility studies of a novel decay pion spectroscopy of electro-produced hypernuclei were carried out. Preliminary analysis shows quite promising peak structure of $^{4}_{\Lambda}$H which is quite important for understanding of the CSB effect of the ΛN interaction.

Agreement on academic exchange program between graduate school of science, Tohoku University and Faculty of physics, mathematics and computer science, Mainz University was established based on our active collaboration.

Summary of FY 2013 Exchange Plan

Joint Research

Data of hypernuclei in wide mass range accumulated at JLab will be analyzed under the international collaboration. Now analysis is in final phase. Based on the achieved result, a new proposal will be compiled by a new collaboration which includes former HKS-HES and Hall-A hypernuclear collaborations.

At Mainz Univ., a test beamtime for GEM detector development will be performed in early summer and a beam time of the decay pion spectroscopy of hypernuclei is planned in winter. A study of the elementary strangeness electro-production is studied based on JLab result and new measurement is planned at Mainz. When ELPH-Tohoku will provide beam for the first time after recovery from the earthquake's damage, we will submit a new proposal to carry out the experiment on the photo-production of $K^0\Lambda$.

Seminar

The 9th JSPS core-to-core seminar (Strangeness Nuclear Physics and Astrophysics) will be jointly performed with SPHERE EU seminar in collaboration with the international conference on nuclear fragmentation (NUFRA2013) at Kemer, Turkey from 29th Sep. to 5th Oct. NUFRA2013 features hypernuclear physics, nuclear fragmentations and astro-physics. The JSPS-core-to-core & SPHERE seminar put stress on young researchers' presentation.

Another seminar (Study of Lambda Hypernuclei with Electron Beams) will be carried out at Czech Science Academy, NPI-Rez. The strangeness photo-production processes and hypernuclear physics will be discussed in terms of experiments and theories.

To encourage young researchers, an international school of strangeness nuclear physics (SNP School 2014) will be carried out at Tokai and Sendai in Feb, 2014. This is the continuation of the successful SNP School 2012 and 2013.

Researcher Exchanges

An invited plenary talk on "strange light nuclei" at the international nuclear physics conference (INPC2013, 2-7 June 2013) was given at Firenze, Italy.

An oral presentation on MPPC counter will be given at IEEE NSS/MIC/RTSD conference (Soeul, Korea, 27 Oct – 2 Nov 2013).