RIBF ULIC Symposium/mini-WS Report

* English only

Date: 2024/05/20

Name of Applicant	Kenichi Yoshida		
Affiliation	RCNP, Osaka Univ.	e-mail	kyoshida@rcnp.osaka-u.ac.jp
Tel	06-6879-8947	Fax	

Title	[RIBF-ULIC- :]
Date	16 May, 2024
Place	Nishina hall
Language	[ ] English [○] Japanese
HP address	
Contact Person(s) (Name, Affiliation)	K. Yoshida (RCNP), Y. Hirayama(KEK), T. Naito(RIKEN), H. Ishiyama(RIKEN)

Financial support from ULIC (Users Office Use Only)	Total : JPY
	[Breakdown]
Co-hosting / any financial support from other organization(s)	No

Summary of discussions and its (expected) results:

KISS is the only facility capable of performing laser nuclear spectroscopy experiments on high-melting-point elements. Systematic laser nuclear spectroscopy is conducted for atomic nuclei such as Pt, Re, and W to study their shape changes. The theoretical interpretation of these experimental results involves discussions with researchers who utilize Density Functional Theory (DFT). Additionally, KISS is considering the introduction of a high-resolution collinear laser resonance ionization spectroscopy apparatus to further investigate nuclear structure around N=126 and in the vicinity of uranium. These results will contribute to precise half-lives and mass predictions for neutron-rich nuclei, and discussions were held regarding how to provide feedback to nuclear models. This mini-WS served as an opportunity to establish close collaborative relationships for studying nuclear structure in heavy regions and connecting it to the r-process understanding.

Participants list(Name, Affiliation):

K. Yoshida (RCNP), Y. Hirayama(KEK), T. Naito(RIKEN), H. Ishiyama(RIKEN), H. Nakada(Chiba Univ.), N. Hinohara (Tsukuba), M. Mukai(KEK)

Report of mini-WS :
How can laser spectroscopy at KISS contribute valuable insights to nuclear models?

There were two oral presentations on KISS experiments and four oral presentations on DFT(MFT) calculations. Detailed presentations were given on theoretical models and interactions, and discussions were held on how to provide feedback on the understanding of nuclear structure from experimental results of laser nuclear spectroscopy, half-life measurements, and mass measurements. Below are short summaries of each presentation.

Hirayama: An overview of the KISS project was presented, and it was discussed how feeding back precise laser nuclear spectroscopy results into DFT theory could achieve precise predictions of mass and half-life for N=126 waiting-point nuclei, which are difficult to reach experimentally, and make a progress towards elucidating the explosive astrophysical environment of the r-process. The latest laser spectroscopy results of rhenium isotopes obtained from KISS were presented, and discussions were held on what calculations are possible to theoretically understand the nuclear structure from the obtained nuclear spins and magnetic moments.

Yoshida: In DFT calculations, it is possible to calculate the properties of atomic nuclei in heavy regions such as the vicinity of N=126 and the vicinity of 238U. Generally, Skyrme-type EDFs are constructed based on even-even nuclei and widely used, but there is significant uncertainty in the dependence on time-antisymmetric densities such as spin density, which is essential for calculating the properties of odd-odd nuclei. The values of beta-decay half-lives and magnetic moments can impose restrictions on these time-antisymmetric terms, potentially greatly reducing uncertainty. DFT calculations also consider first-forbidden transitions and have been successful in predicting beta-decay half-lives.

Naito: Based on a careful explanation of the basic concepts of DFT calculations, the importance of model and interaction selection and construction was stated. For a systematic understanding, including the kink in charge radii obtained from laser spectroscopy, it is necessary to consider many origins such as symmetry energy and spin-orbit interactions. The values of radii and magnetic moments are important for determining the appropriate EDF.

Nakata: By improving the EDF from mean-field calculations using the information on magnetic moments, Q moments, and charge radii obtained from laser spectroscopy, it is possible to lead to precise calculations of mass and half-life for neutron-rich nuclei. Using the interaction M3Y-P6 allows accurate calculation of magic numbers across the entire nuclear chart. Comparing the values of magnetic moments with experimental values, there are nuclei with significant discrepancies, indicating that quenching of magnetic moments is occurring. Understanding the time-antisymmetric term is essential.

Hinohara: A presentation was given on the systematic calculation of parameters of the isovector EDF (time-antisymmetric term) of the Skyrme EDF, introducing which physical quantities affect which parameters. If restrictions can be imposed on the C1S, C1ΔS terms of the time-antisymmetric term from the experimental values of magnetic moments, there is potential for improved accuracy in half-life predictions.

Mukai: Based on the results of laser spectroscopy of iridium and tungsten isotopes conducted by KISS, comparisons with theoretical calculations are being made to understand the nuclear structure. Discussions were held on these calculation results. In addition, systematic precision mass measurements showed discrepancies from AME2020 for 190W and 192Re. Discussions were also held on the possibility of gaining new insights, such as deformation, from theoretical calculations.

Through this workshop, it is expected to build a close research cooperation system and advance nuclear structure research in heavy regions at KISS.