RIBF ULIC Symposium/mini-WS Report

*** English only**

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Title	[RIBF-ULIC-Sym12 : X-ray objects and element synthesis]
Date	7/20 - 21
Place	Large Meeting room, RIBF bldg. 2nd-floor
Language	[ ] English [○] Japanese
HP address	http://www.cns.s.u-tokyo.ac.jp/ukakuren/ws/ws-22Feb2016.html
Contact Person(s) (Name, Affiliation)	Kentaro Terada, Osaka Univ., Hidetoshi Yamaguchi, CNS Univ. of Tokyo, Taketo Hayakawa, QST, Shunji Nishimura, RNC

Financial support from ULIC (Users Office Use Only)	Total : 405,500 JPY [Breakdown] Travel Expense and Accomodation for Participans: 368,540 Coffee and Snacks: 36,960
Co-hosting / any financial support from other organization(s)	Japan Forum of Nuclear Astrophysics

Summary of discussions and its (expected) results:

[Overview]

We have organized a meeting related to topics for nuclear astrophysics. Main subject of this meeting was focused on the physics relevant to “X-ray objects and element synthesis”. The workshop has a characteristic of having interdisciplinary fields, where coherent efforts from nuclear physics, astronomy, astrophysics, and cosmo-chemistry are essential to entangle the unsolved mysteries for the X-ray objects, γ-ray bursts, neutron star (NS), NS-NS merger , supernovae, BigBang, and nucleosynthesis in such extreme environments. The goal of the workshop is to discuss the recent results, future plan, and to form new collaborations by getting together scientists in frontier of each research field. We have prepared 7 sessions with dedicated conveners as followings.

(a-1) Physics of neutron stars with X-ray observatories (Tamagawa, RIKEN),
(a-2) Neutron star mergers, gravitational wave observatories, and nucleo-synthesis (Nagataki, RIKEN),
(a-3) Meteorites and other extraterrestrial materials (Terada, Osaka Univ.),
(a-4) Nuclear data in terms of nuclear astrophysics (Iwamoto, JAEA),
(b-1) Status of underground laboratories for astrophysics (Shima, RCNP),
(b-2) Nuclear physics experiments concerning to the dark matter and nucleosynthesis (Yamaguchi, CNS),
(b-3) Dark matter and nuclear-neutrino reactions (Kajino, NAOJ).

We had 20 invited speakers and 15 oral speakers. Thanks to great support from the ULIC, we could organize the meeting with many stimulating talks from different research fields. We could share the great progresses in observations, experiments and theories with the fruitful results from RI-beam facilities, innovations in observatories for X-rays and gravitational waves. In each session, we had short review by

the corresponding convener to make smooth connections among different research fields.

In the end, more than 70 participants including many young researchers from various fields have joined together. This workshop could successfully give nice trigger to form new collaborations between nuclear physics and astrophysics communities and will broaden the scientific activities of nuclear physics using the radioactive isotope beam in future.

[Highlights]

One of key subjects in this meeting is a physics of neutron stars (NS) and neutron star mergers (NS mergers). We have heard present status for determining static properties (such as mass and radius) and dynamic properties (such as rotation with magnetic field) of NS and NS mergers probed by X-rays, gravitational waves, and future's supernova neutrinos. A point to be noted here is a preliminary result of X-ray astronomical observation for heavy elements with Monitor of All-sky X-ray Image (MAXI) in the satellite. They observe the energy spectra of photons from X-ray busters. In the energy spectra, there is a candidate for the absorption of heavy elements such as Ni, Zn, and Ge, which were suggested to be a signature for the production of the rapid proton capture process (rp-process). In the rp-process, the successive proton induced reactions in neutron deficient site in high temperature environment occurs. However, the site and the mechanism for the rp-process have not been well known like ones for the r-process.

One of candidates for the astrophysical site of the rp-process is the surface of NS. By the accumulation of light elements such as hydrogen from the binary star, the rp-process in X-ray burst may occur, but there is no clear evidence for the rp-process in NS. If MAXI observes clear evidence, it would be an epoch making. However, this study requires the help of nuclear physics because the theoretical model for the rp-process requires quantitative nuclear properties such as masses, lifetimes, and reaction rates based on the experimental data. This is because the waiting point and termination point of the rp-process have not been established. It also is suggested that nuclear information concerning to the rp-process are important for understanding the light-curve and relevant physics of NS. Possibilities of direct observation of characteristic X-rays from heavy elements will make a hint for further studies of nuclear physics.

Another topics related to the BigBang nucleosynthesis are intensively discussed based on the nuclear reaction studies and recent progress of the astronomical observations for the first generation stars. Inconsistency of the lithium abundance between the standard model prediction and the observation of the cosmic microwave background radiation has still stimulated us. Actually there were two experimental results were reported on the ^{7}Be(α, n) cross sections by means of the inverse reaction method and Trojan-Horse method in the cm-energy range below 1 MeV. Those are agree to the model prediction, but largely different from the extrapolation of the neutron capture experiment. It may indicate this reaction pass can not help to the lithium depletion problem.

From astronomical point of view, a new program was introduced for exploring the early chemical evolution of the Milky Way with LAMOST and Subaru, where the spite plateau of ^{7}Li in very old stars is one of major issues. There also introduced new research proposal with using radioactive targets and polarized neutrons for studying the cosmos between the BigBang and the first generation stars.

On the other hand, we have heard that precise analyses of meteorites and on-going project for picking up extraterrestrial materials (HAYABUSA 2 project) give us important information for the cosmic history before the solar system formation and the early evolution state of the solar system in the frame of the galaxy evolution, where specific information of isotopic abundance relevant to the various synthesis scenarios play an important role. The isotopic abundance anomaly in rare-earth region has been investigated in viewpoint from the astrophysical site for the r-process: two candidates of supernova explosions and NS mergers.

The isotopic abundance anomaly is a shift from the standard isotopic abundance in the solar system. The previous studies for the primitive meteorite analysis show anomalies in some elements such as Os,

W, Hf, Ba, Nd, Pd, Ru, Mo, Zr, and Sr. They can be classified into two groups of relatively light elements which may originate from the weak r-process in supernova explosions and heavy elements which may be originate from NS mergers. The present status for the systematical analysis of the primitive meteorites suggests that the observed isotopic abundance anomalies should be explained by the coupling of the contribution from two different r-process sources and the mechanism of the early solar system formation. This shows the study of the r-process using RI-beam is also important for the cosmic history and the mechanism of the early solar system formation as well as the understanding the astrophysical site of the r-process.

Beside the study concerning the r-process, there are many important topics in Cosmo-chemistry related with the nucleosynthesis. One of key topics is the existence of various unstable isotopes at the time of the solar system formation. They are so-called “nuclear cosmochronometer”. If the initial abundance of the cosmochronometer at the solar system formation has been measured, with the theoretical perdition of its abundance produced by a single nucleosynthesis event, the passing time from the nucleosynthesis event to the solar system formation can be evaluated.

About 15-20 unstable isotopes are known as the chronometers. In this meeting, the recent results for three unstable isotopes ^{10}Be, ^{26}Al, and ^{92}Nb have been reported. One of possible astrophysical sites for ^{26}Al production is considered to the hot Hydrogen burning in Wolf-Rayet stars and massive stars. ^{26}Al is an important isotope. In fact, the nuclear experiment using RI-beam at CNS to produce ^{26}Al was proposed in this meeting.

In addition to above highlights, there were some talks on improvement of reaction theories, nuclear data, and nucleo-synthesis scenarios. We have heard that systematic study on fission mechanism has been started in US (named as FIRE collaboration) and will be so improved both in experimental and theoretical works in the rapid-neutron capture process. In the review talk of the astronomical studies with gravitational waves, challenging observation for NS and black hall mergers are introduced in connection to the element synthesis and nuclear equation of state. We have also heard that comprehensive mass measurements for thousands of nuclides can be available soon at this RIBF and present status for supernova relic neutrino search for solving the history of massive stars.

During this meeting, much of scientific information has been exchanged among different research fields. Actually we have succeeded to give some opportunities for starting new collaborations. New research plans for chemical evolution of heavy elements in galaxies and for the first generation stars have been discussed in this meeting.

Participants list(Name, Affiliation):

Tomokage Yoneyama, Osaka Univ.
Mutsumi Sugizaki, RIKEN
Wataru Iwakiri, RIKEN
Susumu Inoue, RIKEN
Kenichiro Nakazato, Kyushu Univ.
Kentaro Takami, Kobe Univ.
Masaki Ando, Univ. of Tokyo
Nobuya Nishimura, Kyoto Univ.
Ryota Fukai, Tokyo Inst. Tech. Univ.
Tsuyoshi Iizuka, Univ. of Tokyo
Shogo Tachibana, Hokkaido Univ.
Kohei Fukuda, Univ. of Tokyo
Tetsuya Yokoyama, Tokyo Inst. Tech. Univ.
Kentaro Terada, Osaka Univ.
Kazuyuki Ogata, RCNP
Yusuke Koshio, Okayama Univ.
Hirohiko Shimizu, Nagoya Univ.
Masaaki Kitaguchi, Nagaya Univ.
Atsushi Tamii, RCNP
Azusa Inoue, Osaka Univ.
Takahiro Kawabata, Kyoto Univ.
Hideki Shimizu, Univ. of Tokyo
Katsuhisa Nishio, JAEA
Seiya Hayakawa, CNS
Michiharu Wada, KEK
Kenji Mishima, KEK
Tatsushi Shima, RCNP
Sei Yoshida, Osaka Univ.
Wako Aoki, NAOJ
Shinichiro Fujimoto, Nat. Inst. Tech. Kumamoto

Takehito Hayakawa, QST
Toshihiko Kawano, Los Alamos Nat. Inst.
Satoshi Kunieda, JAEA
Yoshihiro Aritomo, Kinki Univ.
Nobuyuki Iwamoto, JAEA
Shigeru Kubono, RIKEN
Yasuhiro Togano, Rikkyo Univ.
Hiroari Miyatake, KEK
Kanji Mori, NAOJ
Hidetoshi Yamaguchi, CNS
Tadaaki Isobe, RIKEN
Yuki Honda, Tohoku Univ.
Shunji Nishimura, RIKEN
Kazuo Makishima, RIKEN
Masaki Sasano, RIKEN
Toru Motobayashi, RIKEN
Toru Tamagawa, RIKEN
Shigehiro Nagataki, RIKEN
Toshitaka Kajino, NAOJ
Toshio Nakano, RIKEN
Yuki Wada, RIKEN
Mizuki Nishimura, RIKEN
Megumi Kubota, RIKEN
Yasuo Yamamoto, RIKEN
Hideyuki Sakai, RIKEN
Tomoya Nagai, Tsukuba Univ.
Asami Hayafuji, RIKEN
Tomoya Harada, RIKEN
Hajime Togashi, RIKEN
Hiroshi Watanabe, Beihang Univ.
Megumi Shidate, RIKEN
Tomoyuki Wakabayashi, Univ. of Tokyo
Tamami Kitaguchi, RIKEN
Noritaka Shimizu, CNS
Yoshikazu Hirayama, KEK
Yutaka Watanabe, KEK
Keiji Matsui, Univ. of Tokyo
Akitsu Ikeda, RIKEN
Toshio Suzuki, Nihon Univ.
Mori Okumura, Tokyo Inst. Tech. Univ.
Kaneyuki Tanaka, RIKEN

(In total 21 institutes)

Scientific Program (in Japanese):

ULIC後援「X線天体と元素合成を中心とする宇宙核物理研究会」プログラム

2017年7月20～21日
理化学研究所 RIBF棟大会議室

7月20日

9:50	9:55	ULICからの挨拶	酒井英行	理研
9:55	10:00	はじめに	宮武宇也	KEK WNSC
		a-1 X線観測を中心とした中性子星の物理 (Cv: 玉川 徹)		
10:00	10:30	X線による中性子星の観測	牧島 一夫	理研
10:30	10:50	MAXIとNICERで迫るX線バースト天体におけるrp過程	岩切 渉	理研
10:50	11:05	X線連星パルサーの光度とスピン周期変化率の相関から探る中性子星の磁気、質量半径関係の検証	杉崎 睦	理研
11:05	11:20	XDINS からのkeV-X 線超過成分の発見	米山 友景	大阪大学
11:20	11:25	まとめ	玉川 徹	理研
11:25	11:45	(Coffee Break)		
		b-3 原子核—ニュートリノ反応、ダークマター (Cv: 梶野 敏貴)		
11:45	12:10	超新星背景ニュートリノ観測の現状と将来	小汐 由介	岡山大学
12:10	12:30	核物質状態方程式と超新星ニュートリノ	中里 健一郎	九州大学
12:30	12:50	超新星ニュートリノ過程におけるTc-98生成	早川 岳人	量子科学技術研究開発機構
12:50	12:55	まとめ	梶野 敏貴	国立天文台
12:55	13:55	(昼食)		
		b-2a 原子核実験—ビッグバン、元素合成反応 (Cv: 山口 英斉)		
13:55	14:10	元素合成に関連した核反応理論研究のいくつかの話題	緒方 一介	阪大RCNP
14:10	14:30	Time-reversal measurement of the p-wave cross sections of the 7Be(n,α)4He reaction for the cosmological Li problem	川畑 貴裕	京都大学
14:30	14:50	インプラント標的と高分解能スペクトロメータを用いた元素合成反応の測定計画	民井 淳	阪大RCNP
14:50	15:05	ビッグバン元素合成過程における7Be(d, p)反応のリチウム７問題への寄与の研究	井上 梓	大阪大学
15:05	15:20	J-PARCパルス中性子を用いた中性子寿命の精密測定	三島 賢二	KEK物質構造科学研究所
15:20	15:35	CRIBでの7Beビームを用いたビッグバン元素合成反応の測定	早川 勢也	東大CNS

15:35	— 16:05	(Coffee Break)		
		a-3 隕石分析 (Cv: 寺田 健太郎)		
16:05	— 16:35	はやぶさ２－近地球C型小惑星リュウグウからのサンプルリターン	橘 省吾	北海道大学
16:35	— 16:55	隕石構成物質のＬｉ－Ｂｅ－Ｂ同位体比から探るベリリウム10の起源	福田 航平	東京大学
16:55	— 17:15	隕石の同位体異常からひもとくr-核種の起源	横山 哲也	東工大
17:15	— 17:35	太陽系におけるニオブ92の初期存在量と分布	飯塚 毅	東京大学
17:35	— 17:55	隕石の希土類元素に見られるp核種の同位体不均質性	深井 稜汰	東工大
17:55	— 18:00	まとめ	寺田 健太郎	大阪大学
18:00	— 18:05	(Break)		
18:05	— 19:00	宇核連総会		
19:00	— 20:30	懇親会(RIBF棟 4F)		

7月21日

b-1 地下実験の進展、高エネルギー天体現象 (Cv: 嶋 達志)

9:00	— 9:25	ビッグバン元素合成とr-プロセスに関する天体観測	青木 和光	国立天文台
9:25	— 9:50	中性子を用いた時間反転対称性の研究	清水 裕彦	名古屋大学
9:50	— 10:05	中性子を用いた重力・ダークエネルギーの研究	北口 雅暁	名古屋大学
10:05	— 10:30	新学術領域・地下素粒子原子核研究の現状	吉田 斉	大阪大学
10:30	— 10:35	まとめ	嶋 達志	阪大RCNP
10:35	— 10:55	(Coffee Break)		
		a-2 中性子星衝突におけるEOS、重力研究、元素合成 (Cv: 長瀧 重博)		
10:55	— 11:25	中性子星合体と状態方程式・重力波（仮）	高見 健太郎	神戸高専
11:25	— 11:55	重力波観測の現状と今後	安東 正樹	東京大学
11:55	— 12:25	天体核反応率の不定性と元素合成への影響	西村 信哉	京都大学
12:25	— 13:30	(昼食)		

13:30 —	13:45	重力崩壊型超新星爆発におけるK合成および関連する核反応	藤本 信一郎	熊本高専
13:45 —	14:00	中性子星合体における r-process 元素合成の X 線分光診断に向けて	井上 進	理研
14:00 —	14:05	まとめ	長瀧 重博	理研
14:05 —	14:15	(Coffee Break)		
		a-4 核データの現状と課題 (Cv: 岩本 信之)		
14:15 —	14:55	核分裂核データに関する最近の話題について	河野 俊彦	ロスアラモス国立研究所
14:55 —	15:25	R行列理論に基づく核反応断面積評価手法の検討（仮）	国枝 賢	原子力機構
15:25 —	15:50	動力学模型を用いた核子移行反応と核分裂に関する理論的研究	有友 嘉浩	近畿大学
15:50 —	15:55	まとめ	岩本 信之	原子力機構
15:55 —	16:25	(Coffee Break)		
		b-2b 原子核実験—陽子過剰核 (Cv: 山口 英斉)		
16:25 —	16:40	放射化法による40Ca(α,γ)44Ti反応断面積測定	嶋 達志	阪大RCNP
16:40 —	16:55	X線バースト、超新星初期の爆発的水素燃焼過程への実験的アプローチ	久保野 茂	理研
16:55 —	17:10	CRIBにおけるAl-26核異性体の陽子弾性共鳴散乱実験	清水 英樹	東大CNS
17:10 —	17:30	陽子過剰核Hg領域の核分裂	西尾 勝久	原子力機構
17:30 —	17:50	MRTOFを用いた短寿命核の網羅的質量測定による宇宙核物理研究	和田 道治	KEK WNSC
17:50 —	17:55	まとめ	山口 英斉	東大CNS
17:55 —	18:00	総括	西村俊二	理研