The 17th CNS International Summer School (CNSSS18)

Report of Contributions

https://indico3.cns.s.u-tokyo.ac.jp/e/30

Contribution ID: **1** Type: **oral contribution**

The properties of nuclear matter under the Bethe-Brueckner-Goldstone Expansion

Thursday, 23 August 2018 16:10 (15 minutes)

The accurate computation of the properties of bulk nuclear matter is a long-lasting theoretical problem in nuclear physics. The basic difficulties stem from the strong short-range repulsion between nucleons.This renders a straightforward perturbative calculation impossible. In the last few decades, different many-body perturbation theories have been devised to affront this problem. We mainly employ Bethe-Brueckner-Goldstone (BBG) theory. Recently, we investigate the properties of both symmetric nuclear matter (SNM) and pure neutron matter (PNM) under BBG expansion up to the third order. Various representative nucleon-nucleon (NN) interactions are used, such as AV18 and CDBONN as well as the recent popular chiral potentials like N3LO and N4LO. The convergence of BBG expansion are well proved with high-precision modern NN interactions. However, for SNM, no satisfactory saturation points are obtained which means strong three-body forces (TBF) are required for all considered cases.

Primary authors: Dr LU, Jia-Jing (Institute of Modern Physics, Fudan University); Prof. LI, Zeng-Hua (Institute of Modern Physics, Fudan Univeristy)

Co-authors: Dr SCHULZE, Hans-Josef (Dipartimento di Fisica, INFN Sezione di Catania, Università di Catania); Prof. BALDO, Marcello (Dipartimento di Fisica, INFN Sezione di Catania, Università di Catania)

Presenter: Dr LU, Jia-Jing (Institute of Modern Physics, Fudan University)

Session Classification: YSS

Contribution ID: **2** Type: **not specified**

Greetings

Wednesday, 22 August 2018 09:50 (10 minutes)

Presenter: Prof. SHIMOURA, Susumu (CNS, Univ. of Tokyo)

Contribution ID: **3** Type: **oral contribution**

Nuclear Structure Studies with RIB 1

Wednesday, 22 August 2018 10:00 (50 minutes)

Presenter: Prof. BUTLER, Peter (The University of Liverpool)

Session Classification: Lectures

Contribution ID: **4** Type: **oral contribution**

Nuclear Structure Studies with RIB 2

Thursday, 23 August 2018 11:05 (50 minutes)

Presenter: Prof. BUTLER, Peter (The University of Liverpool)

Session Classification: Lectures

Contribution ID: **5** Type: **oral contribution**

Nuclear Structure Studies with RIB 3

Monday, 27 August 2018 10:00 (50 minutes)

Presenter: Prof. BUTLER, Peter (The University of Liverpool)

Session Classification: Lectures

Contribution ID: **6** Type: **oral contribution**

Nuclear Structure Studies with RIB 4

Tuesday, 28 August 2018 11:05 (50 minutes)

Presenter: Prof. BUTLER, Peter (The University of Liverpool)

Session Classification: Lectures

Contribution ID: **7** Type: **oral contribution**

Quark-Gluon Plasma 1

Wednesday, 22 August 2018 11:05 (50 minutes)

Presenter: Dr AKIBA, Yasuyuki (RIKEN)

Session Classification: Lectures

Contribution ID: **8** Type: **oral contribution**

Quark-Gluon Plasma 2

Thursday, 23 August 2018 10:00 (50 minutes)

Presenter: Dr AKIBA, Yasuyuki (RIKEN)

Session Classification: Lectures

Contribution ID: **9** Type: **oral contribution**

Quark-Gluon Plasma 3

Saturday, 25 August 2018 14:35 (50 minutes)

Presenter: Dr AKIBA, Yasuyuki (RIKEN)

Session Classification: Lectures

Contribution ID: **10** Type: **oral contribution**

Quark-Gluon Plasma 4

Tuesday, 28 August 2018 10:00 (50 minutes)

Presenter: Dr AKIBA, Yasuyuki (RIKEN)

Session Classification: Lectures

Contribution ID: **11** Type: **oral contribution**

Experimental and Theoretical Nuclear Astrophysics 1

Wednesday, 22 August 2018 14:35 (50 minutes)

Presenter: Dr MENGONI, Alberto (Bologna/INFN)

Session Classification: Lectures

Contribution ID: **12** Type: **oral contribution**

Experimental and Theoretical Nuclear Astrophysics 2

Thursday, 23 August 2018 13:30 (50 minutes)

Presenter: Dr MENGONI, Alberto (Bologna/INFN)

Session Classification: Lectures

Contribution ID: **13** Type: **oral contribution**

Experimental and Theoretical Nuclear Astrophysics 3

Saturday, 25 August 2018 10:00 (50 minutes)

Presenter: Dr MENGONI, Alberto (Bologna/INFN)

Session Classification: Lectures

Contribution ID: **14** Type: **oral contribution**

Experimental and Theoretical Nuclear Astrophysics 4

Monday, 27 August 2018 11:05 (50 minutes)

Presenter: Dr MENGONI, Alberto (Bologna/INFN)

Session Classification: Lectures

Contribution ID: **15** Type: **oral contribution**

TBA (nuclear structure ab-initio theory)

Wednesday, 22 August 2018 13:30 (50 minutes)

Presenter: Dr ABE, Takashi (CNS)

Session Classification: Lectures

Contribution ID: **16** Type: **oral contribution**

TBA (nuclear structure theory) 1

Thursday, 23 August 2018 14:35 (50 minutes)

Presenter: Prof. KIMURA, Masaaki (Hokkaido Univ.)

Session Classification: Lectures

Contribution ID: **17** Type: **oral contribution**

TBA (nuclear structure theory) 2

Friday, 24 August 2018 10:00 (50 minutes)

Presenter: Prof. KIMURA, Masaaki (Hokkaido Univ.)

Session Classification: Lectures

Contribution ID: **18** Type: **oral contribution**

TBA (nuclear structure theory) 3

Friday, 24 August 2018 11:05 (50 minutes)

Presenter: Prof. KIMURA, Masaaki (Hokkaido Univ.)

Session Classification: Lectures

Contribution ID: **19** Type: **oral contribution**

Electron scattering from nucleon and nuclei 1

Friday, 24 August 2018 13:30 (50 minutes)

Presenter: Prof. SUDA, Toshimi (Tohoku University)

Session Classification: Lectures

Contribution ID: **20** Type: **oral contribution**

Electron scattering from nucleon and nuclei 2

Friday, 24 August 2018 14:35 (50 minutes)

Presenter: Prof. SUDA, Toshimi (Tohoku University)

Session Classification: Lectures

Contribution ID: **21** Type: **oral contribution**

Electron scattering from nucleon and nuclei 3

Saturday, 25 August 2018 11:05 (50 minutes)

Presenter: Prof. SUDA, Toshimi (Tohoku University)

Session Classification: Lectures

Contribution ID: **22** Type: **oral contribution**

Electron scattering from nucleon and nuclei 4

Saturday, 25 August 2018 13:30 (50 minutes)

Presenter: Prof. SUDA, Toshimi (Tohoku University)

Session Classification: Lectures

Contribution ID: **23** Type: **oral contribution**

Overview of RIBF

Monday, 27 August 2018 13:30 (50 minutes)

Presenter: Dr ZENIHIRO, Juzo (RIKEN)

Session Classification: Lectures

Contribution ID: **24** Type: **not specified**

Closing of CNSSS18

Tuesday, 28 August 2018 12:10 (10 minutes)

Contribution ID: **25** Type: **not specified**

CNSSS YSS Awards ceremony

Tuesday, 28 August 2018 11:55 (15 minutes)

Contribution ID: **27** Type: **oral contribution**

Coulomb Energy Density Functionals for Nuclear Systems

Thursday, 23 August 2018 15:55 (15 minutes)

Atomic nuclei are self-bound quantum many-body systems that consist of protons and neutrons, and protons and neutrons interact with each other by the nuclear and electromagnetic forces. In nuclear physics, the study of the nuclear force is still one of the most important topics, since the exact form of the nuclear force is still unknown [1]. It is known that nuclear force has almost the isospin symmetry, i.e., the nuclear force between protons and that between neutrons are almost the same [2] and the study of isospin symmetry breaking of the nuclear force is important to understand the nuclear force itself [3]. Although the contribution of the nuclear force for the binding energy is much larger than that of the electromagnetic force, in order to understand isospin symmetry breaking of the nuclear force, it is important to study the electromagnetic contribution, for example for the mirror nuclei mass difference [4] and the isospin symmetry-breaking correction to superallowed β decay [5, 6], which are caused only by the electromagnetic force if the nuclear force has full isospin symmetry.

The density functional theory (DFT) in principle gives the exact ground-state energy as a functional of the charge density [7, 8]. The accuracy of DFT depends only on the accuracy of the energy density functional (EDF). High-accuracy non-empirical EDFs for electron systems have been proposed for decades, although a systematic way of deriving the exact EDF is still an open problem [9, 10]. The ground-state energy of atomic nuclei in DFT is $E_{\rm gs} = T_0\left[\rho_{\rm gs}\right] + E_{\rm Ch}\left[\rho_{\rm gs}\right] + E_{\rm Cx}\left[\rho_{\rm gs}\right] + E_{\rm nucl}\left[\rho_{\rm gs}\right]$, where T_0 is the kinetic energy of the non-interacting reference system and $E_{\rm ch}$, $E_{\rm Cx}$, and $E_{\rm nucl}$ are the Coulomb Hartree, Coulomb exchange, and nuclear terms, respectively [11]. It in principle allows high-accuracy evaluation of such electromagnetic contributions. However, so far the widely used scheme is the Hartree-Fock-Slater or Hartree approximations in nuclear physics [12].

Recently, we examined whether the exchange and correlation EDFs developed for the electron systems is applicable to atomic nuclei [13]. Both the local density approximation (LDA) and generalized gradient approximation (GGA) functionals were investigated. We employed the experimental charge-density distributions $\rho_{\rm ch}$ [14] of the selected nuclei as inputs of ground-state density distributions. For the exchange Coulomb energies, it is found that the deviation between the LDA and GGA, $\Delta E_{\rm x} = \left(E_{\rm x}^{\rm GGA} - E_{\rm x}^{\rm LDA}\right)/E_{\rm x}^{\rm GGA}$ ranges from around $11\,\%$ in ^{4}He to around $2.2\,\%$ in ^{208}Pb, with the GGA-PBE functional [15] for example. From light to heavy nuclei, it is seen that $\Delta E_{\rm x}$ behaves in a very similar way as the deviation between the Hartree-Fock-Slater approximation and the exact Hartree-Fock calculation given by Le Bloas *et al.* [16]. In this sense, the GGA exchange functionals of electron systems can be applied in a straightforward manner with practical accuracy to atomic nuclei. In contrast, the correlation Coulomb energy density functionals of electron systems are not applicable for atomic nuclei, because correlation effects caused from the Coulomb force and from the nuclear force are not separable and the nuclear interaction determines the properties of atomic nuclei. The self-consistent calculation of the Kohn-Sham equation with the PBE exchange energy density functional was also tested [17]. In most cases, once one of the PBE-functional coefficient μ is changed to 1.25μ, the PBE exchange functional successfully reproduces the exact-Fock Coulomb energy. This fact is remarkable since the numerical cost of GGA is $O\left(N^3\right)$, whereas that cost of exact Hartree-Fock approximation is $O\left(N^4\right)$ for the self-consistent calculations.

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[16] J. Le Bloas, M.-H. Koh, P. Quentin, L. Bonneau, and J. I. A. Ithnin. Phys. Rev. C **84**, 014310 (2011).
[17] T. Naito, X. Roca-Maza, G. Colò, and H. Liang. *In Progress.*

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Presenter: Mr NAITO, Tomoya (Department of Physics, the University of Tokyo/RIKEN Nishina Center)

Session Classification: YSS

Contribution ID: **28** Type: **oral contribution**

Quantitative analysis of tensor effects in the relativistic Hartree-Fock theory*

Thursday, 23 August 2018 17:10 (15 minutes)

Tensor force is one of the important components of the nucleon-nucleon interaction. With the advance of radioactive-ion-beam facilities around the world, much progress has been made in the study of the structure of exotic nuclei, and the critical role of the tensor force in the shell evolution of the exotic nuclei has been of great interest in the new century.
The nuclear density functional theory (DFT) is the only approach that can cover almost the whole nuclear chart. In the framework of non-relativistic DFT, the tensor force is isolated from other components and its effects can be identified clearly. However, in the case of relativistic DFT, it is naturally contained through the Fock terms and mixed together with other components. Thus, a quantitative analysis of tensor effects in the relativistic DFT, i.e., relativistic Hartree-Fock (RHF) theory and fair and direct comparison with the results from non-relativistic DFT has been missing for long.
In this work, we have identified the tensor force up to the $1/M^2$ order in each meson-nucleon coupling in the RHF theory, by the non-relativistic reduction for the relativistic two-body interactions. With the present formalism, for the first time, we achieved a fair comparison between the tensor effects in relativistic and non-relativistic DFT. Through the investigation of the isotopes and isotones $Z, N = 8, 20$, and 28, we found that the total tensor effects in the RHF effective interaction PKA1 is weaker than those in the Skyrme SLy5wT and Gogny GT2 effective interactions. This work is supposed to promote the developments of the relativistic DFT.

*Zhiheng Wang, Qiang Zhao, Haozhao Liang, Wen Hui Long, arXiv:1806.11270

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Co-authors: Dr LIANG, Haozhao (RIKEN); Mr ZHAO, Qiang; Prof. LONG, Wenhui (Lanzhou University)

Presenter: Mr WANG, Zhiheng (Lanzhou University and University of Tsukuba)

Session Classification: YSS

Contribution ID: **29** Type: **poster contribution**

The study of resonant states in ^{12}C via ^{12}C + nucleon scattering

Saturday, 25 August 2018 15:25 (10 minutes)

In carbon isotopes, the cluster structure is developed and some excited resonant states regarded as gaslike state of α particles appears. For example, the resonant state called the Hoyle state in ^{12}C is important in the process of the nucleosynthesis. It is very important to study the excited states in ^{12}C including the Hoyle state, especially resonant states. In the previous works, there are many experiments to probe those states. However, not only resonant states, but also non-resonant states are included in the data from the experiments, so we need to get only information of resonant states.

In our study, we analyze ^{12}C + nucleon scattering to understand the effects of the resonant and non- resonant states in ^{12}C. We adapt the complex scaling method (CSM) for the description of the resonant states, and calculate the cross sections with the four-body CDCC method. In the CDCC calculation, we use the JLM potential, which is the optical-model potential and we consider the $0^+, 1^-,$ and 2^+ states of ^{12}C.

In this conference, we report the results of the breakup cross sections, and discuss the effects of the resonant and non-resonant states in ^{12}C.

Primary authors: YAMADA, Yushin (Kyushu University); Dr MATSUMOTO, Takuma (Kyushu University)

Presenter: YAMADA, Yushin (Kyushu University)

Session Classification: YSS

Contribution ID: **30** Type: **poster contribution**

Microscopic optical potentials including the breakup effects for unstable nucleus scattering

Saturday, 25 August 2018 15:35 (10 minutes)

Recently, study on unstable nuclei near the neutron dripline has been attracted by the development of radioactive ion-beam experiments. The optical potential between a projectile and a target is a basic ingredient to describe the elastic scattering. In the neutron-rich region, it is difficult to determine the phenomenological optical potential due to restrictions on experimental data. Therefore, we need to construct the optical potential microscopically.

The g-matrix folding model has been widely used as a reliable method to obtain the microscopic optical potential. However, this approach does not work well for the case of unstable nuclei, since the folding model neglects projectile-excitation effects that are important for reactions involving weakly-binding nuclei.

In our study, we propose a method to construct a microscopic optical potential including projectile-excitation effects by combining the folding model with the Glauber model. In this conference, we will report the results applied to ^{3,6}He scattering, and discuss applicability to the case of the proton target.

Primary authors: Mr OGAWA, Shoya (Kyushu University); Dr MATSUMOTO, Takuma (Kyushu University); Dr TOYOKAWA, Masakazu (Kyushu University); Mr HORINOUCHI, Ryo (Kyushu University)

Presenter: Mr OGAWA, Shoya (Kyushu University)

Session Classification: YSS

Contribution ID: **31** Type: **poster contribution**

Study of proton- and deuteron- induced reactions on the long-lived fission product 93Zr at 30MeV/u in inverse kinematics

Saturday, 25 August 2018 15:45 (10 minutes)

[background]
Nuclear reactions for the long-lived fission product (LLFP) ^{93}Zr($T_{1/2}$=1.6million years) have been studied for the purpose of nuclear waste transmutation. According to the previous report[1], it was found that the proton- and deuteron-induced spallation reactions at 105 MeV/u are effective for the ^{93}Zr transmutation. For systematic study, we performed an experiment for the proton- and deuteron- induced reactions on ^{93}Zr at 30 MeV/u. In this energy region, the fusion evaporation process is dominant. Thus, the reaction mechanism dependence can be studied by comparison with the high energy spallation data.

[experimental method]
This experiment was performed at RIKEN Radioactive Isotope Beam Factory (RIBF). The degraded RI beams at 30 MeV/u were produced by a newly developed beam line, OEDO. To induce the reactions, the high-pressure cooled gas targets (H_2 and D_2) were used. Reaction residues were analyzed by the SHARAQ spectrometer.

In this talk, we will present the details of experiments and the obtained results.

References
[1] S. Kawase et al., Prog. Theor. Exp. Phys. 2017 , 093D03 (2017).

Primary authors: IRIBE, Kotaro (Department of Physics , Kyushu University); DOZONO, Masanori; IMAI, Nobuaki; SHIN'ICHIRO , Michimasa; SUSUMU, Shimoura; SHINSUKE , Ota; TOSHIYUKI , Sumikama; NOBUYUKI , Chiga; HIDEAKI , Otsu

Presenter: IRIBE, Kotaro (Department of Physics , Kyushu University)

Session Classification: YSS

Contribution ID: **33** Type: **oral contribution**

Systematic treatment of odd-mass nuclei in Hartree-Fock-Bogoliubov calculation

Thursday, 23 August 2018 15:40 (15 minutes)

Odd-mass nuclei are different from even-even nuclei in having finite spins in the ground state and breaking time-reversal symmetry. These differences make odd-mass nuclei more interesting and at the same time more difficult to study. Conventionally, an odd-particle system in Hartree-Fock-Bogoliubov theory or density functional theory is treated as a one-quasiparticle excited state on the neighbor even-particle vacuum. The inequal treatment between odd and even particle systems prevents the systematic study of odd-mass nuclei. I present the method of treating odd and even particle systems uniformly in Hartree-Fock-Bogoliubov calculation, showing calculation results.

Primary author: Mr KASUYA, Haruki (Yukawa Institute for Theoretical Physics, Kyoto University)

Presenter: Mr KASUYA, Haruki (Yukawa Institute for Theoretical Physics, Kyoto University)

Session Classification: YSS

Contribution ID: **34** Type: **oral contribution**

Production of n-rich nuclei via 2-proton knockout with deuterium target

Wednesday, 22 August 2018 15:55 (15 minutes)

Production of neutron-rich nuclei through one-nucleon knockout (p,2p) reactions has been successfully demonstrated with the MINOS at RIBF. In future RIBF experiments, a method to remove more than one protons with a reasonable rate will be required for production of more neutron-rich nuclei. At present there is no consensus on what the best reaction for two-proton removal is. In this presentation, a performance of the (d, 3pn) reaction with the MINOS as a candidate of the two-proton knockout driver in future RIBF experiments is discussed. The experiment was carried out using the SAMURAI spectrometer. A secondary cocktail beam including 58Ti was produced with projectile fragmentation reactions of a primary 70Zn beam at 345 MeV/u impinging on a beryllium target. The liquid hydrogen and deuterium with thicknesses of 1.1 g/cm2 and 1.8 g/cm2, respectively, were used as the secondary targets. The cross sections were derived by counting the numbers of particles before and after the target, considering an effective beam intensity. The secondary beam and fragments were identified event by event using the ΔE–TOF–Bρ method. It was found that cross section for two-proton removal with a deuteron target is larger by a factor of ~3 than that with a proton target. This fact may imply possible advantages of a deuteron target to produce neutron-rich nuclei via two-proton knockout.

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Presenter: MIWA, Midori (Department of Physics, Saitama University)

Session Classification: YSS

Contribution ID: **35** Type: **oral contribution**

Proton Radius Measurements with electron scattering at ELPH

Wednesday, 22 August 2018 16:25 (15 minutes)

The proton radius has a serious problem in the today's physics. The proton charge radius has been measured by electron scattering for more than fifty years and hydrogen spectroscopy. Since these results were consistent within experimental error, the proton radius has been believed to be 0.88 fm. However, the radius extracted from muonic hydrogen spectroscopy reported in 2010 was about 5% smaller than the value measured with electron. Despite intensive measurements and analyses, this discrepancy has not been explained reasonably yet, thus called "the proton radius puzzle".

We are going to obtain the proton radius, using elastic electron scattering with the highest accuracy at ELPH, Tohoku Univ. This experiment has two remarkable features. First, we will use low and variable energy electron beam accelerated by the 60 MeV linac in ELPH. In electron scattering, the proton radius is deduced from the charge form factor, which is related to scattering cross sections, at the limit of the momentum transfer $Q^2 \to 0$. We will measure cross section in lowest-ever Q^2 and a wide range of the scattering angle, which enables to determine reliable distribution of charge form factor for the radius. Second, we will use polyethylene (CH_2) as a target, because it is not an easy task to determine absolute cross sections. In our experiment, we will observe the scattered electron from proton (hydrogen) and carbon in the same time. The cross sections of electron-proton scattering can be determined relative to that of ^{12}C, as it is well known.

In this presentation, I will discuss the present status of the proton radius problems, and the detail of our experiment.

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Presenter: AOYAGI, Taihei (ELPH, Tohoku University)

Session Classification: YSS

Contribution ID: **36** Type: **oral contribution**

Measurement of the Two-Halo Neutron Transfer Reaction 11Li(p,t)9Li at 62.4 MeV

Wednesday, 22 August 2018 16:55 (15 minutes)

We report the measurement of differential cross section of the 11Li(p,t)9Li reaction performed at TRIUMF. Previous investigation of the reaction was reported at lower energy of 3A MeV [1]. Present data were taken at higher energy where the direct reaction mechanism is expected to be more dominant. It will be shown that the present measurement shows the transition to a higher excited state than the previous report.
We used the ISAC-II facility to accelerate 11Li to 62.4 MeV and the IRIS facility was used for measuring the 11Li(p,t) reaction. This experimental data were simultaneously taken with the published experiment of (p,p')[2].
The transition to the second excited state of 9Li was observed for the first time. The presentation will describe the experiment and analysis.
[1] I. Tanihata et al., Phys. Rev. Lett. 100, 192502 (2008).
[2] J. Tanaka et al., Phys. Lett B 774, 268 (2017)

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Presenter: Mr WANG, Xuan (RCNP Osaka Univ)

Session Classification: YSS

Contribution ID: **37** Type: **poster contribution**

Development of Fast Neutron Detection Based on Multi-size Fiber Array

Saturday, 25 August 2018 15:55 (10 minutes)

Fast neutron detection using recoil proton track detector based on organic fiber array is widely used to detect single neutron event. To broaden its energy detection range, a multi-size fiber array structure is designed and evaluated under Monte-Carlo simulation in our work. A test detector is also developed, archieving a energy resolution of 43% at neutron energy of 14.1MeV generated by D-T neutron generator, and having a simulated energy response up to 100MeV. In order to reduce the detector volume, a compact structure of single-ended light output coupling directly with photomultiplier tube is then designed, tested and in continuous improvement.

Primary authors: ZHUANG, Kai (Institute of High Energy Physics, Chinese Academy of Sciences); QIN, Xiubo (Institute of High Energy Physics, Chinese Academy of Sciences); WEI, Long (Institute of High Energy Physics, Chinese Academy of Sciences)

Presenter: ZHUANG, Kai (Institute of High Energy Physics, Chinese Academy of Sciences)

Session Classification: YSS

Contribution ID: **38** Type: **oral contribution**

Production of the Gamma-ray via narrow resonance reaction and its applications

Wednesday, 22 August 2018 16:40 (15 minutes)

High energy γ-ray can be used for nuclear waste transmutation, because of the giant resonance. The generation of high energy γ-ray mainly include bremsstrahlung, laser Compton scatter and resonance reaction. The thick target yield of the $9.17MeV$ γ-ray from the resonance at $1.75MeV$ in the $^{13}C(p,\gamma)^{14}N$ was measured by use of HPGe detector. The absolutely efficiency of the detector was calibrated by the GEANT4 simulation and the known radioactive activities of ^{56}Co and ^{152}Eu. The energy and angular distribution of the $9.17MeV$ γ-ray are determined. Meanwhile, the photo neutron cross section at the energy of $9.17MeV$ for $^{197}Au(\gamma,n)$ has been determined.

Primary author: Dr DANG, YONGLE (China Institute of Atomic Energy, CIAE)

Presenter: Dr DANG, YONGLE (China Institute of Atomic Energy, CIAE)

Session Classification: YSS

Contribution ID: **39** Type: **poster contribution**

18F(p,α)15O reaction in novae

Saturday, 25 August 2018 16:05 (10 minutes)

The 511 keV gamma rays and below emitted by novae are mainly produced by 18F, the flux may be detected by satellite detectors. We can effectively constrain the novae model by comparing the theory and observation results. As the main consumed reaction of 18F, 18F(p,α)15O, its reaction rate is extremely important and has been invested for decades. This poster is mainly to introduce the gamma rays from novae and progress in studying the 18F(p,α)15O reaction rate at nova temperature.

Primary author: Mr RU, Longhui

Presenter: Mr RU, Longhui

Session Classification: YSS

Contribution ID: **40** Type: **oral contribution**

Mean-field study of the radiative capture 12C(p,γ)13N and 13C(p,γ)14N reactions

Friday, 24 August 2018 15:40 (15 minutes)

In this framework we study the effect of local optical potential on the radiative capture 12C(p,γ)13N and 13C(p,γ)14N reactions. The optical potential of nucleon-nucleus interaction is constructed by parameterization of Woods-Saxon potential and folding model using the effective nucleon-nucleon interaction CDM3Yn based on an extended Hartree-Fock calculation. The result indicates that the both potentials described effectively the (p,γ) reactions compared to the experimental data.

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Session Classification: YSS

Contribution ID: **41** Type: **poster contribution**

PRE(Photospheric radius expansion) X-ray burst simulation with 1D stellar evolution code

Saturday, 25 August 2018 17:05 (10 minutes)

MESA(Modules for Experiments in Stellar Astrophysics) simulate stellar evolution to solve the equations including many physical processes such as nuclear reaction, equation of state, and opacity in 1-D. It can also simulate the X-ray burst using the profile of neutron star surface and the accretion information. But MESA does not deal with the PRE(Photospheric Raidus Expansion) phenomena because if its luminosity goes beyond the Eddington limit without special conditions, the simulation does not proceed due to time step problem. So here, we are looking for a way to solve this problem to simulate the PRE burst using MESA. Next, we will study the conditions that cause PRE.

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Presenter: SEONG, GWANGEON (UNIST)

Session Classification: YSS

Contribution ID: **42** Type: **poster contribution**

Building the interstellar cloud model for describing the composition of chemical species

Saturday, 25 August 2018 16:15 (10 minutes)

The molecular absorption spectra revealed the existence of molecular species in interstellar media(ISM). However, the reason for the existence is still unknown. To explain the existence of molecules, we make an interstellar cloud model which can describe the current chemical state of ISM. We have improved a previously suggested static cloud model, which fit only a few observational data, by increasing the number of molecular species.

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Presenter: YOON, Jeongkwan (Ulsan National Institute of Science and Technology (UNIST))

Session Classification: YSS

Contribution ID: **43** Type: **oral contribution**

Isovector and isotensor forces in sd-shell

Wednesday, 22 August 2018 15:40 (15 minutes)

Isochronous mass spectrometry has been applied in the storage ring CSRe to measure the masses of the $T_z = -3/2$ nuclei ^{27}P and ^{29}S in sd-shell. The new mass excess value is 66(52)~keV larger than the result of the previous ^{32}S(^{3}He,^{6}He)^{29}S reaction measurement in 1973 and a factor of 3.8 more precise. The new result for ^{29}S, together with those of the $T = 3/2$ isobaric analog states (IAS) in ^{29}P, ^{29}Si, and ^{29}Al, fit well into the quadratic form of the Isobaric Multiplet Mass Equation IMME. The mass excess of ^{27}P has also been remeasured. By analyzing the linear and quadratic coefficients of the IMME in the $T_z = -3/2$ sd-shell nuclei, it was found that the ratio of the Coulomb radius parameters is $R \approx 0.96$ and is nearly the same for all $T = 3/2$ isospin multiplets. Such a nearly constant R-value, apparently valid for the entire light mass region with $A > 9$, can be used to set stringent constraints on the isovector and isotensor components of the isospin non-conserving forces in theoretical calculations.

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Session Classification: YSS

Contribution ID: **44** Type: **poster contribution**

2nd-order superfluid Thomas-Fermi approximation and FAM-QRPA method for ultracold fermions

Saturday, 25 August 2018 16:25 (10 minutes)

The superfluid many-body systems can be described by Hartree-Fock-Bogoliubov equation. However, the HFB calculations is not feasible when systems have a large number of particles or quasi-continuum spectrum. In this case, the superfluid Thomas-Fermi approximation is very useful. Furthermore, the second-order superfluid Thomas-Fermi approximation has been derived. We know the 2nd-order Thomas-Fermi method without pairing has been applied a long time ago. The 2nd-order superfluid Thomas-Fermi method is very complex and has been applied to only a few examples. Based on the Green's function expansion method, we derived the 2nd-order superfluid Thomas-Fermi method with effective mass and spin-orbit potential so that it can be applied to general cases. The expressions have been examined in nuclei.
The collective modes of many particle systems are usually described by linear response approximation or hydrodynamic method. For cold atomic systems, there are strong experimental interests for measurements of multipole collective modes, which are related to equation of state and superfluidity. We have developed the FAM-QRPA code for describing collective modes of deformed nuclei and general superfluid systems. Compared with the conventional QRPA method, the FAM-QRPA is more efficient and can be applied to large deformed systems. In this cases, the detailed discrepancy between QRPA and hydrodynamic method for cold atomic systems in a trap have been studied to explore the finite-size effects.

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Presenter: Ms FEI, Na (Peking University)

Session Classification: YSS

Contribution ID: **45** Type: **poster contribution**

GAMMA STRENGTH FUNCTION OF 49Ti BASE ON (n, 2□) REACTION

Saturday, 25 August 2018 16:35 (10 minutes)

Gamma strength function is importance information to study nuclear structure by experiment. The experiment data is corrected the nuclear structure models. Nowadays, the comparison between experiment and theory of gamma strength function is significant two to four order differences. This report presents some results of experimental of gamma strength function which is based on 48Ti(n,2□)49Ti reaction.

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Presenter: Mr NGUYEN AN, Son (Dalat University)

Session Classification: YSS

Contribution ID: **46** Type: **poster contribution**

Research on SiPM-based detector for gamma ray detection

Saturday, 25 August 2018 16:45 (10 minutes)

Nuclear medicine is an important application of nuclear physics in the field of medicine. As the primary means of nuclear medicine, Positron Emission Tomography (PET) and Gamma Camera are the most effective methods for early diagnosis of tumors by detecting and imaging the gamma rays produced by radioactive tracers. In this work, the characteristics of pixel silicon photomultiplier (SiPM) and the spatial resolution, energy resolution and time resolution of SiPM-based detector module were studied. On this basis, a large area double-plane detector were designed for early diagnosis of breast tumors with both PET and gamma camera imaging capability. The detector consists of pixelated LYSO scintillators and SiPM arrays with an effective detection area of 168.6×202.4 mm2, which could achieve the image of a single breast rapidly. Self-designed front-end electronics are used to simplify the readout circuit and retain good detector performances. Test results show that the detector have a good spatial resolution superior to 2mm, a 1.32ns coincidence time resolution and energy resolutions of 11.39%@511keV and 20.37%@141keV respectively. It suggests that the detector is promising to be applied in the dual modality system. In addition, the optimal performance of SiPM arrays under the discrete readout circuits is further studied by using application specific integrated circuit (ASIC) to enhance resolutions of the detector. In this case, the optimal coincidence time resolution is up to 417ps and the average energy resolution is increased to 9.7% @511keV, 20.6% @ 122keV respectively.

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Session Classification: YSS

Contribution ID: **47** Type: **oral contribution**

Initial geometry effect on HBT correlation in C+Au collisions in AMPT model

Friday, 24 August 2018 16:25 (15 minutes)

In high-energy nuclear physics, the property of quark gluon plasma is a key target. In traditional nuclear physics, the structure of light nuclei is always an important field. In recent years, it has been proposed that relativistic heavy-ion collision also offers a possibility of studying low-energy nuclear structure phenomena. Through ^{12}C+^{197}Au collisions from the AMPT model, the azimuthal angle dependence of correlation lengths (the Hanbury Brown-Twiss radii) is calculated. Three configurations of ^{12}C are considered, which are α-clustered triangle, α-clustered chain and Woods-Saxon distribution of nucleons. The evolution of the angular distribution of the HBT radii from pion-pion correlation and phi-phi correlation is discussed. From our study, one can learn that the HBT correlation from identical particles at freeze-out is able to distinguish the different initial configurations and hadronic rescattering time plays an important role in the evolution.

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Session Classification: YSS

Contribution ID: **48** Type: **oral contribution**

Development of GEM based BPM for Muon g-2/EDM experiment

Friday, 24 August 2018 16:10 (15 minutes)

The experimental value of muon g-2 factor is different with theoretical value that calculated from standard model. Therefore, measuring the g-2 factor has been considered as the key for beyond standard model. Muon g-2/EDM E34 experiment in J-PARC is one of the experimental effort to measure the magnetic moment of muon more precisely. Since the muon beam is used for this experiment, it is important to profile the properties of the beam. MCP BPM and CsI BPM is used for this work now, but using Gas electron multiplier(GEM) based BPM can be more economical way than using these BPMs. The development is ongoing, and the final goal of this work is to provide cost-effective method for profile the muon beam.

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Session Classification: YSS

Contribution ID: **50** Type: **oral contribution**

How to Improve Functionals in Density Functional Theory?

Thursday, 23 August 2018 16:40 (15 minutes)

The density functional theory (DFT) is one of the most successful approaches to calculate the ground-state properties of atoms, molecules, and solids [1, 2]. The DFT is also applicable to nuclear systems [3, 4]. In principle, the DFT gives the exact ground-state density ρ_0 and energy $E_0 = T_0[\rho_0] + \int v_{\rm ext}(\mathbf{r})\,\rho_0(\mathbf{r})\,{\rm d}\mathbf{r} + E_{\rm H}[\rho_0] + E_{\rm xc}[\rho_0]$, where T_0 is the kinetic energy, $v_{\rm ext}$ is the external field, and $E_{\rm H}[\rho_0]$ and $E_{\rm xc}[\rho]$ is the Hartree and exchange-correlation energy density functional (EDF), respectively. However, in practice, $E_{\rm xc}[\rho]$ is unknown, and thus the accuracy of the DFT calculation depends on the accuracy of the exchange-correlation EDF. Improvement of EDFs is one of the important topics both in electron systems and in nuclear systems.

As one way to tackle the improvement of EDFs, the inverse approach of the DFT, so-called the inverse Kohn-Sham method (IKS), was proposed [5]. In the IKS, the Kohn-Sham potential, $v_{\rm xc}(\mathbf{r}) = \delta E_{\rm xc}[\rho]/\delta\rho(\mathbf{r})$, is calculated from the input ground-state density $\rho_0(\mathbf{r})$. The information obtained from the IKS, for example, the single-particle energies ε_i, is helpful for checking the accuracy of EDFs [6]. However, the way to improve EDFs directly has not been proposed yet.

We proposed the way to improve EDFs based on the density functional perturbation theory (DFPT) [7] and the IKS [8]. Improvement of EDFs is performed under the assumption for $E_{\rm xc}^{(1)}[\rho]$, which is added to conventional EDFs. As a benchmark, we check the reproducibility of the exchange [9] and correlation functionals [10] in the local density approximation (LDA). The assumed form of $E_{\rm xc}^{(1)}[\rho]$ is $A\int\rho^{\alpha}(\mathbf{r})\,{\rm d}\mathbf{r}$, and input ground-state densities are pair of two ground-state density of noble gases. For the LDA exchange functional, it is found that A and α are obtained within $7.2\,\%$ and $1.0\,\%$ from the pair of He and Ne, and within $2.3\,\%$ and $0.1\,\%$ from the pair of Xe and Rn. Although the LDA correlation functional is not a power functional of ρ, it is found that it is reproduced reasonably well especially in the low-density region from the pair of He and Ne, and in the high-density region from the pair of Xe and Rn.

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Session Classification: YSS

Contribution ID: **51** Type: **oral contribution**

A Study of Ground-state Energies with the Strutinsky's Method and Total Binding Energy in the Woods-Saxon Potential

Thursday, 23 August 2018 16:55 (15 minutes)

A single particle states and energies simply are calculated by the Woods-Saxon potential. It corresponds with the concept of one-body potential and is a typical calculation of microscopic understanding the nuclear structure. However, this concept is not enough to make a relation between single particle energy and total binding energy. We, therefore, introduced the Strutinsky's method, as a shell correction method, for our calculation. It could be possible to understand total binding energy from microscopic calculation. And then, we will discuss applying a shell correction to calculation of total binding energy and deformation for light nuclei by using a one-body potential.

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Presenter: KIM, Seonghyun (Soongsil University)

Session Classification: YSS

Contribution ID: **52** Type: **oral contribution**

Neutrino self-interaction and MSW effect on the neutrino-process in core-collapse supernovae

Thursday, 23 August 2018 16:25 (15 minutes)

We investigate the nuclear abundances uniquely produced from the neutrino-process in supernova (SN) explosion. We calculate the neutrino flux propagation and its modification by neutrino self-interactions near the neutrino-sphere along with the Mikheyev-Smirnov-Wolfenstein (MSW) mixing in the outer envelopes. We compute the neutrino-induced nucleosynthesis of ^{7}Li, ^{11}B, ^{92}Nb, ^{98}Tc, ^{138}La, and ^{180}Ta. Near to the neutrino-sphere, the neutrino density is $\sim 10^{32}\mathrm{cm}^{-3}$. This number density is sufficiently large that the neutrino self-interaction becomes important. The interaction effect on the neutrino flux is calculated by solving the evolution equation for the neutrino density matrix with a collision term estimated in the mean field approximation. We discuss how the neutrino self-interaction and the MSW effect influence the nuclear production by using the modified neutrino spectra along with neutrino-nucleus interactions calculated in the Quasiparticle Random Phase Approximation (QRPA). Our results show that abundances of all nuclides considered in this work are increased by the neutrino self-interaction.

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Presenter: Ms KO, Heamin (Soongsil University)

Session Classification: YSS

Contribution ID: **53** Type: **oral contribution**

Study on Colossal Dielectric Constant Mechanism of Al/Nb Co-doped CCTO by PAT

Friday, 24 August 2018 15:55 (15 minutes)

Calcium copper titanate ceramics colossal dielectric constant mechanism is studied by changing its microstructure through co-doping different concentrations of Al/Nb on its Ti4+ sites (CaCu3Ti4-x Al0.5xNb0.5x O12, x=0.2%, 0.5%, 5%). We mainly use positron annihilation technique(PAT), combined with scanning electron microcopy(SEM) and complex impedance spectroscopy(IS), to explore the influence of microstructure on samples dielectric properties. SEM results show that the grain boundary of each sample has a pulpy appearance, and it is hardly for SEM to determine its thickness. However PAT is sensitive to the vacancy type defects trapped by grain boundaries, and can be used to characterize samples grain boundaries microstructure. The variation of coincident Doppler broadening spectra S parameters of samples with different co-doping concentration is consistent with the changing trend of their annihilation mean lifetimes, and the x=0.5% co-doped sample has the smallest S and mean lifetime which implies the thinnest thickness of grain boundary[1]. So the sample with x=0.5% has the highest dielectric constant according to the internal barrier layer capacitance (IBLC) model[2]. Experiment results support the prediction of IBLC model, which describe the colossal dielectric constant mechanism of calcium copper titanate ceramics.

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Presenter: WEN, Ali

Session Classification: YSS

Contribution ID: **54** Type: **oral contribution**

Two-particle angular correlations in pp and p-Pb collisions at LHC energies from a multi-phase transport mode

Friday, 24 August 2018 16:40 (15 minutes)

We apply a multi-phase transport (AMPT) model to study two-particle angular correlations in pp collisions at $\sqrt{s}$ = 7 TeV. Besides being able to describe the angular correlation functions of meson-meson pairs, a large improvement for the angular correlations of baryon-baryon and antibaryon-antibaryon is achieved. We further find that the AMPT model with new quark coalescence provides an even better description on the anti-correlation feature of baryon-baryon correlations observed in the experiments. We also extend the study to p-Pb collisions at $\sqrt{s}$ = 5.02 TeV and obtained similar results. These results help us better understand the particle production mechanism in pp and p-Pb collisions at LHC energies.

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Session Classification: YSS

Contribution ID: **55** Type: **poster contribution**

Study of Gamow-Teller Transition on He-4 with PANDORA

Saturday, 25 August 2018 16:55 (10 minutes)

Gamow-Teller(GT) transition is one of the basic excitation modes in nuclei. Though these kind of excitation modes are well studied on stable nuclei, data on exotic nuclei are still lacking. Due to the high isospin asymmetry [(N-Z)/A] of neutron dripline nuclei, the energy gain of GT resonance of these nuclei is expected to be enhanced. In addition, ⁶He is a halo nucleus, it's neutron halo can be regarded as pure neutron matter. GT transition measurement on ⁶He may extend our knowledge on spin-isospin collectivity to very exotic nuclear matter.

Inverse kinematics gives us chance to study unstable nuclei. Neutrons of ⁶He(p,n)⁶Li reaction were measured to reconstruct missing mass spectra. Because both photon and neutron have no charge, it's hard to distinguish them for traditional detectors. The random gamma-ray background can be a big problem for neutron measurement. So a new detector system, PANDORA(Particle Analyzer Neutron Detector Of Real-time Acquisition), was developed to discriminate neutron events and reduce the gamma background.

Performance of the neutron-gamma discrimination and some preliminary results of the experiments will be shown in the poster.

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Presenter: GAO, Jian

Session Classification: YSS

Contribution ID: **56** Type: **oral contribution**

Characterization of a tritium target for two-neutron transfer studies at TRIUMF

Friday, 24 August 2018 16:55 (15 minutes)

(t,p) two-neutron transfer reactions are well suited for studying pairing correlations and shape coexistence phenomena. At radioactive beam facilities, (t,p) reactions have to be performed in inverse kinematics requiring a tritium target.

At TRIUMF a tritium-loaded titanium target has recently become available. For the analysis and planning of future experiments, it is desirable to characterize the target through elastic scattering measurements using an accelerated beam. We performed the measurements at the ISAC-II facility, TRIUMF. The results for the tritium thickness and the degree of hydrogen contamination will be shown in this talk.

Primary author: KITAMURA, Noritaka

Presenter: KITAMURA, Noritaka

Session Classification: YSS

Contribution ID: **57** Type: **oral contribution**

Proton resonance scattering of a shape-coexistence nucleus ^{118}Sn

Wednesday, 22 August 2018 16:10 (15 minutes)

It is well known that shape coexistence was observed in stable even-even Sn(Z=50) nuclei, and the even-odd neighboring nucleus may have a hint of the structure. So far, some single-particle like states in Sn were observed by measuring (d,p) reaction on Sn. Though the isobaric analog resonances corresponding to the low-lying states in Sn were already measured for the spectroscopic information on Sn, there are some missing resonances expected from (d,p) reaction. It is necessary to measure the excitation function of proton-elastic resonance scattering with the wide energy range to understand the structure of ^{119}Sn. The proton resonance elastic scattering on Sn yields the spectroscopic information of the single particle state coupled to the ground-state of Sn.
The experiment was carried out at the tandem accelerator facility in Kyushu University. An enriched ^{118}Sn target was irradiated by a proton beam while varying the beam energy from 7 to 10 MeV. The reaction channel was identified by the outgoing angle and energy of scattered protons measured by single-sided silicon strip detectors placed at 140-160°.

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Session Classification: YSS

Contribution ID: **58** Type: **poster contribution**

Production of 52Fe 12+ isomer around Fe nucleus via projectile fragmentation

Saturday, 25 August 2018 17:15 (10 minutes)

Electron capture rates of nuclei near iron in stars are important inputs for network calculation. In stars, nuclei may be excited due to the high temperature circumstances and then reactions on excited nuclei plays an important role in nucleosynthesis.
One possible way to perform reaction study on excited state is to measure the reaction with an "isomer"beam in inverse kinematics.The 52Fe(12+) at Ex= 7 MeV is a good candidate around iron nuclei.
We measured the isomer ratio of aiming to clarify the production mechanism of isomer via projectile fragmentation.
Experiments were performed at HIMAC which has synclotoron and fragment separator. The isomer ratio of 52Fe and its neighboring nuclei are measured by using projectile fragmentation with beams of 58Ni,59Co and 82Kr at 350 MeV/u as functions of longitudinal momentum transfer as well as transverse momentum transfers. To obtain the transverse momentum dependence the incident beam angle to the target was changed with a beam swinger system.
The results of on the isomer ratio around 52Fe nucleus will be presented.

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Session Classification: YSS