The 18th CNS International Summer School (CNSSS19)

Wednesday 21 August 2019 - Tuesday 27 August 2019

Wako/Hongo Campus

Book of Abstracts

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$\Lambda\Lambda$ pairing interactions and correlations in multistrange hypernuclei

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We study multistrange Ca, Sn and Pb hypernuclei with $\Lambda\Lambda$ pairing correlations by using the multidimensionally-constraint relativistic Hartree-Bogoliubov (MDC-RHB) model. The axial deformation is allowed and the $\Lambda\Lambda\omega$-tensor coupling is included to reproduce the small spin-orbit splittings for Λ hyperon. The separable pairing force of finite-range form is used for the pp channel and the ratio of the $\Lambda\Lambda$ pairing to NN pairing strength is determined from the quark model. We find that the shell structure for Λ is very different from that in normal nuclei because of the small spin-orbit splittings in the single Λ spectrum. The pairing energy is similar with HFB calculation results. The $\Lambda\Lambda$ pairing makes the Λ density distribution more symmetric but its influence on the total density distribution can be neglected.

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256 channels data acquisition system of wide dynamic range gama camera

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A real-time testing system consisting of a large-area array of 72 QDR II+ SRAMs (larger than 10-Gbit manufactured in 65 nm CMOS technology) was developed and assembled on the Tibetan Plateau at an altitude of 4,300 m. A new topological structure with 9 QDR II+ devices operating synchronously by a single FPGA was proposed and the signal integrity of the large-area high-speed QDR II+ SRAMs was solved. Under harsh natural radiation conditions, the complex and expensive system monitored a large number of devices in parallel for 153 days uninterruptedly. 43 soft errors including single bit upsets (SBUs), multiple-cell upsets (MCUs), and burst errors were observed, 77% of the observed errors in the DUT are SBU, while the MCU fraction is 23%. Surprisingly, incidence of single neutron can upset up to 9 cells. A SER value of 2356 FIT/Mb was obtained at the test site.

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Atomic Spectra of Iron at Black Hole Accretion Disk

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The black hole accretion disks contain highly ionized Fe, including C_{IV}, N_V, and O_{VI} at a temperature of about 10^8K. The relatively hot accretion disk (10^8K) and the relatively cool surrounding

medium (10^6K) are mixed and the iron is ionized and recombined to release the X-ray. This paper investigate the physical properties of turbulent mixing layers and the production of highly ionized irons, by using hydrodynamic simulations with radiative cooling and non-equilibrium ionization (NEI) calculations.

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CALCULATIONS OF THERMAL NEUTRON SCATTERING CROSS SECTIONS FOR BISMUTH AND SAPPHIRE CRYSTALS

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This research presents the calculated results of the thermal neutron inelastic scattering cross sections of Bismuth and Sapphire crystals. In this calculations, the effects of thermal neutron scattering on crystal's phonon vibration and lattice parameters were taken into account by using the NJOY code. This calculated results were updated into the related ACE format data file for MCNP simulation of thermal neutron beams filtered at the Dalat research reactor.

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Cluster Structures in 16C

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Theoretical calculation indicates the existence of molecule configuration in 16C. Linear-chain configuration is a current research hotspot of various molecule configurations. The excited states of 16C with π2σ2 configuration for the four valence neutrons is one of the most promising candidates for the linear-chain structure. The linear-chain configuration generates a rotational band built on the 05+ state at 15.5MeV that is close to the 4He+12Be and 6He+10Be threshold energies and stable against the bending motion.
In experiments, there are several observables for cluster formation in a resonant state:
1.Excitation energy vs spin systematics: Requires good energy resolution, large statistics and good peak separation.
2.Large cluster decay width: Requires coincident measurement of both the fragments and the very low energy recoiled target particles.
3.Characteristic transition strength: Requires measurement of the angular distribution with very small cross sections.
Our group have completed relevant experiments on HIRFL(Lanzhou, China), and the main goal is to investigate the 3 alpha linear-chain structure in the high-lying excited state of 16C(Ex=14 ~ 25MeV)

via 1H(16C,4He + 12Be)1H and 1H (16C,6He + 10Be)1H inelastically break up reaction at 30MeV/A with both the invariant mass and missing mass methods in inverse kinematics.

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Compositional analysis and production of polyethylene targets for the proton charge radius measurements through the electron-proton elastic scattering

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Proton charge radius puzzle is a big problem that the size of protons measured by electron scattering and hydrogen spectroscopy is different from the size of protons measured by μ hydrogen spectroscopy. To solve this problem, we are going to perform proton charge radius measurement by electron-proton elastic scattering using a low energy electron linear accelerator at ELPH, Tohoku University. This experiment requires 12C-enriched polyethylene target with 100μm thickness and of which carbon-to-hydrogen composition ratio is know with 0.1% accuracy. However, it is difficult to obtain 12C-enriched polyethylene powder. First, we improved our method how to produce polyethylene target sheets using FLO-THENE (Sumitomo Seika Chemicals Co., Ltd.), general polyethylene powder. Addition to that we did composition analysis of that powder. In CHN (Carbon-Hydrogen-Nitrogen) elemental analysis, the composition ratios of C and H were measured with an accuracy of 0.1%. And measurements of the degree of crystallinity of polyethylene sheets using a Fourier Transform InfraRed spectrometer (FTIR) were performed. The production of polyethylene target sheets was performed using two types of jigs with different heating and pressing methods. The uniformity of thickness had not been good enough, however, it was improved using a roller. We will report on the results of composition analysis and the current status of target production.

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Data analysis of isochronous mass measurement with two time-of-flight detectors at CSRe

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An upgraded Isochronous Mass Spectrometry (IMS) with two new Time-of-Flight (ToF) detectors has been established in the experimental cooler storage ring (CSRe) in Institute of Modern Physics in Lanzhou. The double-ToF IMS can measure the velocity of an ion stored in CSRe. Some preliminary results of the projectile fragments of $^{58}Ni^{19+}$ experiment conducted at the double-ToF IMS are presented in this poster. It is showed that the mass resolving power can be improved by correcting the momentum spread of stored ions with the velocity information.

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Development of Strip Readout Parallel Plate Avalanche Counter

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In a nuclear physics study using high intensity RI beam, high resolution position and timing detector is required for particle discrimination. We are developing Parallel Plate Avalanche Counter directory and independently reading out signals from strip electrodes, Strip Readout PPAC(SR-PPAC). It has no delay and high position resolution corresponding to strip size and charge resolution, and it is also stable even in high intensity beam without multi-hit. In this presentation, we report the evaluation of SR-PPAC through the results of the previous experiments conducted in HIMAC in Chiba.
It is going to be implemented at RI Beam Factory at RIKEN towards the measurement of 132 Sn (p, p) for the study of the neutron skin.

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Development of a Novel Surface Ionizer for the Electron EDM Measurement using Francium

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Francium (Fr) is expected to be a powerful probe for measuring the electron electric dipole moment (eEDM) in high precision, due to its large EDM enhancement factor. We have developed a surface ionizer to produce a high-intensity Fr ion beam at RIKEN. Due to spatial constraints of the experimental area, the yielded ions must be extracted from the ion source at an angle of 45 degrees with respect to the ionizing surface. By using an electrode of novel design, an efficient extraction of the ion beam is expected based on simulations. The demonstration of Fr ion production using this developed ion source is planned this fiscal year.

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Development of relativistic density functional theory with finite-light-speed correction toward electronic structures of super-heavy elements

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Chemical properties of trans-uranium and super-heavy elements, i.e., electronic properties in their isolated atomic form, are interesting objects of research as well as the nuclear properties. The ionization energy of lawrencium ($Z = 103$) was recently measured to be $4.96\,\mathrm{eV}$ at the tandem accelerator at the Japan Atomic Energy Agency (JAEA) [1]. This result and the ionization energy of lutetium, which is the elements above lawrencium in the periodic table, show a non-monotonic dependence among the other f-block elements. Moreover, the tendency of the ionization energy of lutetium and that of lawrencium are also different from each other. After that, the council of the International Union of Pure and Applied Chemistry (IUPAC) began to discuss whether lutetium and lawrencium belong to d-block elements or f-block elements[2]. Nevertheless, the origin of the different behavior of their ionization energies has not been understood.

To understand the origin of the tendency of such chemical properties, relativistic effects for the electronic structure are thought to be important. Pyykkö calculated the stable electronic configurations and proposed a periodic table of elements theoretically up to $Z = 172$ by using the Dirac Hartree-Fock equation with the Coulomb interaction [3]. However, the anomaly of the ionization energy of lawrencium mentioned above is not yielded according to his calculation. Several years later, Pershina calculated the ionization energy, electron affinity, and absorption enthalpy mainly by the coupled cluster single, double, and perturbative triple (CCSD(T)) method [4-7]. Although these quantities were accurately evaluated by theoretical calculations, the mechanism of the anomaly was not discussed.

To calculate the properties of the trans-uranium and super-heavy elements, we develop the density functional theory (DFT) with the relativistic effects. Since the numerical cost of DFT is much less than the wave function methods, such as the coupled-cluster method, DFT can be easily applied to molecules and solids as well. In our work [8], finite light-speed effect in $O\left(1/c^2\right)$, i.e., the Breit correction [9], is considered as well as effects incorporated by the use of the Dirac equation instead of the Schrödinger equation.

With the conventional non-relativistic calculation, the electronic configurations of the d-block elements are stabilized for both lutetium and lawrencium. In contrast, the present relativistic correction stabilizes the p-block configuration in lawrencium, while the d-block configuration is kept stable for lutetium. This difference of the electron configurations may cause the anomaly of the ionization energy of lawrencium. Since the numerical cost of our method is lower than the wave function methods, our method enables us to study chemical and physical properties of super-heavy elements systematically.

Our method is also promising for calculation of other fundamental physical properties such as the electric dipole moment of electrons.

In this talk, we briefly introduce the idea of our method, its results including the possible origin of the anomaly of the ionization energy of lawrencium, and future perspectives.

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Dr. TadaAki Isobe

Study of EOS

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Equation of States for Neutron Stars Constructed by Machine Learning from GW170817

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Equation of States for Neutron Stars Constructed by Machine Learning from GW170817

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Experimental Research on Single Event Effect in SRAMs with Three Different Feature Sizes

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Experimental studies on single-event effects of static random access memories (SRAMs) with different feature sizes were carried out at 100 MeV cyclotron proton accelerator of China Institute of Atomic Energy. Single-event upset (SEU) cross-section curves with different proton energies and different incident angles were obtained for three SRAMs. The effects of incident proton energies and angles on the single-event upsets saturation cross section of SRAM with different feature sizes are analyzed, and the SEU characteristics of 65 nm SRAM are simulated by Monte Carlo method. The results show that increase the incident angle when the incident proton energy is relatively low, the increase of the single-event cross-section is due to the deposition of sufficient energy in more sensitive volumes, while increase the incident angle when the incident proton energy is relatively high, the increase of the single-event cross-section is due to the occurrence of more multiple-cell upsets. Finally, the complete cross section of 65 nm SRAM at different incident angles is obtained and the error rate estimation results are calculated.

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Experimental study of 4n with 8He(p,2p) reaction

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We will present our recent study of tetraneutron(4n) by using the 8He(p,2p) reaction with inverse kinematics, which was performed at RIKEN RIBF facility in 2017.
Many-neutron systems, in particular the tetraneutron, have attracted lots of attention in the last decades. Their existence of itself, whether as bound or resonate state, is of fundamental importance in nuclear physics, serving as a sensitive probe to investigate the nuclear force free from Coulomb interaction. However, no unambiguous conclusion could be drawn from the experimental data reported by far because of the extremely low statistics.

We have carried out new measurement on tetraneutron by using 8He(p,2p)7H{t+4n} reaction with inverse kinematics at RIBF. Neutrons were detected by NeuLAND demonstrator from GSI and NEBULA array, which can provide the highest 4-neutron detection efficiency(ε4n~1%) at present.

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First Mass Measurements with the Rare-RI Ring in RIKEN

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Nuclear mass plays an essential role in the understanding of the r-process which is responsible for the synthesis of about one-half of elements heavier than iron up to bismuth and all of thorium and uranium. The nuclei around the doubly magic numbers N=50, N=82 and N=126 are believed to be waiting points were matter accumulate and therefore form the major peaks in the r-process abundance. Sensitivity studies for the r-process have indicated that masses of neutron-rich nuclei in those regions have a significant impact on the final elemental abundance pattern. The binding energy deduced directly from nuclear masses of these nuclei can also be a sensitive probe of the structure of these nuclei.
Rare-RI ring (R3) is an isochronous mass spectrometer at RIBF in RIKEN. It aims at measuring the mass of exotic nuclei with a precision of 10-6 within less than 1ms. Thus, we can measure the mass of exotic nuclei with very short half-lives and low production yields.
In this contribution, we report on the first mass measurement campaign at R3 conducted in the Autumn of 2018. The masses of 74,76Ni in the N=50, Z =28 region which is related to the weak r-process nucleosynthesis were measured. The mass of 122Rh, 123,124Pd and 125Ag isotopes in the southwestern of N=82, Z= 50 region which are relevant for the main r-process nucleosynthesis were also measured.

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High-momentum squeezed-out n/p ratio as a probe of Ksym of the symmetry energy

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By involving the constraints of the slope of nuclear symmetry energy L into the question of determination of the high-density symmetry energy, one needs to probe the curvature of nuclear symmetry energy K_{sym}. Based on the Isospin-dependent Boltzmann-Uehling-Uhlenbeck (IBUU) transport model, effects of the curvature of nuclear symmetry energy on the squeezed-out nucleons are demonstrated in the semi-central Au+Au reaction at 400 and 600 MeV/nucleon. It is shown that the squeezed-out isospin-dependent nucleon emissions at high transverse momenta are sensitive to the curvature of nuclear symmetry energy. The curvature of nuclear symmetry energy at saturation density thus can be determined by the high momentum squeezed-out isospin-dependent nucleon emissions experiments from the semi-central Au+Au renaction at 400 or 600 MeV/nucleon.

The curvature of nuclear symmetry energy K_{sym} is related to the high-density and low-density symmetry energy. Thus, the curvature of low-density symmetry energy is constrainted with the n/p of squeezed-out nucleon and direct flows of nucleon in the central ^{132}Sn+^{124}Sn reaction at 270 MeV/nucleon. Then, the constraints of the curvature of high-density symmetry energy are by elliptic flows of nucleon and π^-/π^+, which effected by both of low-density and high-density symmetry energy.

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Hot neutron stars with microscopic equations of state

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We study the properties of hot beta-stable nuclear matter using equations of state derived within the Brueckner-Hartree-Fock approach at finite temperature including consistent three-body forces. Simple and accurate parametrizations of the finite-temperature equations of state are provided. The properties of hot neutron stars are then investigated within this framework, in particular the temperature dependence of the maximum mass. We find very small temperature effects and analyze the interplay of the different contributions.

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Neutron detector using scintillators in LAMPS

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Large Acceptance Multi-Purpose Spectrometer (LAMPS) experiment aims to measure the nuclear symmetry energy for rare isotopes with a wide range of N-Z at Rare isotope Accelerator Complex for ON-line experiment (RAON) in Korea. Neutrons have no net charge so that they cannot be detected by a device using electromagnetic force. The neutron detector for LAMPS is made of 4 layers of scintillators where each layer is arrayed with 20 scintillators. The size of a scintillator is 200 cm x 10 cm x 10 cm. When the neutron passes through the scintillator, the gamma ray from (n, gamma) reaction enters the photomultiplier tube at both ends. Then they generate an electrical signal. The 2-D scintillator is expected to be useful for measuring the Time of Flight and hit position of the neutrons. In this talk, the principle and the structure of the neutron detector and the results from cosmic ray will be presented. Furthermore, a plan for DAQ development will be introduced.

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New effective interactions IOPB-I and G3

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In this talk, we will discuss two new parameter sets for the energy density functional such as G3 and IOPB-I for finite nuclei, and infinite nuclear matter system within the effective field theory motivated relativistic mean-field (ERMF) formalism. The isovector part of the ERMF model employed in the present study includes the coupling of nucleons to the δ and ρ mesons and the cross-coupling of ρ mesons to the σ and ω mesons. The results for the finite and infinite nuclear systems obtained using our parameter sets are in harmony with those data extracted from various experiments. In particular, the neutron-skin thickness of 208Pb nucleus and canonical radius of the neutron star are compatible with the GW170817. The low-density behavior of the equation of state for pure neutron matter is in good agreement with other microscopic models. Also, we calculate the maximum mass and tidal deformability which is in quite well with the GW170817 as well as with the pulsar data.

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Nuclear rainbow in the inelastic nucleus-nucleus scattering

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The nuclear rainbow, observed in the elastic α-nucleus and light heavy-ion (HI) scattering at medium energies, is proven to be due to the refraction of the incident wave by the attractive nucleus-nucleus optical potential. The rainbow pattern is usually associated with a broad oscillation of the Airy minima in elastic scattering cross section, as a result of an interference of the refracted far-side trajectories. A similar refractive scattering pattern is naturally expected to be seen also in the inelastic scattering of the nucleus-nucleus system that exhibits a pronounced rainbow pattern in the elastic scattering. Some feature of the nuclear rainbow in the inelastic light HI scattering has been observed so far in experiments, like the measurement of the inelastic 16O+12C scattering at refractive energies by the Kurchatov-institute group. As variance with the elastic channel, the obtained data show a much weaker rainbow pattern in the inelastic scattering cross section, with the Airy structure much suppressed and smeared out. To investigate this effect, a method of the decomposition of the inelastic scattering amplitude into subamplitudes is proposed in the present work to explicitly reveal the coherent partial-wave contributions to the inelastic cross section. Based on the new decomposition technique, our coupled channel analysis of the elastic and inelastic 12C+12C , 16O+12C , and α+90Zr scattering at refractive energies has shown unambiguously that the suppression of the Airy structure of nuclear rainbow in the inelastic nucleus-nucleus scattering is due to the multipole mixing of different partial waves that give rise to the inelastic cross section.

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Optimal collectvie coordinate in nulcear collective dynamics

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Collective reaction paths for fusion reactions are microscopically determined on the basis of the adiabatic self-consistent collective coordinate (ASCC) method. This path is maximally decoupled from other intrinsic degrees of freedom. The reaction paths turn out to deviate from those obtained

with standard mean-field calculations with constraints on quadrupole and octupole moments. The potentials and inertial masses defined in the ASCC method are calculated along the reaction paths, which leads to the collective Hamiltonian used for calculation of the subbarrier fusion cross sections.

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Particle Identification by Pulse-Shape Analysis with Neural Network

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Recent cluster-model calculation predict that α condensed states emerge in self-conjugate $N = 4n$ nuclei. In the α condensed states, all of the α clusters are condensed in the lowest orbit, and their matter density is as low as 1/4−1/5 of normal nuclear states. Therefore, observation of the α condensed states is very important for clarifying physical properties of low-density nuclear matter. Once nuclear nuclei in the α condensed states are excited, they are expected to decay with emitting 1−3 MeV α particles. However it difficult to identify such low-energy particles by $E - \Delta E$ telescope, one of the most conventional Particle identification (PID) method, because these particles cannot penetrate ΔE detectors. Thus, In order to search for α condensed states, it is necessary to establish a new PID method to identify low energy particles.
In the present study, we have attempted to identify particles by analyzing pulse shape output from Si detectors. This method has been somewhat successful mainly for high-energy heavy ions, but it has not been establish for low-energy light ions.
In addition, we applied neural networks to PID. In conventional pulse-shape analysis (PSA), PID was performed by defining some parameters and comparing them between different particles. On the other hand, neural networks enable to performed multi-dimensional analysis and it is expected to go beyond the limit of the conventional methods. We acquired pulse shape for known particles and used them to train the neural networks. As a result, we succeeded to develop the neural networks to separate to separate α particles with hydrogen with very high accuracy. We will report details of our study and PID ability of the neural networks.

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Performance test of LaBr3(Ce) detectors for fast-timing gamma-ray measurements

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In nuclear physics, the precise measurement on the lifetime of the quantum state is essential to understand the many-body quantum system. Specifically, the lifetime information of first 2+ level in even-Z even-N nucleus provides crucial information on the nuclear structure. As the rare-isotope beams could be produced, the nuclear shell or shape evolution toward the drip-line has become significant to understand the interactions of nucleons in the extreme environment.

A fast-timing gamma-ray detector system composed of the LaBr3(Ce) scintillators are now under the development by the Center for Extreme Nuclear Matters (CENuM) in Korea to investigate the fundamental nuclear structure study on the very unstable nuclei far off the stability region. For the performance test, the bench tests of two LaBr3(Ce) scintillators with the size of 1.5 inch diameter attached to the R13408 PMTs are carried out. In this talk, the results from the performance tests of the LaBr3(Ce) detectors will be introduced.

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Precise magnetic field measurement of electron spectrometer for the electron scattering off unstable nuclei experiment

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There are two types of atomic nuclei: "stable nuclei" and "unstable nuclei". The unstable nuclei make up about 97\% of all nuclides, including those expected to theoretically exist. It has become clear that many of their characteristics such as shape and structure cannot be explained by the standard nuclear structure models. So far, the internal structure of the atomic nuclei have been elucidated mainly by electron scattering experiments using the stable nuclear targets. However, the electron scattering experiments using short-lived unstable nuclear targets have not been realized yet.

We have built the SCRIT (Self-Confining Radioactiv-isotope Ion Target)[1] electron scattering facility[2] at RIKEN RI Beam Factory in order to determine the charge density distribution of short-lived unstable nuclei by electron scattering. WiSES (Window-frame Spectrometer for Elecltron Scattering) is an electron spectrometer for the SCRIT experiment. WiSES consists of a dipole magnet, two drift chambers at the entrance and the exit of the magnet, two scintillation counters for trigger generation, and a helium-gas filled bag installed between the two drift chambers.The momentum of the scattered electrons is determined by reconstructing the trajectories from the magnetic field distribution of the magnet and information of the position and the angle of the scattered electrons obtained from two drift chambers. In order to determine the charge density distribution by elastic scattering, we need to identify the elastic and the inelastic scattering events by WiSES. The momentum resolution of WiSES is necessary to be at least 10^{-3} in the energy range of 150 to 300 MeV to be used for the SCRIT experiment. But the past studies show that it has not been reached yet. One of the possible causes is the incomplete knowledge of the magnetic field distribution. The calculated magnetic field map has been used so far. I will measure the magnetic fields instead of the calculated fieldmap in order to improve the momentum resolution of the spectrometer.Since three components of magnetic field are needed, I am developing a 3D Hall device.

In this talk, I will report the current status and future prospects of the WiSES magnetic field measurement.

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Young Scientist Session 1 / 22

Production mechanism of heavy and superheavy nuclei in multinucleon transfer reactions near Coulomb barrier energies

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To reach heavy neutron rich nuclei region and superheavy stability island, multinucleon transfer reaction is the most possible way, which has been investigated within dinuclear system model. The calculated transfer cross sections can reproduce the experimental data nicely. The transfer dynamics in the reaction of ^{124,132} Sn+^{238} U/^{248} Cm near Coulomb barrier energies is thoroughly analyzed. It is found that the total kinetic energies of primary fragments are dissipated from the relative motion energy of two touching nuclei and exhibit a symmetric distribution along the fragment mass. The angular distribution of the projectile-like fragments is moved forward with increasing the beam energy. However, the target-like fragments exhibit an opposite trend. The shell effect is pronounced from the fragment yields in multinucleon transfer reactions. More neutron-rich radioactive projectile ^{132} Sn in comparison to the stable beam ^{124} Sn are favorable to produce neutron rich nulcei with massive nucleons transfer. Numerous unknown neutron rich isotopes in prediction have been listed in form.

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Young Scientist Session 2 / 54

Progress in FRG for 1D nuclear matter

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The Density functional theory (DFT) is a microscopic method to get the ground-state energy of quantum many-body systems.
Due to the low numerical cost, it is widely applicable to nuclear, atomic and molecule physics.

In the DFT, the Hohenberg-Kohn theorem ensures that energy can be expressed as a functional of density, so-called "energy density functional (EDF)" and the EDF is uniquely determined. However, the theorem does not provide how to construct the EDF.

Recently, the functional renormalization group (FRG) in the quantum field theory helps to construct the EDF[1,2]. This idea is applied to the 1D nucleon system[3] and the 2D electron system[4], where these results are similar to those of Monte Carlo.
In order to apply to the inhomogeneous systems, we propose a new method with the flow equation for the density.

In this talk, we will report the comparison between this new method and the previous one in 1D homogeneous nucleon system.

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Young Scientist Session 2 / **39**

Research on Collective Flow in Small Systems with Special Geometric Initialization Structure

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A multiphase transport model (AMPT) is successful in describing the experimental data, mainly from heavy ion collisions at the BNL Relativistic Heavy Ion Collider. By using this AMPT model,
the initial geometry effect on collective flows, which are inherited from initial projectile structure, is studied in 4He+12C system. Elliptic flow (v2) and triangular flow (v3) which are significantly resulted from the chain and triangle structure of 12C with three-alpha clusters, respectively, in 4He+12C collisions are compared with the flow from the Woods-Saxon distribution of nucleons in 12C. We use an exact method which based on multiparticle correlations (cumulants) to suppress nonflow contribution. Our study demonstrates that the initial geometry of the collision zone can be explored by collective flow at the final stage in heavy-ion collisions.

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Ring artifacts removal from CT image slice using CNN and RNN net

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CT image ring artifacts are caused by the unsatisfactory response of detector pixels, which degrades the reconstructed image and affects the subsequent processing and quantitative analysis of the image. A novel algorithm based on deep learning is proposed to correct CT ring artifacts. The proposed correction procedure includes the following steps: (1) transfrom the training reconstructed images into polar coordinates; (2) seperate the transformed training images to two parts, near and far from the center;(3) train the two parts separately by the proposed deep learning net to achieve the weights and bias; (4) transfrom the test reconstructed CT images into polar coordinates; (5) seperate the transformed test image to two parts, near and far from the center; (6) input the two parts to the trained network and obtain two outputs; (7) merge the two outputs to one data; (8) transform the merged data back to Cartesain coordinates to restore the CT image slice with reduced ring artifacts. This approach has been successfully used on the CT data with simulated ring artifacts and the real data.

Poster Session by Young Scientists / 44

Search for α clustering in ^{14}O

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α clustering is a well-known phenomenon in light nuclei where two neutrons and two protons strongly correlate to constitute an α particle as a building block of atomic nuclei. A linear alignment of the α clusters, referred to as linear-chain cluster state (LCCS), has been of great interest since 1950s but until now there is no clear experimental evidence demonstrating the existence of such a state. Recently, it was theoretically pointed out that excess nucleons in non-4N nuclei occupy molecular orbitals between α clusters and the excess nucleons may stabilize LCCS. A candidate of LCCS in ^{14}C was experimentally proposed by H. Yamaguchi et al. [1].

It is an interesting issue whether the similar LCCS also exists in the mirror nucleus ^{14}O or not. The excess neutrons are replaced by protons in this case, and thus the energy shifts between ^{14}C and ^{14}O due to the Coulomb force should reflect spatial distribution of the excess nucleons. Therefore, it is expected to reveal the structure of the LCCS candidate by measuring its energy in ^{14}O and comparing it with that in ^{14}C and theoretical calculation.

Since ^{14}O is an unstable nucleus, it must be generated as a secondary particle. We conducted the experiment to search for α cluster states in ^{14}O at CRIB facility of CNS, the Univ. of Tokyo in June 2019. In this experiment, we injected a ^{10}C secondary beam at 36 MeV into the He gas target at 650 Torr, and measured the resonant elastic scattering of α+^{10}C with the Si detectors at 0 and $\pm$9 degrees by the thick target method. We will report details of the experiment and results in the talk.

References
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Poster Session by Young Scientists / 56

Study of Gamow-Teller Transition on N=Z nucleus Cr-48 with an improved DAQ

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A (p,n) reaction experiment on two N=Z nuclei, Cr-48, was performed in RIBF. In this study, we used inverse kinematics with 190MeV/u Cr-48 beam. We would like to make missing mass spectra using time of flight of neutrons. As neutrons are quite easy to pass through materials and heavy particles carrying up to 190MeV/u don't loss much energy in liquid hydrogen, a 6mm-thick liquid hydrogen target was used to increase statistics. We used PANDORA detector system, which has capability of discriminating neutrons and gamma rays, to detect neutrons from (p,n) reaction. The reaction residues were analyzed using SAMURAI spectrometer. By optimizing the DAQ setup, we achieved about 5.5kHz accepted trigger rate (which was at maximum ~2kHz before optimization). In this contribution, some preliminary result of Cr-48 data analysis and DAQ optimization information will be shown.

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Study of Gamow-Teller states in neutron-rich ^{11}Li

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The (p, n) reaction at intermediate energies (about 200MeV) is a very effective tool to investigate spin-isospin excitations in nuclei. Gamow-Teller (GT) states is one of the most basic spin-isospin excitations. GT states are changed spin and isospin of the nuclei by one unit without being changed the orbital angular momentum from the initial quantum state. Fermi states are also one of the most basic spin-isospin excitations. Fermi states occurs only between Isobaric Analog states (IAS), that only change isospin by one unit from the initial quantum state. These excited states appear such as Gamow-Teller Resonance (GTR) or IAS peaks and are the basic process involving spin and isospins. The energy difference between the peak of GTR and the peak of IAS is very sensitive for the neutron-proton asymmetry. While the research on the behavior of the neutron-proton asymmetry has been studied in stable nuclei, the research on unstable nuclei with the large asymmetry such as neutron-rich nuclei has not been well studied.

^{11}Li is a neutron-rich nucleus having very large asymmetry such as $N - Z/A = 0.45$. We investigated the spin-isospin excitation of ^{11}Li using the (p, n) reaction of ^{11}Li at Radioactive Isotope Beam factory (RIBF) in RIKEN. Because high Q value of ^{11}Li opens various decay channels after the (p, n) reaction, it is difficult to comprehensively study all decay channels in beta decay. At RIBF, it is possible to measure multiple particles simultaneously using Superconducting Analyser for MUti-particle from Radio Isotope beam (SAMURAI). we selected decay channels and comprehensively studied various decay channels for ^{11}Li. As a result, we got the excitation energy spectrum of ^{11}Be which seems to contain GTR around 18 MeV. It is the first time that GTR was observed by comprehensively measuring the (p, n) reaction of the neutron-rich ^{11}Li with high Q values.

In this presentation, I will talk about preliminary results in the ^{11}Li(p, n) reaction.

Young Scientist Session 3 / 33

Study on LaBr3(Ce) gamma-ray detectors by using Geant4 simulation

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The gamma-ray detector array composed of 24 LaBr3(Ce) scintillators is now in preparation for the decay spectroscopy with the fast-timing gamma-ray measurements by the Center for Extreme Nuclear Matters (CENuM) in Korea. Accordingly, the simulation based on the Geant4 framework has been performed for various purposes.
The encapsulated LaBr3(Ce) crystal with a size of 1.5-inch diameter was applied to the simulation to reproduce the energy spectra from the experiments with several radiation sources. Moreover, the self-radioactivity of La-138 contained in the crystal was considered to reproduce the background energy spectrum.
From our work on the simulation, the primary goals are as followings: reproducing the expected energy spectra from the specific beta-decay experiments, designing the detector configuration, and the efficiency calculations. In this presentation, we introduce our recent results from the Geant4 simulation of the LaBr3(Ce) gamma-ray detectors.

Poster Session by Young Scientists / 28

Study on high-density supersonic gas jet targets for laser-driven electron acceleration

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Laser wakefield acceleration is a novel concept for particle acceleration which can provide for a significant reduction of the accelerator length compared to conventional accelerators. The main issue in this field is a lack of control over the injection of electrons into the wakefield, resulting in a large spread in energy of the accelerated electron bunches. For producing this particular density profile, supersonic gas jets are a promising approach which is under intense investigation. The report mainly introduces team's the research progress and future plans of the supersonic gas jets providing sharp density gradients in plasma, which can be used for injection of electrons in laser wakefield acceleration.

Young Scientist Session 2 / 34

System scan in LHC energy

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The particle production and their ratios for π, k, p are studied in different collisions system at different centre of mass energy based on a blast-wave model with thermal equilibrium mechanism.
The transverse momentum spectra of the above-mentioned particles at the kinetic freeze-out stage are also discussed.

The kinematics freeze-out properties were fitted by the blast wave model. For the existing experimental data, the fitting results are consistent with the data given by the CERN-ALICE experimental group.
Under the framework of interacting hadron resonance gas, chemical freeze-out parameters such as chemical freeze-out temperature, baryon and strangeness chemical potential, and ad hoc suppression factors can be given simultaneously.
Through the thermal equilibrium model, our study constrains the chemical and kinematic freeze-out parameters. This gives us a better understanding of the nature of the dense and hot matter created in high-energy heavy-ion collisions at freeze-out stage.

Poster Session by Young Scientists / 30

The development of AT-TPC for nuclear astrophysics experiments at IMP

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New and next generation RIB facilities provide new insight into the nuclear structure and reaction dynamics of exotic nuclei. However, many of the most interesting species are always produced with very low intensities. Active target Time Projection Chamber (AT-TPC) is one powerful device with several significant features, including 4π acceptance of the reaction products, full detection efficiency and high sensitivity, and an event-by-event reconstruction in three dimensions. This enables the use of TPC to break through beam limitation and study nuclei very far away from stability. One novel TPC is being developed in a collaboration at IMP. Our primary goal is to study astrophysically important fusion reactions and key (α,p) reactions in the X-ray bursts.

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The electron screening effectct on the nuclear burning stages of stars

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We discuss the electron screening effects on the nuclear burning stages of stars. There is a dense electron cloud in the environment of fully ionized stellar plasma. The nucleus, which has a positive charge, streams in the electron cloud. This nucleus seems to have smaller charge than the original one. This phenomenon is called the electron screening effect. In this situation, the reaction rate could increase due to the lowered Coulomb barrier. In this work, we investigate the effect of electron screening using the network calculation of nuclear burning stages.

Poster Session by Young Scientists / 32

The generalized parton distributions with the higher twist order

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The generalized parton distributions(GPDs) is constructed in the high limit of the virtuality. The leading twist is only considered to make the process factorizable. In this presentation the higher twist order, cat's ears contribution, is included to confirm the correction in the low virtuality. To solve the integration with complicated singularities and to avoid the regularization problem, we use the 1+1 light-front dynamics. We obtain the scattering amplitude satisfying the Ward identity and the real/imaginary part of the Compton form factor. With assuming the deeply virtual scattering, the full calculation is reduced to like the generalized parton distributions and we compare the full calculation with GPDs reduction to show the contribution of higher twist order in the virtuality of the current experiment.

Poster Session by Young Scientists / 57

Thin non-isochronous position sensitive detector for use in the rare RI-ring

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The Rare RI-ring is a newly constructed mass storage ring at RIKEN, built with the purpose of measuring the mass' of exotic nuclei, such as those produced during the r-process. In order to develop the rings mass measuring capabilities, in ring beam diagnostics is required. For this purpose, a large area, non-isochronous, position sensitive detector with low energy loss is being developed to monitor beam position inside the ring.

The chosen design uses accelerated secondary electrons which are then reflected, by an electrostatic mirror, towards an MCP and delay line to measure position. Simulation tests suggest that, for the non-isochronous condition, the optimum acceleration and mirror potential ratio is 1:1. A prototype detector has been built as was able to achieve a resolution of up to 2.3mm in the x-direction during recent online tests at HIMAC.

Young Scientist Session 3 / 47

Towards inverse modeling problems in nuclear physics

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Recent developments in nuclear potentials based on chiral effective field theory and in various ab-initio approaches have enlarged our microscopic understandings to a wide range of nuclear chart including doubly open-shell nuclei.
However, is it enough to consider only those bottom-up approaches for making reliable predictions about exotic nuclei for which experimental verification is extremely difficult?
In this talk, I will explain importance of so-called "inverse modeling problems" and the preprocessing towards inverse modeling problems, that is, uncertainty quantification of theoretical predictions, by taking recent publications as examples.

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microsopic study of fission dynamics

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nuclear fission is a large amplitude collective motion. It is particularly important in the areas of energy production and nuclear waste disposal. Microsopic study of fission phenomenon is a truly predictive theory. We use the TDHF method to study the fission process after the fission barrier. we compare the fission process and fission fragment disturbution at different inital deformation point(β_2,β_3). Also,we have studied the pairing effect influence in the fission process.

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opening greeting

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overview of RIBF facility