Seminars EBSS 2014

Monday, 28th July

6:15 -6:35 pm
Dan Shields
"SPIDER Progress Towards High Resolution Correlated Fission Product Data"
Abstract: The SPIDER detector (SPectrometer for Ion DEtermination in fission Research) is under development with the goal of obtaining high-resolution, high-efficiency, correlated fission product data needed for many applications including the modeling of next generation nuclear reactors, stockpile stewardship, and the fundamental understanding of the fission process. SPIDER simultaneously measures velocity and energy of both fission products to calculate fission product yields (FPYs), neutron multiplicity (nu), and total kinetic energy (TKE). A detailed description of the prototype SPIDER detector components will be presented. Characterization measurements with alpha and spontaneous fission sources will also be discussed. Supported through LA-UR-14-24875

6:35 -6:55 pm
Yu Kiyokawa
"Construction of Isomer Search System at RIKEN SHARAQ"
Abstract: The direct mass of neutron-rich argon(Z=18), potassium(Z=19) and calcium(Z=20) isotopes beyond N=32 was measured with SHARAQ (Spectroscopy with High-resolution Analyzer of Radio Active Quantum beams)spectrometer at RIKEN RI Beam Factory in Japan. One of the assumed origins of background is a contribution from the isomeric states of fragments. They are considered to make the centroid of deduced mass higher. Ar, K and Ca isotopes are expected not have to isomer states. However since long-lived isomers are found in even-mass Sc isotopes, we will be ready to find unknown isomers. In order to identify the isomers and to determine isomer ratios, a beam stopper with suitable thickness for Sc isotopes and gamma-ray detectors such as Ge and NaI detectors was installed downstream of S2. Now I am analyzing data searching for new isomers.

Fig.1. Big-RIPS-SHARAQ beam line

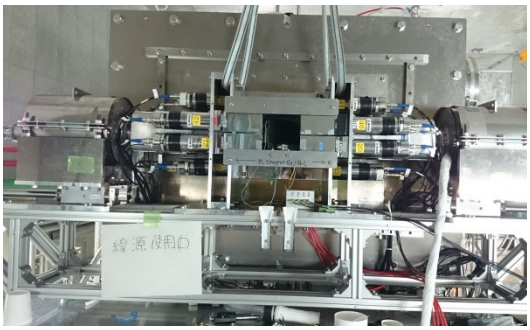

Fig.2. Ge & NaI rack

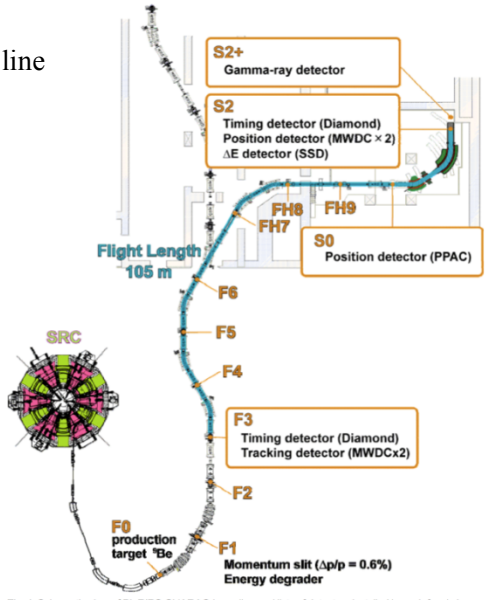

Fig. 4: Schematic view of BigRIPS-SHARAQ beamline and lists of detectors installed in each focal plane.

6:55 – 7:15 pm

Dominic Rafferty

"Investigating energy dissipation through nucleon transfer reactions"

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Abstract: Nucleon and cluster transfer probabilities have been measured in the systems $^{16,18}O$,^{19}F + $^{208,204}Pb$, ^{209}Bi for proton stripping channels down to Z = - 2. Strong pairing correlations have been observed, with visible enhancements of 2p and 2n transfer probabilities relative to expectations of an independent particle transfer picture in particular channels. New measurements were made using an improved ΔE-E telescope developed from a previous design, which support previous observations from the ANU. The back-scattered projectile-like fragments were measured in the telescope at θ_lab = 160.6 degrees, and in combination with monitor detectors at forward angles allowed determination of absolute transfer probabilities. The improved design allows better mass resolution, with different isotopic yields now measurable to greater precision. An analysis of neutron transfer channels has shown that 2n stripping in ^{18}O + ^{208}Pb at energies below the Coulomb barrier, whilst negligible in ^{16}O + ^{208}Pb, is significant, being comparable to that of 1n stripping. A Q-value analysis of the reaction products again indicates the population of highly excited states in the residual target- and projectile-like fragments, in agreement with previous observations[1].

[1] M. Evers et al. Phys Rev C 84(2011).

Tuesday, 29th July

6:15 -6:35 pm

Mark Spieker

"Octupole Correlations in Positive-Parity States of the Rare-Earth and Actinide Nuclei"

Mark Spieker1, Dorel Bucurescu2, Janis Endres1, Thomas Faestermann3,
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Abstract: Low-lying and collective octupole excitations are not a common feature of the atomic nucleus. Therefore, their observation at specific parts of the nuclear chart yields important information about the interactions, which govern the atomic nucleus. Very recently, experimental data for 220Rn and 224Ra [1] have triggered new interest in the octupole degree of freedom in the actinides and rare earths [2-4]. While these studies discussed the possibility of a first-order phase transition to octupole-deformed shapes to be observed already in the ground state, also second-order phase transitions to octupole-deformed shapes at higher spins have been studied in the actinides [5]. Furthermore, the possibility of octupole-phonon condensation [6] has been discussed to describe the experimental results in the actinides [7] and rare earths [8]. A common feature of Refs. [5-8] has been the inclusion of double-octupole phonon excitations.

In this contribution, we will present further evidence to support the importance of multiphonon-octupole excitations to describe new and existing experimental data. First, we will present new results

of a (p,t) experiment at the Q3D magnetic spectrograph, which we performed to selectively excite Jp=0+ states in ^{240}Pu. Especially for the second J^{π}=0+ states of the actinides, a pairing isomeric character has been previously discussed because of their uniformly strong (p,t) population. In our recent publication we have shown that the spdf interacting boson model (IBM) is able to describe this strong (p,t) population, while predicting a double-octupole structure of the second J^{π}=0+ state in ^{240}Pu [9]. It will also be shown that the inclusion of the negative-parity bosons is important to describe the enhanced E1 transitions observed for the second K^{π}=0+ rotational band members [9]. Second, we have adopted the framework of the IBM to test the description of experimental observables related to octupole excitations in the rare earths. Here, we could show that the IBM is able to describe the signature splitting and the *E1/E2* ratios between positive- and negative-parity states when multi-dipole and multi-octupole phonons are included. The present study might support the idea of octupole-phonon condensation at intermediate spin (Jp=10+) to describe the change in Yrast structure observed in the rare earths.

[1] L. P. Gaffney et al., Nature 497 (2013) 199
[2] R. V. Jolos, P. von Brentano, and J. Jolie, Phys. Rev. C 86 (2012) 024319
[3] L. M. Robledo and P.A. Butler, Phys. Rev. C 88 (2013) 051302(R)
[4] K. Nomura et al., Phys. Rev. C 89 (2014) 024312
[5] R. V. Jolos, P. von Brentano, and R. F. Casten, Phys. Rev. C 88 (2013) 034306
[6] S. Frauendorf, Phys. Rev. C 77 (2008) 021304(R)
[7] X. Wang et al., Phys. Rev. Lett. 102 (2009) 122501
[8] S.P. Bvumbi et al., Phys. Rev. C 87 (2013) 044333
[9] M. Spieker et al., Phys. Rev. C 88 (2013) 041303(R)

6:35 -6:55 pm

Kyle Brown

"Two-proton decay from T=2 isobaric analog states."

Abstract: Two-proton decay is the most recently discovered type of radioactive decay and was originally thought to occur only when one-proton decay was energetically forbidden. This description was extended to democratic two-proton decay, in which the one-proton intermediate is energetically allowed but where the decay energy is of the same magnitude as the intermediate width. Our work further extends this description to a third class of two-proton emitters in which one-proton decay is energetically allowed, but isospin forbidden. Three possible examples of this type will be discussed ($8B_{IAS}$, $12N_{IAS}$, and $16F_{IAS}$). The measurements of these decays at the National Superconducting Cyclotron Laboratory and Texas A&M will be described.

6:55 – 7:15 pm

Dana Duke

"Average Total Kinetic Energy Measurements of Neutron Induced Fission for ^{235}U, ^{238}U, and ^{239}Pu"

Abstract: Most of the energy released in neutron-induced fission goes into the kinetic energy of the resulting fission fragments. Additional average Total Kinetic Energy (TKE) information at incident neutron energies relevant to defense- and energy-related applications would provide a valuable observable against which simulations can be benchmarked. These data could also be used as inputs in theoretical fission models. Experiments at the Los Alamos Neutron Science Center - Weapons Neutron Research (LANSCE - WNR), measured TKE of fission products following the neutron induced fission of ^{235}U, ^{238}U, and ^{239}Pu over incident neutron energies from thermal to hundreds of MeV. Depending on

isotope, little or no TKE data exist for high neutron energies. Measurements were made using a double Frisch-gridded ionization chamber. Preliminary analysis using the double energy (2E) method will be presented, including fission fragment emission angles, masses, and energies for 238U. LA-UR-14-21782

7:15 – 7:35
James Tracy
"Reporting on the A=74 chain in the beta decay of Z=29-31"
Abstract: With the objective of developing our understanding of the excited states of neutron-rich nuclei in the Z=29-31 decay chain, gamma-rays in the 20-5200 keV range along with $\gamma\gamma$ and $\beta\gamma$ coincidences starting with ^{74}Cu parent nuclide have been collected using 4 "clover" germanium (Ge) detectors and analyzed. Using $\gamma\gamma$ and $\beta\gamma\gamma$ coincidences, decay schemes have been constructed and compared to existing data at the National Nuclear Database Center. Gaussian fits of the peaks in the data have been performed, yielding centroids and areas, from which energy levels, gamma energies and their intensities have been determined. New transitions and new energy levels have been identified for the decays of ^{74}Cu and ^{74}Zn. Previous placements of transitions in ^{74}Ga are confirmed, and some possible double placements may be clarified through further analysis.

Wednesday, 30th July

6:15 -6:35 pm
Cody Parker
"Measurement of the 3H(d,gamma)/3H(d,n) Branching Ratio at Center-of-Mass Energies Below 300 keV."
Abstract: The branching ratio ^{3}H(d;γ)^{5}He/^{3}H(d; n)α has been measured using a 500-keV pulsed deuteron beam incident on a stopping titanium tritide target at the Edwards Accelerator Laboratory. The time-of-flight technique has been used to distinguish the γ-rays from the neutrons in the bismuth germinate γ-ray detector. Two stilbene scintillators and an NE-213 scintillator have been used to detect the neutrons using both the pulse-shape discrimination and time-of-flight techniques. The preliminary measurement at a cross-section-weighted average energy of 196 keV that produced a branching ratio measurement of 6.9(1.6)x10^{-5}. Data from the recently completed measurements, which include improvements from a newly designed target holder, the addition of a silicon detector to simultaneously measure α-particles, and a new titanium tritide target, will briefly be discussed.

6:35 -6:55 pm
Andrea Richard
"Measurement of the Breakup Cross Section of the D+D Reaction at 6.94 MeV for the Active Interrogation of Hidden Fissile Materials."

Abstract: The D-D reactions are well known and widely used for a variety of purposes, mainly due to the mono-energetic neutron peak from the D(d; n)^{3}He reaction. The least studied of the D-D reactions is the D(d; np)D reaction known as the deuteron breakup reaction. The D(d; np)D reaction produces a continuum of neutrons at energies lower than that of the mono-energetic peak. In this work, the D(d,np)D reaction has been studied for the purpose of use as a neutron source for the active interrogation of hidden fissile materials. The neutron energy distribution as a function of angle for the

cross section, $d^2\sigma/(d\Omega dE)$, of the D(d,np)D reaction has been measured in the Edwards Accelerator Laboratory using a 6.94-MeV pulsed deuteron beam incident upon a D2 gas target. The time-of-flight technique was used to determine the energy of the neutrons detected in the array of two lithium glass scintillators and one NE-213 scintillator. The breakup cross section was determined as low as 225-keV neutron energy in the lithium glass detectors.

6:55 – 7:15 pm

Elisa Romero-Romero

FORMATION OF LARGE CLUSTER ANIONS OF CU WITH A Cs-SPUTTERING SOURCE

Elisa Romero-Romero1,2, Ran Chu1,2, Shiyu Fan1,2, Alfredo Galindo-Uribarri1,2, Yuan Liu2, Gerald Mills2,
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2 Physics Division, Oak Ridge National Laboratory, Oak Ridge TN 37831, USA

Abstract: Intense beams of Cu cluster negative ions have been observed with a cesium-sputter negative-ion source. The formation of large cluster is being investigated. Using different bombarding energies up to 8 keV, sputtered Cu cluster anions containing up to about 50 atoms have been obtained. Mass analyses reveal that the Cu clusters comprise 63,65Cu isotopes and the composition distributions of the two isotopes follow a binomial distribution of their corresponding natural abundances. We observed breaks in the Cu cluster anion intensity distributions at certain "magic numbers" and odd-even alternation, with the odd clusters more abundant than the adjacent even clusters.

Thursday, 31th July

6:15 -6:35 pm

Nikita Bernier

"Investigations of Background and Compton Suppression Shields for GRIFFIN".

GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei) will replace the 8pi spectrometer at the TRIUMF ISAC facility by the end of 2014 with an array of 16 large-volume hyper-pure germanium (HPGe) clover detectors and instrument them with a state-of-the-art digital data acquisition system. The facility will be used to investigate a variety of aspects in nuclear structure, nuclear astrophysics and fundamental symmetries using stopped radioactive beams from ISAC. The most exotic nuclei are generally produced with the lowest intensity so in order to perform spectroscopy with these beams the greatest possible sensitivity is required. In addition, in the decay of intense beams it is often the weakest decay branches which are of the greatest interest. It is well established that active Compton-suppression shields comprised of bismuth germanate (BGO) can be an effective tool to increase the peak-to-total ratio of gamma-ray spectra collected with HPGe detectors. These active shields will also suppress background radiations originating from the experimental hall, which will further improve spectral quality. A series of measurements have been performed at ISAC using a GRIFFIN HPGe clover to characterize the spectrum of background events. The detector was then coupled with a TIGRESS BGO Suppression shield to investigate the effectiveness of such active shielding on the final gamma-ray spectrum.

These measurements support the funding application for instrumenting the entire GRIFFIN array with suppression shields. A detailed description of the investigations and results will be presented.

6:35 -6:55 pm
Cristian Xavier Baldenegro Barrera
"PROSPECT Project: measurement of anti-neutrino spectrum near High Flux Isotope Reactor at ORNL"

Abstract: Segmented antineutrino detectors placed near a compact research reactor provide an excellent opportunity to probe short-baseline neutrino oscillations and precisely measure the reactor antineutrino spectrum. Such a measurement can be performed in the High Flux Isotope Reactor highly-enriched uranium fueled research reactor using near-surface segmented scintillator detectors. Here are presented the main goals of the collaboration and the recent results of the background radiation measurements.

6:55 – 7:15 pm
Rutger Dungan
"Gamma Ray Spectroscopy of ^{19}O".

Abstract: The ^{14}C(^{9}Be, α) reaction was used to study excited states of ^{19}O at 30 MeV and 35 MeV. The Florida State University (FSU) γ array was used to detect γ radiation and charged particles were detected and identified with a silicon ΔE-E particle telescope. From α-γ-γ coincidences three new states of ^{19}O have been identified and an additional γ transition from the 3067 keV state to the 96 keV state has been observed. Future work includes comparing our results to shell model calculations.

7:15 – 7:35
Ivy Krystal Jones
Spectroscopic Properties of Pr3+ doped PbCl2 for Eye-Safe ~ 1.6 µm Laser Applications
Ivy Krystal Jones, E. Brown , U. Hömmerich
Department of Physics, Hampton University, Hampton, Virginia 23668

Abstract: The development of new gain media for eye-safe laser applications continues to be an active area of research. Most efforts have been focused on bulk solid-state gain media using the well known 1.5 mm transition of Er3+ ions doped into oxide host materials (e.g. Er: YAG, Er: Y2O3). A new eye-safe laser transition at ~1.6 mm was recently reported from Pr3+ doped into the low-phonon energy host RbPb2Cl5. In this work, results of the purification, crystal, and IR spectroscopy of Pr3+ doped PbCl2 are presented. PbCl2 is non-hygroscopic and has a low maximum phonon energy (~180 cm-1), which enables efficient emission in the infrared (IR) spectral region. Commercial PbCl2 was purified through a combination of zone-refinement and chlorination of the melt. The dopant PrCl3 was added to the purified PbCl2 and molten under bubbling of HCl gas. The crystal growth of Pr: PbCl2 was performed using horizontal Bridgman technique. The resulting Pr3+ doped PbCl2 crystal exhibited strong IR absorption bands in the 1.4-1.6 µm region, which allow for resonant pumping using commercial diode lasers. Pumping at ~1.45mm resulted in a broad IR emission band (~75nm @ FWHM) assigned to the

3F3→3H4 transition. Decay time studies revealed an average lifetime of ~170 μs at room-temperature, which increased to ~350 μs at 40 K. Results of temperature dependent absorption and emission studies as well as an analysis of the 1.6 mm emission cross-section will be discussed at the conference.