

IOP Nuclear Physics Conference

13–15 April 2026

University of Brighton, Brighton, UK



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IOP Institute of Physics

Monday 13 April 2026

10:30	Location: Foyer, Huxley Building Registration and Refreshments Exhibition Opens
	Location: Huxley 300
11:00	(Invited) Were the Superheavy Elements Made in Nature? Ani Aprahamian
11:30	(Invited) Nuclear structure and dynamics at finite temperature Nils Paar
12:00	(Invited) Storage Rings for Nuclear Physics and Astrophysics Ragandeep Singh Sidhu
12:30	Location: Cockcroft Building Lunch and Exhibition <i>(Tea and Coffee will be served in the Foyer, Huxley Building)</i>
	Location: Huxley 300
13:45	(Invited) Extending the Chart of Nuclides: How to Create New (Super)Heavy Nuclei Sophia Heinz
14:15	(Invited) Neutrino–Nucleus Interactions from Reactors to the Cosmos: Precision Measurements and New Physics Opportunities Ivan Martinez-Soler

14:45	(Featured) Quantum entanglement of positron annihilation gamma – fundamental research applied to Positron Emission Tomography (PET) imaging Laura Stephenson		
15:00	(Featured) Detector-Aware Neural Networks for Particle Identification in Pb-Pb Collisions: Feature Set Embedding with Adaptive Attention Mechanisms Robert Forynski		
15:15	Location: Huxley Foyer Tea Break and Exhibition		
	Location: Huxley 300 Parallel Session A	Location: Huxley 406 Parallel Session B	Location: Huxley 407 Parallel Session C
15:45	Production of Terbium-161 at HF-ADNeF Max Conroy	A Compact Multimode Detector for the Decommissioning of Irradiated Graphite Nia Hunter	Exploring intense photon/muon beams as Dark Matter detectors Mikhail Bashkanov
16:00	Nuclear Reaction Studies at NIF: Establishing the Method and Recent Results Daniel Pitman-Weymouth	Transforming Inorganic Scintillators Into Neutron Spectrometers Joseph O'Neill	GEn-RP: Neutron Electric Form Factor Measurement using Recoil Polarimetry at Jefferson Lab Andrew Cheyne
16:15	Nuclear and radiation backgrounds for the BUTON anti-neutrino detector testbed at Boulby William Hopkins	The Structure of Neutron-Rich $N \sim 126$ Nuclei Gee Bartram	Quantum Machine Learning Meets Predicting Nuclear Binding Energy Serkan Akkoyun
16:30	Detecting water in spent nuclear fuel using the prompt neutron capture reaction on hydrogen Brendan Green	Competing decay modes from the $25/2^-$ spin-gap isomer in ^{155}Lu Andy Briscoe	Investigating the boundaries of enhanced octupole collectivity in the rare-earth region Pietro Spagnoletti
16:45	Probing Short Range Correlations via (p,pd) Quasi-Free Scattering reactions Matthew Whitehead	Investigations of the unbound states in ^{20}C Sidong Chen	Direct Measurements of Low-Lying Monopole Transitions in ^{28}Si Jacob Towers

17:00	Location: G50, Cockcroft Building Poster Session and Refreshments
19:30	Close of Day 1

Tuesday 14 April

08:30	Location: Huxley Foyer Arrival Refreshments
	Location: Huxley 300
09:00	(Invited) Radioactive ion beams for real-time PET-guided adaptive particle therapy Daria Boscolo
09:30	(Invited) Measurement of exclusive J/ψ photo-production with CLAS12: present status and future proposals Bryan McKinnon
10:00	(Featured) Evidence of isomeric states in $^{183,184}\text{Ta}$ Siddharth Doshi
10:15	(Featured) First identification of resonant states in the $^{45}\text{V}(p,\gamma)^{46}\text{Cr}$ reaction and their influence on the production of ^{44}Ti in core-collapse supernovae Chris Cousins
10:30	Latest developments in nuclear physics detectors Damian Ralet
10:45	Location: Huxley Foyer Coffee and Exhibitors

	Location: Huxley 300 Parallel Session D	Location: Huxley 406 Parallel Session E	Location: Huxley 407 Parallel Session F
11:15	Constraining the density-dependence of the symmetry energy by cross section measurements at R3B Lukas Ponnath	Particle identification with Bragg spectroscopy at ISOLDE Solenoidal Spectrometer Michał Włodarczyk	The dynamical evolution of the parity splitting energy in nuclei with octupole deformation Radu Budaca
11:30	Uncertainty quantification of spin-parity assignments in ^{19}Ne with ML methods Benjamin Wood	A Novel Method for PET Radioisotope Photoproduction Josephine Stone	Recent developments for microscopic optical potentials for nucleon-nucleus elastic scattering Ashley Pitt
11:45	Evidence of the $9\text{B}(1/2^+)$ state in the $^{12}\text{C}(p,a)^9\text{B}$ reaction Alex Brooks	Differential cross section measurements for (n,α) reactions with a Time Projection Chamber Jack Bishop	Lifetime measurements of the 2^+ state in ^{128}Nd and ^{132}Sm Jacob Heery
12:00	Lifetime measurements in neutron-rich barium and cerium isotopes using the fast-timing technique Faye Rowntree	Deep Learning for Enhanced Muon Tomography Imaging William O'Donnell	Laser spectroscopy measurements of $^{151-175}\text{Tm}$. On behalf of the COLLAPS collaboration Jack Hughes
12:15	$B(E2)$ measurements of heavy $N = Z$ nuclei at FRIB Michael Bentley	Position resolution estimation of Adaptive Grid search algorithm for multi-site interactions position determination in 'SIGMA' detector Nawaf Altasan	Radiative decay and electromagnetic moments in ^{229}Th determined within nuclear DFT Alejandro Restrepo-Giraldo
12:30	Location: Cockcroft Building Lunch		
	Location: Huxley 300		
13:30	(Invited) Quantum algorithms for the nuclear shell model Arnau Rios Huguet		

14:00	(Invited) The Path to Commercial Fusion Energy Chantal Shand
14:30	(Featured) Development of collectivity beyond N=50 in the Ge and Se isotopes Frank Browne
14:45	(Featured) Stress-Testing AGATA: Benchmarking the High-Spin Capabilities of the 1 π AGATA Spectrometer at LNL Connor Sullivan
15:00	Location: Huxley Foyer Tea Break
15:30	Location: Huxley 300 STFC Town Meeting
17:30	Location: Huxley Foyer Exhibitors Reception
19:00	Location: Palm Court Restaurant, Brighton Palace Pier, Madeira Drive, Brighton, England, BN2 1TW Conference Dinner
23:00	End

Wednesday 15 April

09:00	<p>Location: Huxley Foyer Arrival Refreshments</p>		
	<p>Location: Huxley 300</p>		
09:30	<p>Exploring the key astrophysical reaction $^{12}\text{C}(\alpha, \gamma)$ with TPCs and γ beams Robin Smith</p>		
10:00	<p>Unveiling nucleon structure through measurements of Generalized Parton Distributions Silvia Niccolai</p>		
10:30	<p>Location: Huxley Foyer Coffee Break</p>		
	<p>Location: Huxley 300 Parallel Session G</p>	<p>Location: Huxley 406 Parallel Session H</p>	<p>Location: Huxley 407 Parallel Session I</p>
11:00	<p>Pixel-based Target Recoil Tracker (TRT) for R3B at FAIR Beatriz Amorim</p>	<p>First Cross-Section Measurements of the $^{93}\text{Sr}(\alpha, xn)^{95-96}\text{Zr}$ Reactions: Implications for the Weak r-Process Claire Jameson</p>	<p>Decay Spectroscopy of Medical Imaging Isotope Terbium-152 Edward O'Sullivan</p>
11:15	<p>Development of novel LaBr3(Ce) Detector Modules for Nuclear Astrophysics Applications Sulagna Dutta</p>	<p>Beta-decay spectroscopy of proton-rich N=82 isotones Norah Alwadie</p>	<p>Water neutron moderation of AmBe: a computational approach with Geant4 Filippo Falezza</p>
11:30	<p>Elucidating Strangeness with Electromagnetic Probes Asli Acar</p>	<p>A direct measurement of the $^{27}\text{Al}(\alpha, p)^{30}\text{Si}$ cross section with TACTIC Annabelle Cyster</p>	<p>Shell evolution and neutron halo formation in heavy sodium isotopes Jagjit Singh</p>
11:45	<p>Preliminary $2\text{Pi}0$ channel analysis at GlueX Alexandra Berger</p>	<p>A Novel Approach to Observing Nuclear Excitation by Electron Capture John Fuller</p>	<p>Unveiling proton-neutron pairing in homogeneous and isotropic nuclear matter Betania Backes</p>

12:00	Jet measurements with the ALICE experiment at the LHC Jaime Norman	Probing the $10B + \alpha$ pathway for primordial stars at LUNA: Experimental techniques and preliminary results Rhys Bonnell	Thermal effects on neutron capture cross sections using a quantum dynamical approach Nicholas Lightfoot
12:15	Location: Cockcroft Building		
12:45	Lunch	Location: Huxley 300 IOP Nuclear Physics Group AGM	
13:30	(Featured) Fission studies using quasi-free scattering reactions in inverse kinematics Jose Benlliure		
13:45	(Featured) Anapole Moment Calculated within Nuclear DFT Herlik Wibowo		
14:00	(Invited) Spectroscopy of pear-shaped nuclei John Smith		
14:30	(Invited) Nuclear signatures from binary stars Rob Izzard		
15:00	Closing Remarks		
15:15	End of Conference		

Poster Programme

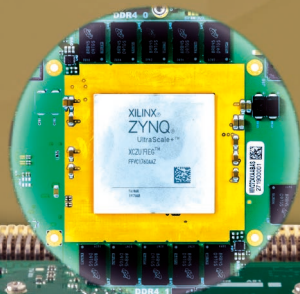
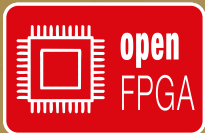
- P1 Electrons for Neutrinos
Jhanzeb Ahmed, University of York
- P2 Beta-delayed gamma-ray Spectroscopy of ^{225}Fr to ^{225}Ra
Abdulrahman Alshammari, University of Ha'il, University of Surrey
- P3 Development of an isotopic inventory model for cross section measurements made at the National Ignition Facility
James Benstead, AWE Nuclear Security Technologies
- P4 Measurement of Λ_b production in pp collisions with ALICE
Chris Carr, University of Birmingham
- P5 Hyperon Nucleon Interactions at CLAS
Joshua Bryce, University of York
- P6 Lifetime Measurement of the 2^+ Excited State in ^{78}Y
Cameron Cassells, University of the West of Scotland
- P7 Prompt and delayed spectroscopy of ^{196}At – installation of the novel detector SIGMA in the focal plane
Sneha Das, University of Liverpool
- P8 Alpha-particle condensation in diluted neutron-rich oxygen nuclei
Miriam Davies, University of Surrey
- P9 LiquidO opaque scintillator radiation detectors for particle tracking
Max de Carlos Generowicz, University of Sussex
- P10 The KLong Experiment in Hall D at Jefferson Lab
Stuart Fegan, University of York
- P11 Exploring and Developing an Analysis Framework for the Application of the Trojan Horse Method to Radiative Neutron Capture Reactions for Fusion
Patrick Galvin, University of Birmingham
- P12 Coulomb Excitation of $^{50-54}\text{Ca}$: E2 strength beyond $N = 28$
Ting Gao, University of York
- P13 Interpolation of Lutetium Neutron Optical Model Potential Parameters using Bayesian Monte-Carlo Analysis
Adam Giambone, University of Surrey
- P14 Investigating the Low Lying Nuclear Structure of ^{40}Ar using Coulomb Excitation
Adam Giambone, University of Surrey
- P15 Investigation of Octupole Collectively in Light Actinides via Multinucleon Transfer Reactions with AGATA-PRISMA
Henry Hilton, University of Liverpool

- P16 Identification of excited states in Ba-114 using recoil-decay tagging
Ben Hogg, University of the West of Scotland
- P17 Lifetime measurements in ^{53}V
Calum Jones, University of Surrey
- P18 In-situ spectral analysis for strontium-90/caesium-137 discrimination in contaminated land
Malcolm Joyce, University of Lancaster
- P19 Determination of absolute gamma ray emission intensities and the half-life of Ho-166m
Arshjot Kaur, National Physical Laboratory, UK
- P20 The effect of non-locality on the (p,t) transfer reaction applied to surrogate reaction modelling
Javier Kenyon-Reyero, University of Surrey
- P21 Probing shape coexistence in the neutron-deficient mercury isotopes with the Coulomb-excitation technique
Hannah Kleis, University of Liverpool
- P22 Fault-Tolerant Quantum Algorithms for Complex Nuclear Systems
Lloyd La Ronde, University of Surrey
- P23 Generalising the Formalism of Electroproduction with Polarised Targets by Implementing Moments Analysis
Dillon Leahy, University of Glasgow
- P24 MuDirac 1.2.5: A Sustainable Software Tool for Calculating Ground State Nuclear Properties Using Muonic X-Ray Measurements
Leandro Liborio, Scientific Computing Department, STFC
- P25 Dosimetric Characterisation of a Reproducible Helium Ion Beam at the MC40 Cyclotron
Isobel Lock, University of Birmingham
- P26 The performance of the μ -RWELL MPGD at low pressures using the TACTIC test chamber
Lara Rose Malpas, University of York
- P27 The optimisation of neutron production from the d-Li reaction
John Murphy, University of Birmingham
- P28 Precision Measurements of MeV scale Quantum Entanglement and decoherence at TRIUMF
Nicholas Michaelides, University of York
- P29 A Unified Quantum-Geometric Framework for Generalized Artificial Neural Networks
Muhammad Nawaf Nafi, Bangladesh Air Force Shaheen College Dhaka

- P30 Constraining the Neutron Skin of ^{120}Sn via Dipole Polarizability and Charge Exchange Reactions
Amritpal Singh Nafria, Lamrin Tech Skills University
- P31 Isomers, Masses, and Half-lives in Neutron Rich Nuclei at the GSI Experimental Storage Ring
Zachary Nunns, University of Surrey
- P32 Modelling In-Plasma Nuclear Reactions with FISPACT
Daniel Pitman-Weymouth, AWE
- P33 Preliminary Studies of Charged Pion Electroproduction on Deuterium
Kathleen Ramage, University of Glasgow
- P34 Hybrid Classical-Quantum Non-Perturbative Simulation of Nucleon-Nucleon Scattering
Saba Rani, University of Trento
- P35 Investigation of a Novel Segmented Point-Contact BEGe Detector
Emily Richardson, University of Liverpool
- P36 BUTON at Boulby - a testbed for monitoring the anti-neutrino flux from nuclear reactors
Bjoern Seitz, University of Glasgow
- P37 In-Beam Gamma-Ray Spectroscopy of Neutron Rich Calcium isotopes
Joshua Sharpe, University of York
- P38 Exploring the Use of the Trojan Horse Method for Radiative Neutron Capture Reactions
Dominik Stajkowski, University of Birmingham
- P39 Producing covariances for fast neutron incident reactions on deformed isotopes using the TALYS code
Aaron Stott, AWE
- P40 Bayesian calibration of optical potentials and propagation of uncertainties to compound nucleus reactions
Samuel Sullivan, University of Surrey
- P41 CeBr_3 scintillator development for HYPATIA: a next-generation hybrid gamma-ray detector array at the RIBF
Luke Tetley, University of York
- P42 Machine Learning Enhanced Analysis of Silica Glass Jewellery Beads for Thermoluminescence Dosimetry Health Monitoring
Lukasz Tomaszewski, NTR-Net, University of Surrey
- P43 Moments of Angular Distribution of K^+K^- with CLAS12
Charlie Velasquez, University of York
- P44 Benchmarking SRO Performance of CAEN Digitizers
Yuri Venturini, Caen Spa

- P45 Coulomb Excitation of $^{200,202}\text{Hg}$
Greg Willmott, University of Surrey
- P46 Pulse Shape Discrimination Plastic Scintillators for the Detection of Radioactive Materials
Toby Wolverson, University of Surrey
- P47 "Engineering Spin-Dependent Potential Barriers for Enhanced Neutron Flux Filtration in the neV Energy Regime"
Pranjal Bhardwaj, Fergusson College, Pune

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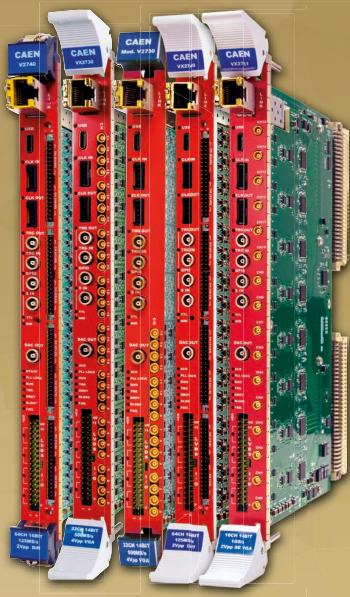
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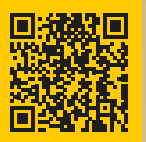


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(Invited) Were the Superheavy Elements Made in Nature?

Ani Aprahamian¹

¹University of Notre Dame, USA

The periodic table of elements is now full up to the $Z=118$, element, Oganesson, the last element in the noble gas column of elements. The table contains elements that were in time identified by fission and by nuclear reactions. Some of them were deliberately created in the laboratory while others were sought after after weapons tests to reach the superheavy elements or rather the predicted island of stability. Environmental tests of nuclear weapons had indicated the creation of new elements. Theoretical chemists expect no limitations on the creation of chemical elements up to an astonishing $Z=174$ well beyond Oganesson. The question that has remained unanswered is whether the exotic elements or the superheavy elements were ever made in nature. Simulations of the rapid neutron capture process indicates that there are enough neutrons to reach the actinides and beyond. What would be the evidence that nature had in fact made the superheavy elements? One can point to the observational evidence of fission recycling in old stars. Can similar signatures answer the question?

I will discuss the possibilities.

This work was supported by the US National Science Foundation under contract PHY-2310059

(Invited) Nuclear structure and dynamics at finite temperature

Nils Paar¹

¹University of Zagreb, Croatia

Nuclear reactions in stellar environments such as core-collapse supernovae and neutron star mergers proceed under extreme thermal conditions, where temperatures reach up to billions of kelvin and profoundly modify nuclear structure and reactions. This talk presents recent advances in the microscopic description of hot nuclei based on relativistic energy density functional theory. First, a comprehensive mapping of neutron and proton drip lines at finite temperature, up to 23 GK, is explored within the finite-temperature relativistic Hartree–Bogoliubov framework including the particle continuum. Temperature dependencies of neutron emission lifetimes, quadrupole deformations, neutron skins, and pairing gaps are analyzed, revealing modest effects below $T \approx 1$ MeV and pronounced structural changes at higher temperatures. Finite temperature effects are also important in electromagnetic response in hot nuclei. A microscopic finite-temperature description of electric (E1) and magnetic (M1) γ -ray strength functions shows strong low-energy modifications due to thermal unblocking. Notably, the M1 contribution becomes increasingly important at finite temperature, in contrast to zero-temperature behavior, with direct implications for neutron-capture rates. Finally, the emergence of hot pygmy dipole strength is explored using finite-temperature relativistic quasiparticle random-phase approximation calculations for Ni isotopes. Significant enhancement of low-energy dipole strength is predicted with increasing temperature, especially in neutron-rich systems, providing key benchmarks for ongoing experiments and nucleosynthesis modeling in explosive astrophysical scenarios.

(Invited) Storage Rings for Nuclear Physics and Astrophysics

Ragandeep Singh Sidhu¹

¹University of Surrey, UK

Storage rings are powerful and versatile tools for high-precision experiments with highly charged stable and radioactive ions, enabling unique studies at the interface of atomic and nuclear physics. At the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, Germany, the Experimental Storage Ring (ESR) provides exceptional opportunities for the efficient use of rare and short-lived ion species. Advanced beam-manipulation techniques, such as accumulation, bunching, and deceleration, allow ions to be stored at sufficient intensities and at energies relevant for astrophysical processes.

This talk will present recent highlight results from the FAIR Phase-0 research programme at the ESR, with an emphasis on their relevance to nuclear physics and astrophysics. An outlook on planned future measurements and upcoming facilities will also be discussed.

(Invited) Extending the Chart of Nuclides: How to Create New (Super)Heavy Nuclei

Sophia Heinz¹

¹GSI Helmholtz, Germany

How and where are the heaviest chemical elements created in the universe? Where is the upper end of the periodic table? And what is the nature of the still obscure nuclear force? Such fundamental questions occupy nuclear physicists. The answers are mostly hidden in the properties of still unknown exotic nuclei, mainly located on the very neutron-rich side and at the upper end of the nuclide chart. But how does one populate these still vacant areas? The standard nucleosynthesis reactions, which are fragmentation, fission and fusion, are reaching their limits. Therefore, other pathways to exotic nuclei are needed. This talk will present an overview of emerging concepts and current experimental strategies aimed at accessing these unexplored territories.

(Invited) Neutrino–Nucleus Interactions from Reactors to the Cosmos: Precision Measurements and New Physics Opportunities

Ivan Martinez Soler¹

¹Durham University, UK

Understanding neutrino–nucleus cross sections has become central to modern neutrino physics, providing a powerful means to probe fundamental neutrino properties and to search for physics beyond the Standard Model. At MeV energies, the observation of coherent elastic neutrino–nucleus scattering (CEvNS) from a variety of sources has opened new opportunities to test light mediators and non standard interactions, while exploring neutrino cross sections at higher energies offers the possibility of identifying new neutrino sources. In this talk, I will show how

precise cross section measurements across these regimes advance three interconnected goals: determining intrinsic neutrino properties, enabling searches for new physics, and identifying or characterizing new neutrino sources, including astrophysical ones. Leveraging the capabilities of current and upcoming detectors, I will discuss how sources such as reactor antineutrinos and the Diffuse Supernova Neutrino Background (DSNB) can contribute to this broader program, and how accurate modeling of neutrino cross sections is essential to fully unlock the scientific potential of low energy neutrino measurements.

(Featured) Quantum entanglement of positron annihilation gamma – fundamental research applied to Positron Emission Tomography (PET) imaging

[Laura Stephenson](#)¹, and Daniel Watts¹

¹University of York, UK

The University of York nuclear group led recent paradigm-shifting advances in our understanding of the quantum entanglement (QE) of the 2-gamma final state following positron annihilation, including establishing benefits in next-generation QE-PET imaging and revealing QE is extremely robust to interactions with the environment.

This talk will present first results from our next stage programme to establish and quantify QE in the 3-gamma final state following positronium annihilation. Such systems are among the few in nature predicted to exhibit genuine tripartite QE. However, this has never been tested or confirmed. There are therefore rich possibilities for both fundamental science and applications, e.g. the emerging modality of 3-gamma PET, which offers event-by-event source reconstruction and the potential for clinically relevant environmental sensitivities.

Preliminary analysis of a new dataset will be presented, obtained with a large acceptance array comprising 2048 LYSO and 1024 GAAG detector crystals - assembled through a new collaboration between the universities of York and Tokyo. Measurements were obtained using clinically relevant F-18 positron sources, in a range of annihilating media, prepared by collaborators at King's College London. Early results from analysis of these new data will be presented, including new methods to isolate 3-gamma and 2-gamma yields in PET crystals, comparison of yields with a new Geant4 simulation, and some first studies of the dependence of the 3-gamma/2-gamma ratio on the annihilating media employed in the experiment. An outlook for the next stages of the programme, including the key QE measurements, will also be presented.

(Featured) Detector-Aware Neural Networks for Particle Identification in Pb-Pb Collisions: Feature Set Embedding with Adaptive Attention Mechanisms

Robert Forynski^{1,2}

¹University of Derby, UK, ²CERN, Switzerland

Particle identification (PID) is crucial for reconstructing rare probes in heavy-ion collisions. Traditional approaches — such as Bayesian methods utilising Time-of-Flight and dE/dx information — are limited by detector availability and correlations. A novel detector-aware neural network architecture combining Feature Set Embedding (FSE) with group-wise multi-head self-attention mechanisms is presented, designed to optimise PID performance across varying detector configurations in Pb-Pb Run 3 data.

The approach addresses a critical challenge in heavy-ion physics: a significant fraction of events lack complete detector signatures due to geometric acceptance and reconstruction inefficiencies. Rather than discarding incomplete data, an adaptive framework is developed that learns specialised decision boundaries conditioned on available detector information (TPC-only, TOF-only, or combined TPC+TOF).

The FSE architecture encodes detector-specific embeddings, learns group-wise attention patterns, and gracefully handles missing Bayesian PID probabilities through masked training. Evaluated on the intermediate momentum range (0.7–1.5 GeV/c), the detector-aware model achieves +2.2% improvement in classification accuracy compared to standard FSE baselines, with particularly strong gains in TPC-only configurations (+16.9%).

Comparative analysis against established machine learning baselines (XGBoost, Random Forest, DNN) and traditional Bayesian methods demonstrates competitive performance on real detector data whilst maintaining computational efficiency. This work illustrates how domain-aware neural network design can transform detector limitations into opportunities for improved particle identification in collider physics.

Parallel Session A

Production of Terbium-161 at HF-ADNeF

Max Conroy¹, Tony Price¹, Carl Wheldon¹, Luigi Capponi², and Robert Mills²

¹University of Birmingham, UK, ²UK National Nuclear Laboratory, UK

Terbium-161 is a highly promising theranostic isotope, with a potent combination of β - and Auger electron emission. Production is typically via neutron activation in research reactors, meaning the UK has no domestic production capabilities for ¹⁶¹Tb. At the University of Birmingham, the High-Flux Accelerator-Driven Neutron Facility (HF-ADNeF) can produce neutron fluxes on the order of 10^{12} n/cm²/s, making it an ideal location to investigate the production of neutron-rich medical radioisotopes, such as ¹⁶¹Tb. In this work, a detailed simulation of HF-ADNeF has been designed using the radiation transport code, OpenMC. This has been used to predict achievable ¹⁶¹Tb

activities and to explore combinations of moderator and reflector geometries, optimising both production yield and radionuclidic purity. In addition, the simulation produces facility-specific neutron energy spectra, enabling experimental spectrum-averaged cross-section measurements to be made.

Nuclear Reaction Studies at NIF: Establishing the Method and Recent Results

Daniel Pitman-Weymouth¹

¹AWE, UK

Since achieving ignition at NIF in 2022, a collaboration between LLNL and AWE has been developing a method of exploiting the high neutron yield to perform nuclear reaction studies. Last year, proof of principal measurements were presented. This presentation will give a brief run through of the method with a focus on our recent $^{88}\text{Y}(n,2n)$ cross-section results.

Nuclear and radiation backgrounds for the BUTTON anti-neutrino detector testbed at Boulby

Bjoern Seitz¹, and William Hopkins¹

¹University of Glasgow, Glasgow, UK

The sensitivity of antineutrino detectors is ultimately limited by radiological and cosmogenic backgrounds that populate the low-energy region relevant for inverse beta decay detection. A detailed understanding of these backgrounds is essential for both detector optimisation. The Boulby Underground Technology Testbed for Observing Neutrinos (BUTTON), located 1.1 km underground at the Boulby Laboratory, provides a uniquely low-background environment in which such studies can be undertaken.

This presentation focuses on the identification, measurement, and modelling of the dominant background sources relevant to water-based and hybrid antineutrino detectors. We discuss intrinsic radioactivity from detector materials and surrounding infrastructure, including contributions from uranium and thorium decay chains, potassium-40, and radon progeny, and their impact on trigger rates.

Despite the substantial cosmic-ray attenuation at Boulby, residual muons remain an important source of correlated backgrounds. We present ongoing and planned studies of muon-induced neutron production in the surrounding rock and detector materials, including spallation and muon-induced fission processes. Particular emphasis is placed on cosmogenic neutrons, their transport, moderation, and capture, and the resulting delayed backgrounds that can mimic antineutrino signals.

Monte Carlo simulations incorporating underground muon transport and detailed detector response are used alongside in situ measurements to validate background models and inform

shielding, veto strategies, and detector media choices. These studies provide essential input for scaling hybrid antineutrino detectors toward practical reactor monitoring applications.

Detecting water in spent nuclear fuel using the prompt neutron capture reaction on hydrogen

Brendan Green¹, Damilola Folley¹, Robert Mills², David Hambley², and Malcom Joyce¹

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An approach to detect and locate water in spent nuclear fuel (SNF) utilising the neutron capture reaction on hydrogen (to yield deuterium) to exploit the resulting prompt 2.223 MeV γ ray is described. Water present in spent nuclear fuel (SNF) and other fuel element debris (FED) is detrimental to the long-term storage stability of the material due to chemical and structural effects it induces. This research builds on previous efforts to construct a mock AGR fuel element using zinc as a fuel analogue and polyethylene (HDPE) as a water substitute. A series of simulations in Geant4 have been carried out of a modelled fuel element surrounded by reverse electrode germanium (REGe) detectors. Water was added selectively to fuel pins and a γ -ray spectrum from each detector was obtained with both SNF and zinc in the place of fuel material. The features of each spectrum have been processed by a machine learning model allowing for the triangulation of the water-logged fuel pin. Additional randomised water-logged pins will be simulated, and the efficacy of the machine learning model will be tested and optimised. These simulations will be replicated using the physical model and two REGe detectors. Small ²⁵²Cf neutron sources will be placed within select pins in the element so as to emulate the natural production of spontaneous fission neutrons and neutrons from (α , n) reactions. If successful in measuring 2.223 MeV γ rays from the HDPE, machine learning will be applied to the experimental arrangement using spectra from the two REGe's.

Probing Short Range Correlations via (p,pd) Quasi-Free Scattering reactions

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The experimental evidence points to the existence, at short distances, of strongly correlated neutron-proton pairs much like they are in the deuteron or in free scattering processes. As it moves through the nuclear medium, a "bare" nucleon in the presence of the nucleon-nucleon interaction becomes "dressed" in a quasi-deuteron cloud [1], about 20% of the time. A phenomenological analysis of the quenching of spectroscopic factors [2] and recent data from Jefferson Lab [3] point to an isospin dependence of the independent-particle model content in a dressed nucleon. It is expected that this dependence should also be reflected in the dressed amplitude and thus, in the virtual quasi-deuteron content in the ground state. Following from the qualitative arguments above, quasi-free scattering (QFS) of deuterons could offer a sensitive probe to examine these concepts.

We have performed a pioneering experiment at the R3B setup at GSI-FAIR that can serve as a template to test the above conjecture; we have measured the (p,pd) QFS cross section for knocking out a deuteron in $^{10,14,16}\text{C}$ relative to ^{12}C as an additional tool to probe short-range correlations and their isospin dependency.

In this contribution, the motivation for this experiment and the experimental setup used will be presented, together with the analysis and preliminary results.

[1] K. Brueckner, in Proceedings of the Rutherford Jubilee Int. Conf. Manchester 1961

[2] S. Paschalis, M. Petri, A. O. Macchiavelli, O. Hen, and E. Piasetzky, Physics Letters B 800 (2020) 135110

[3] M. Duer, et al., Nature 560 (2018) 617

Parallel Session B

A Compact Multimode Detector for the Decommissioning of Irradiated Graphite

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The decommissioning of aging nuclear reactors and future Gen-IV reactors is a global challenge. The processing and disposal of radioactive material from these reactors is a massive endeavour with far reaching environmental and economic implications. The classification and characterisation of these materials is vital not only for reducing the environmental impact of long-lived radionuclides but also in processing them in a fiscally responsible way. One material of particular interest is graphite used in the construction of aging Magnox and AGR reactors. The long-lived radionuclides present in irradiated graphite, particularly ^{14}C and ^{36}Cl present unique issues in their characterisation, processing, and disposal. A novel scintillation detector for this purpose was developed and tested in a series of experiments at Atomfa Trawsfynydd, a twin Magnox reactor site undergoing decommissioning works in North Wales. The prototype detectors were deployed in fuel channels from the reactor charge face, and a radiation survey was conducted at a series of fixed points throughout the channel. In this presentation, the properties of the prototype detectors are examined, particularly their efficiency, noise characteristics, and gamma sensitivity. The results from the experiment are presented and evaluated in comparison to a trepanning study which was conducted in July 2022. Preliminary analysis demonstrates that the detector system is capable of measuring beta activity as a function of depth inside the fuel channel and provide a pulse height spectrum at each position.

Transforming Inorganic Scintillators Into Neutron Spectrometers

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Scintillator materials capable of dual-mode gamma-neutron detection are of vital importance to the nuclear energy and national security sectors, as well as to fundamental scientific research. Inorganic scintillators such as LaCl₃(Ce), LaBr₃(Ce), and CeBr₃ offer high light yields, fast emission times, and exhibit intrinsic fast-neutron sensitivity via (n,p) and (n,α) reactions.

LaCl₃(Ce) and LaBr₃(Ce) scintillators can typically distinguish neutron and gamma scintillation signals using pulse shape discrimination (PSD); however, their performance varies significantly between samples and depends strongly on dopant concentration and material purity. Recent work has explored advanced waveform analysis techniques to greatly improve discrimination performance, by up to 300%. In this work, we demonstrate the use of fast Fourier transform-based analysis to perform neutron spectroscopy measurements with LaCl₃(Ce) and LaBr₃(Ce) detectors.

Furthermore, while CeBr₃ exhibits negligible conventional PSD capability, we show clear separation of neutron-induced gamma, proton, and alpha particle signals arising from fast-neutron interactions using this analysis method. This presents benefits from both neutron spectrometry and from greatly improved neutron signal suppression in mixed-field environments.

The Structure of Neutron-Rich N~126 Nuclei

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An experiment was performed at GSI Helmholtzzentrum für Schwerionenforschung using a high-intensity ²⁰⁸Pb primary beam at 1 GeV/u incident on a ⁹Be target to populate neutron-rich fragmentation products near the N = 126 shell closure. Nuclei in this region are of particular interest for testing shell-model predictions and constraining the astrophysical r-process path toward heavy nuclei.

Reaction products from the GSI Fragment Separator were implanted into two 1 mm thick AIDA active silicon stoppers (24 × 8 cm²), surrounded by two scintillating β-plastic detectors. Gamma-ray spectroscopy was performed using an array of eight newly developed DEGAS detectors and two EUROBALL high-purity germanium detectors.

The primary aim of the experiment was to investigate the structure of neutron-rich N = 126 nuclei through the observation of isomeric transitions. The Fragment Separator was centred on ²⁰³Ir and ²⁰²Os for approximately one day and three days, respectively. In total, 62 neutron-rich nuclei were populated, with γ-ray spectroscopy carried out for 40 nuclei. Experimental level schemes and transition strengths for N = 125 and N = 126 nuclei were established where possible and compared with predictions from three shell-model parameterisations.

Key results include a revised level scheme and improved isomeric lifetime for ^{203}Ir , a tentative partial level scheme for the most neutron-rich $N = 126$ nucleus ^{202}Os , and the first spectroscopic information on ^{197}Re and the newly observed ^{200}Re . The properties of ^{197}Re indicate a prolate–oblate shape transition between $A = 196$ and 197 .

Competing decay modes from the $25/2^-$ spin-gap isomer in ^{155}Lu

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The decay properties of the neutron-deficient $N=84$ isotones are characterised by the presence of spin-gap isomers arising from the attractive monopole interaction between $h_{11/2}$ protons and $h_{9/2}$ neutrons, which perturbs the ordering of the single-particle orbitals. The resulting irregular spin sequences necessitate a large change in angular momentum, leading to hindered α -decaying isomeric states. Spin-gap isomers have been observed in the $N=84$ isotones ^{156}Hf , ^{155}Lu , ^{158}W , and ^{160}Os , that decay exclusively via α decay. Investigating the properties of these states provides vital information on nuclear structure near the limits of stability, where the ordering of single-particle orbitals is drastically changing.

Previous studies of ^{155}Lu established the $25/2^-$ isomer as decaying exclusively via hindered α decays with a half-life of 2.7 ms. Until now, a complete experimental characterization of this state has been constrained by the difficulty of identifying weak electromagnetic decay branches amidst the substantial background that precludes the identification of transitions when correlating γ rays on millisecond time scales.

The experiment was performed at the Accelerator Laboratory of the University of Jyväskylä. Nuclei were produced in the $^{102}\text{Pd}(58\text{Ni},3\text{p}2\text{n})^{155}\text{Lu}$ fusion-evaporation reaction. By exploiting the MARA recoil separator, the decay properties of ^{155}Lu were studied via conversion-electron spectroscopy of the implanted nuclei. An electromagnetic branch depopulating the $25/2^-$ isomeric state will be presented, and the experimental extraction of $B(\text{M}3)$ and $B(\text{E}4)$ strengths will be discussed alongside new α -decay fine-structure to non-yrast states in ^{151}Tm . These results provide new spectroscopic insights into the decay dynamics of the most neutron-deficient lutetium isotopes.

Investigations of the unbound states in ^{20}C

Sidong Chen¹, Liam Atkins¹, Marina Petri¹, Stefanos Paschalis¹, Ryo Taniuchi¹, Nigel Orr², Julien Gibelin², and SAMURAI DayOne Collaboration

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Carbon isotopes ($Z=6$), which exhibit the first spin-orbit shell gap originating from the splitting of the $1p_{1/2}$ – $1p_{3/2}$ orbitals, provide an excellent ground for studying the evolution of proton spin-orbit splitting toward the neutron dripline. Neutron-rich carbon isotopes have been extensively investigated over the last decade. Measurements of transition probabilities $B(\text{E}2;2^+ \rightarrow 0^+)$ up to ^{20}C have revealed an increase in collectivity from ^{16}C to ^{20}C , interpreted as enhanced mixing

between unperturbed neutron and proton $2+$ excitations, driven by a reduction of the proton spin-orbit splitting.

More recently, neutron-rich $^{16,18,20}\text{C}$ were studied via proton removal reactions from nitrogen isotopes. Cross sections populating the ground and $2+1$ states indicated an increasing proton component of the $2+1$ state, supporting a moderate reduction of the proton spin-orbit splitting. These studies also predicted a mixed-symmetry $2+$ state at an excitation energy of around 7 MeV, expected to be strongly populated in proton removal reactions. As this state lies above the neutron separation energy, it is unbound and predominantly decays by neutron emission.

In this work, we report on an investigation of unbound states in ^{20}C , populated via proton removal from ^{21}N . The radioactive ^{21}N beam was produced by the BigRIPS separator at RIBF and impinged on a carbon target. The unbound states in ^{20}C were analyzed using the SAMURAI spectrometer via invariant mass spectroscopy. In this report, the experimental setup, the data analysis as well as the preliminary results will be presented.

Parallel Session C

Exploring intense photon/muon beams as Dark Matter detectors

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The presence of Dark Matter is known only through its gravitational pull, which shapes galaxies and holds them together, and it is therefore rarely questioned whether DM could be detected through light.

Previously assumed to be invisible, our study suggests that DM could leave faint, measurable marks on light as it passes through regions where the elusive substance is present — challenging long-held assumptions that the two never interact. We show that despite the fact that DM has no direct coupling to photons, the light-DM cross-section is non-vanishing, albeit small. The cross-section, calculated within the SM framework, is large in the case of heavy WIMPs. Combined with astrophysical observation, these results can constrain existing DM models in favour of lighter DM, or non-weakly interacting pure gravitational DM. We also show that the energy dependence of light scattering on dark matter should make the DM coloured - red in the case of weak-DM and blue for gravitational-DM, when a white background light is passing through. Gravitational scattering of light on DM particles also leads to non-trivial polarization effects, which might be easier to detect.

Besides astrophysical observations, we will show that dark matter can interact with high-energy photon and muon beams at hadron facilities and can therefore be detected there. We will discuss how photon beamlines of future facilities can be modified to not only serve its usual purpose of studying hadrons, but also to detect DM particles in a parasitic mode.

GEn-RP: Neutron Electric Form Factor Measurement using Recoil Polarimetry at Jefferson Lab

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The electromagnetic form factors of nucleons are fundamental observables that provide crucial constraints for theoretical predictions of hadron structure. The Super Bigbite Spectrometer (SBS) program at Jefferson Lab (JLab) comprises a suite of experiments measuring nucleon electromagnetic form factors at high momentum transfer. This presentation focuses on one of these experiments, GEn-RP, which aims to measure the neutron electric form factor (GEn) at the highest Q^2 to date using recoil polarimetry (RP).

The experiment makes use of CEBAF's high-luminosity, highly polarised electron beam scattered from an unpolarised liquid deuterium target. By measuring the polarisation transfer to recoiling neutrons, GEn can be extracted from the ratio of transverse to longitudinal polarisation components (Pt/Pl). At high momentum transfer, traditional neutron polarimetry via $np \rightarrow np$ scattering becomes challenging due to decreasing analysing power. GEn-RP aims to validate the charge exchange ($np \rightarrow pn$) polarimetry technique that maintains analysing power at higher Q^2 , enabling future form factor measurements at unprecedented energies.

Data collection was completed in Hall A at Jefferson Lab between April 16 and May 14, 2024, using typical beam current of 10-12 μA on LD2 at $Q^2 = 4.4 \text{ (GeV/c)}^2$. Preliminary analysis reveals expected azimuthal asymmetry, with ongoing work to refine these results. This presentation will detail the experimental setup, analysis procedures, and preliminary findings from the collaboration.

Quantum Machine Learning Meets Predicting Nuclear Binding Energy

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¹Surrey University, Guildford, UK, ²Sivas Cumhuriyet University, Türkiye, ³Artvin Çoruh University, Türkiye

Nuclear binding energy is a fundamental observable quantity for understanding nuclear structure, stability, and reaction energies across the nuclear table. Despite decades of theoretical advancements, obtaining fast and accurate binding energy predictions for a wide range of nuclei remains a challenging task due to strong nonlinear effects, shell effects, and region-dependent correlations. This study addresses the success of quantum-based and quantum-inspired machine learning approaches in predicting nuclear binding energy.

Experimental binding energies from the AME2020 database are used; the dataset is divided into Light, Medium, and Heavy mass regions to systematically analyze differences in data density, noise level, and physical behavior. As part of the methodology, hybrid architectures based on variational quantum circuits and quantum-inspired kernel methods are developed to decode the complex structure of nuclear data. The results reveal that the performance of quantum models exhibits characteristic differences depending on the mass regions.

Particularly in the heavy mass region, where data quality and linearity are improved, the developed quantum architectures have been observed to achieve high accuracy rates and possess a strong capacity for modeling nuclear data patterns. Conversely, the learning dynamics and noise sensitivities of the algorithms have been detailed in regions where the dataset is sparser and noisy. This research represents a significant step in integrating quantum computing techniques into nuclear data analysis and demonstrates that QML models are a promising approach for future simulations of nuclear physics problems.

Investigating the boundaries of enhanced octupole collectivity in the rare-earth region

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Atomic nuclei which exhibit a reflection-asymmetric shape are of considerable interest for the understanding of nuclear structure. These "pear-shaped" nuclei are expected to occur in the regions of the nuclear chart where the octupole degree of freedom is enhanced. Strong octupole correlations manifest when the Fermi surface lies close to single-particle orbitals with quantum numbers $[l,j]$ and $[l-3,j-3]$ giving rise to the octupole magic numbers $N,Z=34,56,88$ and $N=134$. Atomic nuclei in these regions can exhibit enhanced particle-hole interactions from the octupole component of the nucleon-nucleon interaction. The electric-octupole (E3) transition rate provides the most unambiguous signature of octupole collectivity; however, such measurements are often extremely challenging, as E3 transitions compete very weakly against other allowed transitions.

The region around $Z=56$, $N=88$ possesses the most complete set of $B(E3)$ values across the nuclear chart, with the largest values observed in ^{148}Gd and ^{150}Gd ; however, spectroscopic data for the dysprosium isotopes is largely missing. Within the $N=82$ chain, increasing $B(E3)$ strength is observed with increasing proton number from $Z=54$ (Xe) to $Z=64$ (Gd) and it remains unknown whether this trend continues in ^{148}Dy ($Z=66$). To investigate whether enhanced octupole collectivity is present in dysprosium isotopes and extend or constrain the boundaries of enhanced octupole collectivity, we performed a direct measurement of the $B(E3)$ value in ^{148}Dy . A beta-decay study of ^{148}Ho was performed at the TRIUMF facility using the GRIFFIN spectrometer. The mean lifetime of the 3^- state was measured using fast-timing methods with LaBr detectors.

Direct Measurements of Low-Lying Monopole Transitions in ^{28}Si

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We report the first model-independent measurements of the $0_{2^+} \rightarrow 0_{1^+}$ and $0_{3^+} \rightarrow 0_{1^+}$ transitions in ^{28}Si . Two inelastic proton scattering experiments have been performed using the Super-e pair spectrometer at the Australian National University's Heavy Ion Accelerator Facility. The squares of the dimensionless monopole transition strengths, $\rho^2(E0)$, were extracted from the observed absolute pair intensities. In a two-state mixing view, $\rho^2(E0)$ values can be related to the difference in the root-mean-square charge radii of the respective initial and final states. Provided that a

transition is not suppressed by low mixing ratios of the wavefunctions of the initial and final states, a larger $\rho^2(E0)$ can serve as an indicator of significant changes in the deformation of the nucleus during that transition. Our preliminary values for the low lying monopole transitions in ^{28}Si are $\rho^2(E0, 0_{2+} \rightarrow 0_{1+}) \times 10^3 = 246(25)$ and $\rho^2(E0, 0_{3+} \rightarrow 0_{1+}) \times 10^3 = 5.9(21)$. The significant monopole strength of the $0_{2+} \rightarrow 0_{1+}$ transition could be attributed to significant mixing between the β -vibration and ground state bands, but a change in the root-mean-square charge radius is also required. In the case of the $0_{3+} \rightarrow 0_{1+}$ transition, we suggest that the transition strength is being suppressed by low mixing ratios between the prolate and ground state bands as a significant change in deformation is expected. Data from the second experiment is currently being processed to reduce the preliminary uncertainties. A further experiment targeting the $0_{3+} \rightarrow 0_{2+}$ transition using electron conversion spectroscopy has been proposed.

(Invited) Radioactive ion beams for real-time PET-guided adaptive particle therapy

Daria Boscolo¹

¹GSI, Germany

Heavy-ion particle therapy provides superior dose conformity compared with conventional radiotherapy, but its clinical benefit is limited by strong sensitivity to range uncertainties at the distal edge of the Bragg peak. To ensure sufficient tumor coverage, large safety margins are typically applied, partially reducing the advantages of particle therapy. Reliable online range verification is therefore crucial, especially for adaptive treatment approaches. Positron emission tomography (PET) is one of the most established techniques for in-beam range verification; however, in conventional ^{12}C -ion therapy its performance is hindered by low signal-to-noise ratios, spatial discrepancies between activity and dose distributions, and long acquisition times.

Using β^+ -emitting radioactive ion beams simultaneously for treatment and imaging represents a promising strategy to overcome these limitations. Within the BARB project, the feasibility of combining ^{11}C -ion beams with real-time in-beam PET has been systematically explored. Here, we present the first demonstration of real-time adaptive particle therapy using radioactive ion beams in a living mouse model. Dynamic beam repositioning produced spatially resolved PET signals that correlated with distinct treatment outcomes. These results highlight the potential of ^{11}C -beam-based imaging for accurate range verification, adaptive treatment delivery, and improved tumor control with reduced toxicity.

(Invited) Measurement of exclusive J/psi photo-production with CLAS12: present status and future proposals

Bryan McKinnon¹

¹University of Glasgow, UK

J/ψ production is of considerable theoretical interest given its sensitivity to the gluonic content and gluonic form factors of the nucleon. These gluonic form factors describe the distribution of colour charge and are one piece of the puzzle which describes the separation of contributions to the nucleon mass. The interaction of the bare quarks with the gluon field itself, through the process of dynamical chiral symmetry breaking (DCSB), being responsible for 99 % of the nucleon mass. DCSB can be related to the trace anomaly of the QCD energy-momentum tensor which dominates at nucleon mass scale. Information on this trace anomaly can be gained via quarkonium production near threshold (large momentum transfer) in which the J/ψ, dominated by the real part of the scattering amplitude, couples only to the gluons and not to light quarks. These motivating theories above, require the probing of production mechanisms both close to the threshold energy, 8.2 GeV, where almost no data exists, and via (quasi-real) photoproduction.

In this talk, I present measurements of the unpolarised cross-section for near-threshold J/ψ photoproduction using CLAS12 data from proton and deuterium targets. Future prospects for beam and target polarisation observables will also be discussed along with a proposal to perform the studies with a dedicated muCLAS12 detector upgrade.

(Featured) Evidence of isomeric states in 183,184Ta

Siddharth Doshi¹, P. M. Walker², A. M. Bruce¹, S. Pascu^{3,2}, Zs. Podolyák², G. Bartram², N. Chandrakumar^{2,4}, J. Chen⁵, J. G. Cubiss⁶, S. Dutt⁷, J. Gada⁷, S. Guo⁷, Y. Hirayama⁸, G. Hudson-Chang^{2,4}, S. Kimura⁸, F. G. Kondev⁹, G. J. Lane¹⁰, G. Li⁷, Y. Litvinov¹¹, Z. Liu^{7,12}, P. Ma⁷, P. Schury⁸, A. Takamine⁴, M. Wada⁸, H. Watanabe^{13,4,5}, Y. X. Watanabe⁸, and J. Yap⁴

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The neutron-rich region around $A \sim 180-190$ is of particular interest for studying high-spin isomers and shape transitions. In this mass range, theory predicts a prolate-to-oblate shape transition, which may lead to prolate high-K isomers decaying to oblate low-K states. Experimentally, neutron richness and the refractory chemical properties of these elements, especially from Hf ($Z=72$) to Pt ($Z=78$), limit the experimental yields.

A recent experiment at the KEK Isotope Separation System (KISS) at RIKEN aimed to study neutron-rich hafnium isotopes produced via multi-nucleon transfer reactions. A ^{136}Xe beam at 7.2 MeV/nucleon was incident on a natural W target. The reaction products were captured in an argon gas cell, selectively ionised using two-step laser resonance ionisation, mass separated, and

implanted on a moving Mylar tape at the decay station. A multi-segmented proportional gas counter was used for beta/conversion-electron detection together with Super HPGe Clover detectors for gamma-ray spectroscopy.

The experiment demonstrates successful production of neutron-rich $^{183,184}\text{Hf}^+$ ions and has yielded clear evidence of a new isomer in ^{183}Ta with $T_{1/2}=41(+6/-4)$ μs , which is interpreted as the missing $\pi 1/2^+[411]$ state decaying to the known $\pi 5/2^+[402]$ level via a low-energy unobserved E2 transition. For $A=184$, our analysis suggests a low-lying isomer with $T_{1/2} \sim 10$ μs in ^{184}Ta fed by the long-lived high-K isomer in ^{184}Hf with $T_{1/2} \sim 10$ min. The presentation will summarise these results, discuss Nilsson-model systematics with ^{183}Ta and present IBM calculations for ^{184}Hf to benchmark structure evolution across this region.

(Featured) First identification of resonant states in the $^{45}\text{V}(p,\gamma)^{46}\text{Cr}$ reaction and their influence on the production of ^{44}Ti in core-collapse supernovae

Chris Cousins¹

¹University of Surrey, UK

Core-collapse supernovae (CCSNe) are among the most spectacular astronomical events to occur in our Galaxy, yet modelling their operation has proven to be a formidable challenge. The long half-life of ^{44}Ti ($t_{1/2} \sim 59$ yr) makes it one of the few cosmic γ -ray-emitting species observable in the Galaxy, providing unique insight into CCSNe. The nucleus ^{44}Ti is expected to be produced during explosive silicon burning in the deepest regions of CCSNe, with observed ejected abundances providing an ideal indicator for the so-called “mass cut” of the star.

Several state-of-the-art sensitivity studies have been performed to identify key reactions that influence the production of ^{44}Ti in CCSNe, with the $^{45}\text{V}(p,\gamma)^{46}\text{Cr}$ reaction being of particular significance. This reaction is expected to be dominated by resonant capture to excited states located above the proton-emission threshold energy of 4874(11) keV in ^{46}Cr . However, at present, no experimental information exists on the properties of resonances in the $^{45}\text{V}(p,\gamma)^{46}\text{Cr}$ reaction.

We present the first identification of resonant states in the $^{45}\text{V}+p$ system, extending to resonance energies of $E_r \sim 2.2$ MeV. In coupling the advanced γ -ray tracking array GRETINA with the Argonne Fragment Mass Analyzer, this enabled access to very weakly-populated, low-spin excited states within the $^{12}\text{C}(^{36}\text{Ar},2n)^{46}\text{Cr}$ fusion-evaporation reaction, hitherto inaccessible with previous setups. By studying the γ decays of resonant states in ^{46}Cr , we are able to significantly reduce uncertainties in the astrophysical $^{45}\text{V}(p,\gamma)^{46}\text{Cr}$ reaction over the temperature range of CCSNe, and subsequently assess the impact of this new rate on ^{44}Ti abundances from CCSNe.

Parallel Session D

Constraining the density-dependence of the symmetry energy by cross section measurements at R3B

Lukas Ponnath¹

¹University of York, UK

The R3B (Reactions with Relativistic Radioactive Beams) experiment, a flagship instrument of the NUSTAR collaboration at the GSI/FAIR facility in Darmstadt, is designed for kinematically complete reactions studies. Part of the R3B physics program is to constrain the asymmetry term of the nuclear equation of state, improving our understanding of highly asymmetric nuclear matter, such as in neutron stars.

One approach to probe the density dependence of the symmetry energy near saturation density is the measurement of the neutron-skin thickness via total interaction or neutron-removal cross sections. These measurements allow for a direct comparison with reaction model predictions.

During the FAIR Phase-0 campaign, total interaction cross sections for $^{12}\text{C}+^{12}\text{C}$ collisions and charge-changing cross sections of tin isotopes were measured, serving as a stringent test of the reaction model. Building on this, the experiment was extended to $^{120,124,132}\text{Sn}+^{12}\text{C}$ collisions at relativistic energies to study the total interaction and neutron-removal cross sections of neutron-rich systems.

In this talk, I will give an overview of the experimental campaign and present results from the finalized and ongoing analyses, including dipole polarizability studies as an additional observable.

Uncertainty quantification of spin-parity assignments in ^{19}Ne with ML methods

Benjamin Wood¹, Carl Wheldon¹, Jack Bishop¹, and Tzanka Kokalova¹

¹University of Birmingham, UK

R-matrix phenomenology is used to extract resonance parameters in compound nucleus reactions from experimental cross-section spectra. Spin-parity assignments of resonances can be difficult, with potentially ambiguous classifications and are typically left without uncertainty quantification. The aim of this work is to develop methods that evaluate and calibrate these uncertainties, enabling more reliable resonance characterisation and reducing the risk of overconfident or misleading assignments. Machine learning (ML) is used here to investigate the astrophysically significant unbound structure of ^{19}Ne by analysing a differential cross-section spectrum for $^{15}\text{O}(a,a)^{15}\text{O}$ elastic scattering. The ML model combines convolutional neural networks (CNNs) and transformer architectures to capture local features and long-range sequence dependencies, while including epistemic and aleatoric uncertainty quantification techniques. This talk overviews the approach, uncertainty treatment, and implications for resonance analysis in compound nuclei, including predicted ^{19}Ne spin-parity sequences with calibrated confidence values.

Evidence of the ${}^9\text{B}(1/2^+)$ state in the ${}^{12}\text{C}(p,\alpha){}^9\text{B}$ reaction

Alex Brooks¹, Jack Bishop¹, Stuart Pirrie¹, Tzany Kokalova¹, Carl Wheldon¹, Neil Curtis¹, Ben Phoenix¹, and Dominik Stajkowski¹

¹University of Birmingham, UK

Following the elucidation of the six-decade-long ${}^9\text{B}(1/2^+)$ state mystery using the R-matrix formalism, the low-lying excitation region in ${}^9\text{B}$ has been studied experimentally with the ${}^{12}\text{C}(p,\alpha){}^9\text{B}$ reaction at the Birmingham MC40 Cyclotron. Data collected at two distinct α -particle recoil angles, over a period of 105 hours at an average current of 1.37 nA, allowed for signatures of the elusive ${}^9\text{B}(1/2^+)$ state to be observed. R-matrix analysis of the obtained excitation spectra, alongside statistical analysis to verify observation significance, indicates the state appears at an excitation energy of 1.83 ± 0.05 MeV, in agreement with previous measurements over the last 25 years. Additionally, no evidence of a low-lying state around ~ 1.0 MeV is found, confirming that mirror symmetry remains unbroken in $1p-1n$ mirror systems and suggesting a resolution to the ${}^9\text{B}(1/2^+)$ state problem.

Lifetime measurements in neutron-rich barium and cerium isotopes using the fast-timing technique

Faye Rowntree¹, Liam Gaffney¹, Pietro Spagnoletti¹, Magda Satrazani¹, Fuad Ali², Corina Andreoiu⁶, Nikita Bernier^{3,8}, S Bhattacharjee³, Mike Bowry³, Roger Cabellero-Folch³, Robin Coleman², Alejandra Diaz Varela², Fatima Garcia⁶, Adam Garnsworthy³, Gwen Grinyer¹⁰, M Hladun¹⁰, James Keatings⁴, Ryan Lefleur², Ben Luna⁵, Konstantin Mashtakov⁴, J Mitchell¹⁰, Bruno Olaizola³, Costel Petrache⁷, Allison Radich², Mustafa Rajabali⁵, Yukiya Saito^{3,8}, Lewis Sexton^{3,9}, Paulina Siuryte^{3,9}, James Smallcombe³, John Smith⁴, Carl Svensson², Elena Timakova³, Kenneth Whitmore⁶, and Daniel Yates^{3,8}

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The neutron-rich lanthanides are expected to exhibit octupole collectivity, which can lead to asymmetric nuclear shapes. The study of low-lying negative-parity states in the even-even nuclei in this region is key to understanding the magnitude of collectivity and whether the nucleus adopts a static or dynamic asymmetric shape. Lifetimes of these states are particularly sensitive to electric-dipole (E1) transition strengths, where an enhancement can signify octupole deformation.

The fast-timing technique is used to measure lifetimes of short-lived excited states in nuclei by analysing γ - γ and β - γ coincidences following radioactive decay. Combining lifetime information with gamma-ray branching ratios, reduced transition probabilities are calculated, allowing for the type and magnitude of deformation of nuclei to be inferred. In this work, lifetimes of low-lying states in barium and cerium isotopes with $A = 146, 148,$ and 150 have been measured using the GRIFFIN spectrometer based at the ISAC-I facility at TRIUMF, Vancouver. Primary beams of caesium with $A = 146, 148,$ and 150 were delivered on to a moving tape collector at the centre of the GRIFFIN spectrometer, which consists of an array of 16 HPGe clover detectors, supplemented

with an array of 8 LaBr₃ scintillator detectors for fast timing, and a zero-degree scintillator for the detection of electrons emitted during β -decay.

This talk will present preliminary results of the lifetime measurements obtained using both the convoluted decay-curve method and the generalised centroid-shift method.

B(E2) measurements of heavy N = Z nuclei at FRIB

Michael Bentley¹

¹University of York, UK

Results will be presented on the measurement, at the new FRIB facility in the USA, of the B(E2) for the decay of the first excited state in N = Z ⁸⁸Ru [1]. This is the heaviest N = Z system for which such a measurement has been made.

Crucial questions remain unanswered in the heaviest accessible region of N = Z nuclei, where both the neutron and proton Fermi levels are located well inside the g_{9/2} shell. The details of how collectivity varies for N = Z nuclei between ⁵⁶Ni and ¹⁰⁰Sn, and the location, and extent, of the maximum collectivity presents a demanding test of our best nuclear-structure models – see e.g. [2].

The experiment was performed in at FRIB, using fragment beams of ⁸⁹Ru and ⁸⁸Tc, separated using the new ARIS spectrometer at FRIB. Gamma rays were recorded using GRETINA and the TRIPLEX plunger device was utilised in order to determine the lifetimes, and hence B(E2).

The results indicate a dramatic collapse of collectivity along the N=Z line. Two new shell-model approaches have been recently developed [3] and have been successfully applied in this case: a full large-scale shell model calculation using a new interaction (ZBM3) as well as the new DNO-shell-model approach, capable of dealing with very large valence spaces.

[1] M A Bentley et. al., submitted to Phys. Rev Lett.. 2025

[2] K. Kaneko, Y. Sun and T. Mizusaki, Phys. Rev. C 97 (2021) 054326

[3] J. Ha et al, Nature Communications 16, 10631 (2025)

Parallel Session E

Particle identification with Bragg spectroscopy at ISOLDE Solenoidal Spectrometer

Michał Włodarczyk¹, Sean Freeman¹, Frank Browne¹, Patrick Macgregor², David Sharp¹, Liam Gaffney³, and ISS Collaboration²

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The development of radioactive ion beam facilities has enabled the study of nuclear reactions involving short-lived nuclei. Experiments of this kind require intense, highly energetic, exotic beams with good emittance, such as those produced using the online separation method employed at ISOLDE, CERN. One potential drawback of this approach is the presence of beam impurities. To address this limitation and enable identification of recoiling species, a new, fast-counting, gas-filled detector was developed. It consists of an axially segmented ionisation chamber and a multi-wire proportional counter (MWPC). The former is used to perform Bragg spectroscopy, allowing for the identification of isotones with atomic numbers up to approximately 50. The MWPC, utilising the delay-line readout method, provides two-dimensional positional information with a resolution of 1 mm and can be used for pileup suppression and beam tuning. The design of the detector and commissioning results, obtained at the ISOLDE Solenoidal Spectrometer during the 2025 experimental campaign, will be presented.

A Novel Method for PET Radioisotope Photoproduction

Josephine Stone¹

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This project is focused on developing a novel method for the production of ¹⁸F radioisotopes used in PET scans for diagnostic purposes. Positron Emission Tomography (PET) is a diagnostic technique which creates an image of metabolic activity inside the body. A positron-emitting isotope (¹⁸F) is attached to a glucose molecule and ingested by a patient. Positron-electron annihilation results in two gamma rays that are detected and create an image of high-glucose uptake regions, which correspond to active cells such as cancer cells.

Currently, the mainstream ¹⁸F production method is with proton-beams on heavy water, with proton cyclotrons. The method is expensive - \$1.5k per dose - and inefficient, with fewer than 10% of UK patients in need able to access a PET scan. Reasons for this include, high cost of proton cyclotrons, the low natural abundance of ¹⁸O, and the difficulty of Fluorine extraction from water.

This project promises a solution: by using a photon beam on a fluorine-containing target, we are expecting to bring the cost down to \$200-\$500 per dose. The method can be implemented in existing electron accelerators within hospitals, currently used for radiation therapy, allowing for widescale improvements in the cost and accessibility of this life-saving technology.

In my talk I will discuss the results of target simulations investigating the optimal parameters such as electron beam energy, radiator thickness, fluorine-containing medium, density, target dimensions, magnetic field, and more.

Differential cross section measurements for (n,α) reactions with a Time Projection Chamber

Jack Bishop¹

¹University of Birmingham, UK

Data for the $^{12}\text{C}(n,\alpha)$ and $^{16}\text{O}(n,\alpha)$ differential cross sections are important for several different areas of nuclear physics such as understanding neutron transmutation in nuclear reactors.

The TexAT Time Projection Chamber was used to measure the differential and angle-integrated cross sections in active-target mode. The chamber was filled with CO_2 gas and used a quasi-monoenergetic neutron beam from the $d(d,n)$ reaction at Edwards Accelerator Lab at Ohio University.

A comparison between our current and previous results at overlapping energies and angles which showed good agreement in angular dependence and absolute cross section. A broader angular coverage than previous results demonstrated that the integrated cross section for the $^{16}\text{O}(n,\alpha_{1,2,3})$ reaction deviates from ENDFVIII.0 evaluations.

This talk will discuss the first instance of neutron-induced measurements with an active-target Time Projection Chamber demonstrating the use of this method for high-quality differential cross section data across a broad angular range, generating good statistics with a relatively low-intensity beam [1].

[1] J. Bishop et al. arXiv:2601.02841 [nucl-ex]

Deep Learning for Enhanced Muon Tomography Imaging

William O'Donnell^{1,2}, David Mahon^{1,2}, Guangliang Yang^{1,2}, and Simon Gardner¹

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Across the civil engineering and nuclear industries, there is an increasing need to perform non-destructive testing on assets such as bridge decks and nuclear waste containers. Techniques such as ground penetrating radar and ultrasound are limited in achieving consistent high-resolution imagery across large volumes, and while X-rays overcome this problem, they are often met with concerns over the use of a highly ionizing source.

Muography is an emerging non-invasive technique that constructs three-dimensional density maps by detecting the interactions of naturally occurring cosmic-ray muons within the scanned volume. While muons can penetrate deep into structures, their low flux results in long acquisition times for high-resolution imaging. Recent work has demonstrated that machine learning can be applied in post-processing of muographic images to reduce noise and perform detailed

segmentations of structural features, when applied to a dataset of simulated concrete data. The ability of machine learning models to produce consistent outputs at lower event counts allow for a significant reduction of imaging time, thus mitigating one of the key drawbacks of the technique.

Ongoing research focuses on validating these simulation-trained models with experimental muography data to assess their robustness in practical scenarios. Furthermore, investigations of model architectures and the format in which data is presented to the model are underway to improve model performance.

This work ultimately aims to enhance the capabilities of muographic imaging, making it more attractive for wide-scale industry adoption.

Position resolution estimation of Adaptive Grid search algorithm for multi-site interactions position determination in 'SIGMA' detector

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High Purity Germanium detectors are widely used in gamma-ray spectroscopy for nuclear structure studies due to their excellent energy resolution and efficiency. However, Doppler broadening and partial gamma-ray absorption can limit energy precision, motivating the use of Pulse Shape Analysis (PSA) to determine gamma-ray interaction positions for Doppler correction and gamma-ray tracking.

Segmented HPGe detectors enable accurate interaction localisation via PSA, and the Segmented Inverted-coaxial Germanium Array (SIGMA) detector is a novel 19-segment design developed for this purpose. In PSA, experimentally measured signals are compared with a validated simulated signal database, generated using the AGATA Detector Library where the expected signals are provided on a 1 mm spatial basis throughout the detector volume.

While single-interaction events are relatively straightforward to localise, determining the positions of multi-interaction events requires more advanced methods. In this work, an adaptive grid search approach using coarse and fine search regions has been developed and applied to determine multi-site interaction positions.

Validation is achieved by comparing experimental data with GEANT4 simulated data. The validation is based on the comparison of simple back-projected images using Compton kinematics. PSA position resolution is estimated to be 6.79 mm for 662 keV full-energy events from ¹³⁷Cs and 7.95 mm for full-energy 1173 and 1332 keV events from ⁶⁰Co.

PSA developed in this work has been applied to data collected with the SIGMA detector at the MARA focal plane at Jyväskylä, enabling the use of gamma tracking to correlate gamma rays with implantations in decay spectroscopy.

Parallel Session E

The dynamical evolution of the parity splitting energy in nuclei with octupole deformation

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The dynamical features of the parity splitting phenomenon observed in the spectra of even-even and odd mass nuclei with strong octupole correlations is investigated within a collective model. Specific phenomenological insight is obtained from the model extensions adopted for the reproduction of the fine spectroscopic aspects in the experimental data, such as the staggering of the negative and parity states. The beat pattern of the higher order parity energy difference in even-even nuclei can therefore be generated by considering a more stabilized octupole deformation for the positive parity states. On the other hand, the staggering of the energy parity splitting in odd mass nuclei, which cannot be accounted by the Coriolis interaction in the strong coupling regime, is shown to emerge from an intermediate coupling regime simulated with an adjustable particle-core coupling. The proposed theoretical description is supported by numerical applications on medium and heavy nuclei.

Recent developments for microscopic optical potentials for nucleon-nucleus elastic scattering

Ashley Pitt¹, Matteo Vorabbi¹, and Natalia Timofeyuk¹

¹University of Surrey, UK

The optical potential (OP) is a fundamental ingredient that is widely used in nuclear reactions. Broadly speaking, there are two types of approaches to determine OPs, phenomenological and microscopic. Phenomenological OPs are based on some free parameters that are fixed to reproduce the existing experimental data, while microscopic OPs are obtained from fundamental theory. Although phenomenological OPs can give a better description of the data, they lack predictive power due to the presence of free parameters.

In contrast, microscopic OPs are obtained from the fundamental theory and they do not rely on any free parameter. Thus, they provide a greater predictive power that makes them suitable for situations where no experimental data is available. A successful approach used to calculate a microscopic OP, in the energy range of 100-300 MeV, is based on the folding integral of the nucleon-nucleon t matrix and the nonlocal target density, obtained by adopting the ab initio No-Core Shell Model method. However, the numerical calculation of this integral is computationally expensive and makes the OP difficult to use in complicated scattering processes.

To address this, we developed an approach to compute the OP faster than the standard method. In our approach, the t matrix and density are both expanded in the harmonic oscillator basis and this allows us to use analytic results for a faster calculation of the folding integral. We will give an overview of this approach and present preliminary results for elastic nucleon scattering off ^{12}C , ^{16}O , and for some non-zero spin targets.

Lifetime measurements of the 2+ state in ^{128}Nd and ^{132}Sm

Jacob Heery¹

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The neutron-deficient neodymium and samarium isotopic chains present a good laboratory for studying the onset of nuclear deformation due to the progression from spherical nuclei ($^{142}\text{Nd}/^{144}\text{Sm}$) to axially quadrupole deformed as neutrons are removed from the $0h_{11/2}$ shell. Energy level systematics suggest that ^{128}Nd and ^{132}Sm are some of the best examples of rigid rotors in the nuclear chart, as both protons and neutrons occupy the mid-shell region. Even accounting for this doubly mid-shell nature, however, there is a sudden enhancement in the $B(E2; 2_{1+} \rightarrow 0_{1+})$ values, thought to occur due to the quasi-SU(3) interaction between the $1f_{7/2}$ and $0h_{11/2}$ $\Delta J = 2$ partner orbitals. Preliminary results will be presented from a recent experiment measuring the lifetime of the 2_{1+} state in ^{128}Nd and ^{132}Sm using the charge plunger method (CPM). The CPM is a technique that allows for sub-ns lifetime measurements in cases where the conventional recoil-distance Doppler shift (RDDS) method is unfavourable due to large internal conversion coefficients for transitions depopulating the state of interest.

Laser spectroscopy measurements of 151-175Tm. On behalf of the COLLAPS collaboration

Jack Hughes¹

¹University of Liverpool, UK

High resolution laser spectroscopy has been used to study the atomic hyperfine structure of thulium isotopes ($Z=69$) leading towards the proton emitter ^{147}Tm . This technique results in a model independent measurement of the nuclear magnetic dipole moments, electric quadrupole moments and change in mean-square charge radii, with respect to the stable ^{169}Tm . Collinear laser spectroscopy measurements were performed using the COLLAPS experiment based at ISOLDE, CERN. These measurements were taken over a series of three beamtimes, resulting in 25 isotopes being measured, with many of the properties being measured for the first time. The status of the data analysis will be presented.

Radiative decay and electromagnetic moments in ^{229}Th determined within nuclear DFT

Alejandro Restrepo-Giraldo¹, Jacek Dobaczewski^{1,2}, Jeremy Bonnard¹, and Xuwei Sun¹

¹University of York, UK, ²University of Warsaw, Poland

Using the nuclear DFT approach with symmetry breaking and restoration we investigated electromagnetic properties of the ground and isomeric states in ^{229}Th . We determine the magnetic dipole transition strength $B(M1; 3/2^+ \rightarrow 5/2^+)$ between these two states and discuss the effects of parity breaking, configuration mixing, and time-odd core polarization. We also determine the corresponding spectroscopic magnetic dipole and electric quadrupole moments. Because the octupole deformability of the Skyrme functionals used here is not described in

sufficient detail, we analyse the results using a set of Skyrme functionals via the regression aligned with measured octupole moments of neighboring even-even nuclei. Without parameter adjustment, the obtained results favorably compare with the experimental data but also indicate the need to systematically adjust the octupole degrees of freedom in future functional parametrizations.

(Invited) Quantum algorithms for the nuclear shell model

Arnau Rios Huguet¹

¹University of Barcelona, Spain

Quantum computers offer a new way to study complex quantum fermionic systems - systems that are extremely hard to handle with today's classical computers. In this talk, I will describe our ongoing work using quantum inspired methods to study atomic nuclei within the nuclear shell model. I will begin with hybrid quantum-classical algorithms and show what kinds of quantum resources future devices would need to tackle different nuclei [1,2]. I will then discuss our recent studies of how quantum entanglement appears inside nuclei [3,4]. Finally, I will present a new adiabatic quantum algorithm we have developed specifically for solving shell model problems [5], along with a compact encoding method that achieves very accurate predictions for nuclear ground states [6].

[1] A. Pérez-Obiol et al., *Sci. Rep.* 13, 12291 (2023).

[2] M. Carrasco-Codina et al., arXiv:2507.13819.

[3] A. Pérez-Obiol et al., *Eur. Phys. J. A* 59, 240 (2023).

[4] A. Pérez-Obiol et al., arXiv:2409.04510.

[5] E. Costa et al., *SciPost Physics* 19, 062 (2025).

[6] E. Costa et al., *Phys. Lett. B* 809, 140042 (2025).

(Invited) The Path to Commercial Fusion Energy

Chantal Shand¹

¹UKAEA, UK

Fusion energy is transitioning from a long-standing scientific ambition to a credible pathway for large-scale, low-carbon energy generation. This presentation examines how fusion is moving from experimental facilities to commercial power plants, and why its success is important for addressing climate change, public health, and global stability. Over the past five years the global landscape has expanded rapidly with more than 40 private fusion companies alongside major national and international programmes. This growth reflects a healthy balance of collaboration and competition focused on realising fusion's unique benefits: an abundant fuel supply, intrinsic safety, and reliable baseload power. In this context, fusion is a critical complement to renewables, enabling resilient net-zero energy systems.

This talk introduces the principles of fusion energy, outlining how fusion reactions work and summarising the confinement technologies currently in operation or under development. As more fusion machines demonstrate record-breaking performance in energy production and plasma duration, it has become clear that fusion is no longer limited by fundamental physics. Instead, the challenge has shifted to the integration of complex multi-physics systems into mature technologies that can be deployed at scale. Key technology enablers, such as high-temperature superconducting magnets, advanced diagnostics, materials and fuel cycle development, AI, and high-performance computing, will be discussed, with particular emphasis on the fuel cycle. Finally, the talk looks ahead outlining the major machines, pilot plants and power stations expected to come online and the exciting opportunities this highly multidisciplinary field offers to the next generations of scientists and engineers.

(Featured) Development of collectivity beyond N=50 in the Ge and Se isotopes

Frank Browne¹

¹University of Manchester, UK

Recent experimental evidence has shown that in the doubly magic nucleus ^{78}Ni , both spherical and deformed structures can be present at similar energies. This contradicts naive assumptions of the absence of deformation-driving intruder configurations. Understanding how these coexisting structures provide insights to traditional and cutting-edge nuclear theories. Elucidation of the origin of the deformed structures present in ^{78}Ni may be achieved by understanding analogous structures in its north-east valence space. To this end, an experiment was conducted at the Radioactive Isotope Beam Factory of the RIKEN Nishina Center focusing on Ge and Se isotopes beyond N=50. In these isotopes, deformed structures correspond to their ground states. The excitation probability from ground-to-excited states reflects the magnitude of deformation present, with comparison to nuclear theories providing insights to the deformation-driving orbitals which are active.

The presentation will detail the experimental setup which was focussed on the inelastic scattering of Ge and Se isotopes on a heavy target at ~ 150 MeV/nucleon to induce Coulomb excitations. A high-resolution gamma-ray detector array was used to record de-excitations to infer reaction cross sections and also perform lineshape analysis which provides access to lifetimes of excited states. Preliminary results of the extracted reduced transition probabilities to low-lying states will be presented along with theoretical predictions and discussed in terms of how collective structures arise beyond the N=50 shell closure and potential co-existing shapes.

(Featured) Stress-Testing AGATA: Benchmarking the High-Spin Capabilities of the 1π AGATA Spectrometer at LNL

Conor Sullivan¹

¹University of Liverpool, UK

The Advanced Gamma Tracking Array (AGATA) is currently undergoing a series of upgrades and commissioning phases at Laboratori Nazionali di Legnaro (LNL). Central to its success is the ability of the spectrometer to achieve maximum sensitivity and spectral quality under the extreme data rates characteristic of high-spin nuclear structure studies.

This presentation discusses the ongoing analysis of a dedicated commissioning experiment designed to benchmark the current 1π configuration of AGATA in both standalone and ancillary-coupled modes. Using the $^{130}\text{Te}(^{32}\text{S},4n)$ reaction to populate high-spin states in ^{158}Er , the study evaluates the spectrometer's performance across varying event rates. We explore key performance metrics, including the stability of the trigger processor and the impact of hardware "fold" triggers on the resulting high-fold coincidence data and spectrum quality.

Current progress of the analysis is presented, alongside a comparison with historical high-spin benchmarks to contextualise the current capabilities of the array. Finally, we discuss the implications of these findings for the future of high-spin spectroscopy with tracking detectors, particularly in view of the transition toward Phase 2 electronics and upcoming experimental campaigns.

(Invited) Exploring the key astrophysical reaction $^{12}\text{C}(\alpha,\gamma)$ with TPCs and γ beams

Robin Smith¹

¹Sheffield Hallam University, UK

Long touted as the "most important nuclear physics uncertainty in astrophysics", direct measurements of the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ cross section have been a key goal for nuclear astrophysics over the last five decades. It is a difficult cross section to measure, since the reaction is not dominated by a single resonance, but instead by the interference between several bound and unbound states.

Experimental measurements are typically made at higher energies, where the cross section is larger, and an R-matrix extrapolation is used to evaluate its value at stellar conditions. Such an extrapolation relies on accurately determining the E1 and E2 partial cross section and their mixing. The goal is to obtain a 5-10% cross section uncertainty on the extrapolation, which is nowhere near the current precision available from existing capture data.

To circumvent the well-documented challenges with directly measuring the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ reaction, our new experimental approach measures the time reverse photodissociation reaction $^{16}\text{O}(\gamma,\alpha)^{12}\text{C}$ using an active target Time Projection Chamber (TPC). Accurate measurements of the outgoing charged particles allow detailed angular distributions to be reconstructed. Proof-of-

principle measurements using an optical TPC, published in 2021 and 2026, laid the groundwork for the present work using the new electronic Warsaw TPC.

This presentation details experiments run in 2022 using the Warsaw TPC with gamma beams at the H_γS facility. Preliminary results on total cross sections and angular distribution analyses are presented.

(Invited) Unveiling nucleon structure through measurements of Generalized Parton Distributions

Silvia Niccolai¹

¹IJCLab Orsay, France

Generalized Parton Distributions (GPDs) are nowadays the object of an intense effort of research, in the perspective of understanding nucleon structure. They describe the correlations between the longitudinal momentum and the transverse spatial position of the partons inside the nucleon and they can give access to the contribution of the orbital momentum of the quarks to the nucleon spin.

Deeply Virtual Compton scattering (DVCS), the electroproduction on the nucleon, at the quark level, of a real photon, is the process more directly interpretable in terms of GPDs. Depending on the target nucleon (proton or neutron) and on the DVCS observable extracted (cross sections, target- or beam-spin asymmetries, ...), different sensitivity to the various GPDs for each quark flavor can be exploited. GPDs can also be accessed in other reactions, such as Timelike Compton Scattering, Double DVCS, or the exclusive electroproduction of mesons.

This talk will provide an overview on recent and new, promising, GPD-related experimental results, mainly obtained at Jefferson Lab with a 12-GeV electron beam, for various target types and final states. These data open the way to a “tomographic” representation of the structure of the nucleon, allowing the extraction of transverse space densities of the quarks at fixed longitudinal momentum, as well as providing an insight on the distribution of forces inside the nucleon.

The perspectives for future JLab experiments using a polarized positrons beam will also be outlined.

Parallel Session G

Pixel-based Target Recoil Tracker (TRT) for R3B at FAIR

Beatriz Amorim¹, Luke Rose¹, Stefanos Paschalis¹, Marina Petri¹, Marcello Borri², Matthew Buckland², Konrad Sutowski², and Marc Labiche²

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The upgraded setup for the R3B experiments at FAIR introduces a pixel-based Target Recoil Tracker (TRT) detector, designed to enhance the detection capabilities of light-charged particles, such as protons, emitted in nuclear reactions. The TRT surrounds the reaction target and is further enclosed within a highly segmented calorimeter, named CALIFA, focusing on precise angle measurements of these particles. This innovative detector utilizes the fully developed ALPIDE Monolithic Active Pixel Sensor (ALPIDE MAPS) technology, originally designed for ALICE/CERN experiments. With the TRT the full kinematics of the recoil and scattered particles can be measured and the missing-mass and missing-momentum spectra can be reconstructed on an event-by-event basis, enabling a model-independent extraction of the complete spectral function. Such measurements will provide unprecedented insight into short-range correlations, single-particle strength quenching, and the underlying nuclear dynamics that drive both electron and hadron induced knockout reactions.

The TRT consists of a barrel-shaped detector array with large angular coverage and an optimized material budget. A future stage of this detector envisions integrating next-generation sensors using large, ultra-thin silicon wafers bent and arranged in perfectly cylindrical layers.

In this contribution, we report on the latest performance studies of the final barrel design. Using R3BRoot (Geant4) simulations, we evaluate its detection efficiency and spatial resolution, and we describe the assembly and characterization procedures for the individual modules. Finally, we will present the results from the last year experimental campaigns at GSI using ALPIDEs in beam, demonstrating the excellent performance of the TRT.

Development of novel LaBr₃(Ce) Detector Modules for Nuclear Astrophysics Applications

Sulagna Dutta¹, Cameron Cassells¹, B.S. Nara Singh¹, M. Bowry¹, D. O'Donnell¹, J.F. Smith¹, P. Joshi², J. Bordes², J.R. Brown², D.G. Jenkins², O. Tengblad³, M.J.G. Borge³, and J.A. Briz⁴

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A LaBr₃(Ce) clover detector system combining compact geometry with good energy resolution and improved detection efficiency is being developed at the University of the West of Scotland. This work represents the first clover-like detector system based on scintillator crystals specifically designed to implement the add-back technique [1]. By reconstructing full-energy γ -ray events through the summation of energy deposited in neighbouring crystals, an improvement of approximately 33% in the peak-to-total (P/T) ratio was achieved for a ¹³⁷Cs source.

The detector consists of LaBr₃(Ce) crystals directly coupled to SiPM readout, with only optical gel between the crystal and photosensor. This direct optical coupling improves light collection and results in enhanced energy resolution. Compared to typical LaBr₃(Ce) detector systems, a reduction of about 12% in the full width at half maximum (FWHM) was observed, improving from approximately 3.3% to 2.9% at 662 keV [2].

The detector's capability for high-energy γ -ray detection in the 5 -7 MeV range has also been investigated through light nuclear reaction experiments carried out in Madrid. Preliminary results are promising and demonstrate the system's potential for nuclear astrophysics measurements, including reactions such as ${}^3\text{He}(\alpha,\gamma)$ related to the long-standing ${}^7\text{Li}$ abundance problem [3]. The detector design, add-back methodology, analysis techniques, and performance results will be presented.

[1] B.S. Nara Singh et al., Nucl. Instrum. Methods Phys. Res. A506, (2003) 238.

[2] C. Mihai et al., Nucl. Instrum. Methods Phys. Res. A953, (2020) 163263.

[3] M.Carmona-Gallardo, B.S. Nara Singh, M.J.G. Borge, J.A. Briz, et al., Phys. Rev. C 86, 032801(R).

Elucidating Strangeness with Electromagnetic Probes

Asli Acar¹

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Theory models predict a total of 44 cascade baryons below 2.5 GeV. Currently, there are only six X_i states that have been assigned at least a three-star rating in the PDG, and the production mechanism of these states still remains mostly elusive. From a theoretical standpoint, the study of cascades is appealing due to the symmetry arising from the presence of two medium-mass s -quarks. Additionally, cascade spectroscopy is a promising tool to differentiate genuine quark states from hadronic molecules, since we have the ability to measure the line shape in various decay branches with unprecedented precision. This work focuses on the analysis of CLAS12 data collected at Jefferson Lab to study the production mechanisms and decays of excited cascade baryon states that are not well established or missing, with the aim of determining their branching ratios and quantum numbers. To address the substantial and complex background arising from out-of-time particles, a novel analysis technique based on multi-dimensional sequential weighting is introduced, allowing for a clean separation of genuine cascade signals from background contributions. The possibility of using the same dataset to explore multi-strange exotics in meson and baryon sectors will also be discussed.

Preliminary 2Pi0 channel analysis at GlueX

Alexandra Berger¹

¹University of Glasgow, UK

Quantum Chromodynamics (QCD) is the theory of the strong force and gives rise to a spectrum of hadrons. Hadrons such as $q\bar{q}$ and qqq states have been observed but others, such as the gg (glueball) or the $q\bar{q}g$ (hybrid) state are not forbidden. A gg pair can share the same quantum numbers as a $q\bar{q}$ meson, resulting in the 'mixing' of their respective states making the observed physical particle a superposition of pure glueball and pure meson state.

The $\pi^0\pi^0$ channel provides a window into these states, and others, due to a high level of statistics and quantum number restraints ensuring the even spin number of the intermediate particle. Through this channel, an analysis sensitive to quantum number of the lowest lying glueball at $J^{PC}=0^{(++)}$ and possible 'mixed' $J^{PC}=2^{(++)}$ state become possible, as well as an analysis of other states which require clearer branching fractions and differential cross sections to compare with theoretical predictions.

Using data obtained as part of the GlueX collaboration at the Thomas Jefferson National Accelerator Facility, alongside sPlot analysis techniques and mass dependent fits, encouraging preliminary moment and partial wave analysis results have been obtained. Future work hopes to clarify these results and allow for a comparison between different parametric and non-parametric moment attainment methods.

Jet measurements with the ALICE experiment at the LHC

Jaime Norman¹, and Daniel Jones¹

¹University of Liverpool, UK

Collisions of ultrarelativistic heavy ions at the LHC generate temperatures large enough for nuclear matter to exist as a deconfined state of quarks and gluons - a state known as the Quark-Gluon Plasma (QGP). Jets - high-energy partons produced in particle collisions - are excellent probes to study the properties of the QGP, where their modification provides key insights into the QGPs transport properties and energy dissipation mechanisms. In this talk, we summarise the status of jet measurements using LHC Run 3 data from the ALICE experiment - the experiment dedicated to measurements of heavy-ion collisions. Focus will be given to semi-inclusive and heavy-flavour jet measurements.

Parallel Session H

First Cross-Section Measurements of the $^{93}\text{Sr}(\alpha, \text{xn})$ $^{95-96}\text{Zr}$ Reactions: Implications for the Weak r-Process

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The origin of the heavy elements remains unclear, in particular the astrophysical sites thought to be responsible for the rapid (r) neutron-capture process are still uncertain. The 2017 LIGO detection of a neutron star merger (NSM) alongside a coincident kilonova provided the first direct evidence of NSMs producing an r-process. However, galactic chemical evolution models indicate that an additional r-process site which was more active during the early history of our galaxy is required to match observations of old metal-poor stars. These ancient stars exhibit significant star-to-star variations of the first r-process peak elemental abundances, which is difficult to explain with a single r-process site. A weak r-process occurring within the neutrino-driven wind of core-collapse supernovae or NSMs has been proposed as a mechanism to solve this problem by preferentially producing the first r-process peak elements. Under these conditions, nucleosynthesis is driven predominantly by (α, n) reactions acting on neutron-rich radioactive nuclei 3-5 neutrons away from stability. Reactions with ^{93}Sr have been identified as crucial for ascertaining the final abundances of weak r-process signatures, however there are large uncertainties surrounding both the astrophysical conditions and the relevant nuclear reaction rates. To address the nuclear physics uncertainties, we recently performed an experimental study at TRIUMF using the EMMA, TIGRESS, and DEMAND detectors to measure the $^{93}\text{Sr}(\alpha, \text{xn})$ $^{95-96}\text{Zr}$ reactions. In this presentation, I will share our findings to date and discuss perspectives on future weak r-process reaction studies at TRIUMF.

Beta-decay spectroscopy of proton-rich N=82 isotones

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The β decay of the heaviest known N=82 nuclide, ^{156}W , was recently reported by Briscoe et al., and was found to exhibit a different decay pattern compared with ^{152}Yb and their lighter isotones. This work investigates the β decays of the intermediate isotone ^{154}Hf to learn about the evolution, with increasing atomic number, of the β decays of even-even N=82 isotones. Although a microsecond isomer in ^{154}Hf has been identified by J. H. McNeill et al., and its half-life has been indirectly determined to be 2(1) s from the time differences between the α decays of ^{158}W and ^{154}Yb by W.-D. Schmidt-Ott et al., the β decay of the ground state remains unknown. The ground state of ^{154}Hf nuclei was populated via the α decay of the ground and isomeric states of ^{158}W . The ^{158}W nuclei were produced at the Jyväskylä Accelerator Laboratory in fusion-evaporation

reactions by bombarding a ^{106}Cd target with a ^{58}Ni ion beam. The ^{158}W nuclei were separated in flight using the recoil separator MARA and implanted into a double-sided silicon strip detector (DSSD) at its focal plane. The DSSD was surrounded by an array of germanium detectors, which were used to measure γ rays in coincidence with β particles emitted in the decay of ^{154}Hf . These measurements enabled the determination of a more precise half-life of $680(40)\text{ms}$ and a preliminary level scheme for ^{154}Hf to be constructed. The latest results from the analysis will be presented along with prospects for future studies.

A direct measurement of the $^{27}\text{Al}(\alpha,p)^{30}\text{Si}$ cross section with TACTIC

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TRIUMF Annular Chamber for Tracking and Identification of Charged Particles (TACTIC) is a cylindrical Active Target Time Projection Chamber (TPC) designed to study alpha-induced charged-particle reactions of astrophysical significance. TACTIC employs the micro-resistive well detector (μRWELL) as the gas amplification stage, enabling excellent tracking of charged particles, in the energy range of a few keV to several MeV, due to the high gain ($>10^4$). Recently, the first measurement of the $^{27}\text{Al}(\alpha,p)^{30}\text{Si}$ reaction cross section in the Gamow window was performed at TRIUMF, using a ^{27}Al beam at 1.65 MeV/u . The $^{27}\text{Al}(\alpha,p)^{30}\text{Si}$ reaction is important for the improvement of existing core-collapse supernovae (CCSNe) model calculations, by modifying the flow of material to heavier masses, specifically affecting the production of ^{56}Ni .

TACTIC utilises a thick target technique, enabling the excitation function over the entire energy region of interest to be measured simultaneously with one beam energy, resulting in a time-efficient measurement. Initial analysis from this experiment will be presented, alongside simulation based work performed in the NPTool framework.

A Novel Approach to Observing Nuclear Excitation by Electron Capture

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Nuclear excitation by electron capture (NEEC) is an exotic mode of nuclear excitation which has yet to be unambiguously observed. An observation of NEEC was reported in Nature in 2018, and has been subsequently significantly challenged, where the inferred NEEC probability exceeds the best theoretical estimates by nine orders of magnitude.

Corresponding to the inverse of internal conversion, an unbound electron is captured into an atomic orbital leading to excitation of the nucleus to a higher-lying excited state. NEEC is highly resonant, requiring precise energy matching between the sum of the electron's kinetic energy and the binding energy of the corresponding orbital with the nuclear transition energy, making observation really challenging. Recent theoretical work has shown that the best case for NEEC observation in an ion-beam setting is ^{83}Kr , with a low-lying first excited state which can be excited to via NEEC. Presented is an entirely new experimental approach to observing NEEC based on

detecting changes in the charge-state distribution following decay of the excited nucleus by internal conversion. This method provides a distinct and potentially more sensitive signature, offering a promising pathway toward its unambiguous experimental identification.

Probing the $10\text{B} + \alpha$ pathway for primordial stars at LUNA: Experimental techniques and preliminary results

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The $10\text{B} + \alpha$ reactions have been proposed as part of potential pathways, alongside the triple-alpha process, to synthesise CNO elements in massive Primordial Population III stars. However, current astrophysical models rely on reaction rates that are poorly constrained at the relevant stellar energies. This talk presents preliminary results from experimental campaigns currently underway at the Laboratory for Underground Nuclear Astrophysics (LUNA) to constrain these rates.

I will discuss the experimental challenges and detection techniques associated with these low-rate reactions and how the deep underground environment of LNGS is exploited to achieve the necessary sensitivity. The presentation details the detection setup, which employs a near 4π segmented BGO array to study the $10\text{B}(a,n)13\text{N}$ reaction via activation technique, and to directly measure gamma-ray emission from the $10\text{B}(a,pg)13\text{C}$ reaction channels. Attention is also devoted to the production and characterisation of the solid $10\text{B}_4\text{C}$ targets, focusing on their durability under intense alpha-beam currents.

Finally, I will report on the current status of the data analysis, focusing on results for the $10\text{B}(a,n)13\text{N}$ reaction and the $10\text{B}(a,pg)13\text{C}$ channels. I present preliminary cross-section data and outline prospective plans to extend the energy range of these measurements.

Parallel Session I

Decay Spectroscopy of Medical Imaging Isotope Terbium-152

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Terbium-152, decaying by electron capture and β^+ emission to 152Gd with $Q_{\text{EC}} = 3990(40)$ keV and $T_{1/2} = 17.8784(95)$ h, shows promise in nuclear medicine. First-in-human trials have demonstrated its suitability for positron emission tomography (PET) imaging, with potential applications in personalised cancer treatments through its membership of the terbium

theragnostic quartet. Routine use of this radionuclide requires improved nuclear data for patient dosimetry, involving precision measurements of gamma-ray emission probabilities and the calculation of beta feeding strengths. Results of a decay spectroscopy study of ^{152}Tb are presented, using sources prepared using spallation of a 1.4 GeV proton beam on a tantalum target, and mass-separated using the ISOL method at CERN-ISOLDE. Gamma-ray coincidences were measured using the Fission Product Prompt γ -ray Spectrometer (FIPPS) at the Institut Laue-Langevin, Grenoble, supported by measurements taken using the PN1 Si(Li)-HPGe conversion electron spectroscopy setup using sources created in the same ISOLDE production run. Over 100 previously unreported excited states in ^{152}Gd up to excitation energies of 3.7 MeV are presented, placed in a level scheme of over 1000 gamma-ray transitions. Angular correlation and electron-gamma coincidence analysis provide multipolarity and mixing ratio assignments to transitions, allowing the inference of level spins and parities. The updated level scheme results in revised gamma-ray and β^+ intensities, showing a reduced dose to patients compared to the previous expected values.

Water neutron moderation of AmBe: a computational approach with Geant4

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Americium-beryllium neutron sources are proven useful in industrial, education, and research environments because of their stable neutron flux and long working life.

Neutron moderation properties of water can be characterised using this source, and thermal diffusion length and neutron age determined by using neutron flux detectors such as He3, BF3 and LiI. Given the non-linear response of these detectors, a computational framework has been set-up within Geant4. A first validation against pre-existing data by Goldstein et al. for mono-energetic neutrons has been made, to then allow characterisation of the AmBe source behaviour in water against the detector distance for proportional counters. An insight into teaching using experiments on neutron moderation that can be performed in equivalent set-ups is given.

Shell evolution and neutron halo formation in heavy sodium isotopes

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The latest generation of radioactive ion beam facilities provides unparalleled access to neutron-rich unstable isotopes. One of the areas of active investigation is the study of the shell evolution between the neutron magic numbers $N=20$ and $N=28$ [1-5] for such unstable nuclei. The nuclei between these magic numbers display exotic structural features such as dampening of shell gaps, formation of halos, and deformed structures.

In this talk, I will discuss our new results on how the inversion of the $2p_{3/2}$ and $1f_{7/2}$ single-particle orbits influences the formation of neutron halos in the ground states of neutron-rich sodium isotopes $^{34,37,39}\text{Na}$ [6]. Using tailored two- and three-body core–neutron models with effective interactions informed by existing experimental trends and theoretical inputs, we demonstrate that a weakened shell gap and orbit inversion can drive the development of one-neutron halo structure in ^{34}Na and Borromean-like halos in $^{37,39}\text{Na}$. Additionally, we show that the electric dipole response serves as a sensitive observable for identifying halo characteristics in these systems. Our results show that heavy sodium isotopes are an interesting area to study shell evolution and halo phenomena [6].

[1] S. Bagchi, et al., Phys. Rev. Lett. 124, 222504 (2020).

[2] D. S. Ahn, et al., Phys. Rev. Lett. 129, 212502 (2022).

[3] J. Casal, Jagjit Singh, et al., Phys. Rev. C 102, 064627 (2020).

[4] G. Singh, Jagjit Singh, et al., Phys. Rev. C 105, 014328 (2022).

[5] Jagjit Singh et al., Phys. Lett. B 853, 138694 (2024).

[6] Jagjit Singh et al., arXiv:2512.22951 [nucl-th] (2025).

Unveiling proton-neutron pairing in homogeneous and isotropic nuclear matter

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Pairing correlations play a crucial role in nuclear physics: their effects go from the odd-even mass staggering in nuclear structure, to the phases of matter found in neutron stars. As the strong interaction governs both nuclei and such astrophysical objects, a universal energy density functional (EDF) should be able to reproduce the properties of both vastly different systems. To this end, the nucleon pairing gaps in infinite nuclear matter (INM) are key ingredients to adjust new EDFs, which should be suitable to describe both astrophysical phenomena and finite systems. A link between gap equations of INM and the isospin symmetry of the Hartree-Fock-Bogoliubov wave function may be assumed straightforwardly. However, what is the true relationship between the structure of the pairing tensor and the wave function itself?

To address this question, we propose a different approach to the problem of proton-neutron pairs in INM, building our knowledge “from the bottom up”: we start from a wave function with a combination of all different ST channels, and from it, we obtain the most general density matrix and pairing tensor of nuclear matter. Our interaction-independent analysis shows that although the different channels separate in the Thouless matrix, they mix in the pairing tensor and the density matrix. We further explore which pairing channels are allowed to form in INM.

Thermal effects on neutron capture cross sections using a quantum dynamical approach

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Thermal effects on neutron capture cross sections using a quantum dynamical approach
The neutron capture process plays a vital role in creating the heavy elements in the universe. The environments involved in these processes are, in general, high in temperature and are characterized by two distinct reaction mechanisms: the slow and rapid neutron capture processes. In this work, the slow neutron capture process is described with the time-dependent coupled channels wave-packet (TDCCWP) method that uses both a many-body nuclear potential and an initial temperature-dependent state to account for the thermal environment. To evaluate the role of a mixed and entangled initial state in the temperature-dependent neutron capture cross section, TDCCWP calculations are compared with those from the coupled-channels density matrix (CCDM) method based on the Lindblad equation. The importance of including temperature in the initialisation step is compared to a thermalisation of the capture cross section using a Hauser-Feshbach style approach. The stellar reaction rates are also compared between these models to compare effective Stellar Enhancement Factors.

(Featured) Fission studies using quasi-free scattering reactions in inverse kinematics

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Fission reactions induced by relativistic heavy nuclei, in combination with an advanced detection setup, have recently allowed, for the first time, the complete identification of both fission fragments in atomic and mass number. In addition, these kinematic conditions allow the study of a wide variety of unstable fissile nuclei. The first experiments made it possible to address the role of shell effects in fission and the dynamics of fission at high excitation energies.

More recently, these experiments have been upgraded. The R3B target area detectors (silicon tracker and Califa calorimeter) allow the determination of the missing energy in quasi-free scattering (p,2p) reactions using a liquid hydrogen target. In the case of (p,2p)-induced fission reactions the missing energy corresponds to the excitation energy of the fissioning nuclei, which was not accessible in previous measurements. In addition, the new setup is able to measure gamma rays and neutrons emitted during the fission process. This provides, for the first time, complete kinematic measurements of fission reactions.

In this contribution we present the first results obtained in the study of the fission of ²³⁸U induced by quasi-free (p,2p) reactions. In particular we will show how the complete identification of both fission fragments and the measurement of the excitation energy of the fissioning nucleus allowed us to study the disappearance of shell effects in the fission yields with temperature and the sharing of the excitation energy between the two fission fragments.

(Featured) Anapole Moment Calculated within Nuclear DFT

Herlik Wibowo¹, Manu Kanerva², Jacek Dobaczewski¹, Markus Kortelainen², and Wick Haxton³

¹University of York, UK, ²University of Jyväskylä, Finland, ³University of California, USA

A parity-violating weak interaction between nucleons gives rise to the parity-odd anapole moment of the nucleus [1]. The extended Siegert's theorem [2] allows us to decompose the anapole moment operator into two terms: the first is constrained by current conservation, while the second is not. Both terms are proportional to the total current of the nucleus. In the nuclear DFT approach, the total current operator is assumed to consist of two parts: the convective (orbital) and magnetic (spin) currents.

Similar to the Schiff moments, the laboratory anapole moment is calculated using perturbation theory. Perturbation theory indicates that the dominant contributions to the laboratory anapole moments arise from the expectation values of the anapole operator and the parity-nonconserving (PNC) potential, evaluated between the ground and partner states of the octupole deformed nucleus, owing to the small energy difference between these states. For example, in the octupole deformed Ac-227 nucleus, this energy difference can be as small as 27.369 keV. The Desplanques, Donoghue, and Holstein (DDH) potential [3] is commonly used as the PNC perturbing potential that induces parity violation. In the nuclear DFT approach, the deformed ground and partner states are determined from Hartree-Fock-Bogolyubov calculations with broken symmetries, in particular time-reversal symmetry and parity.

[1] W. C. Haxton, C. -P. Liu, and M. J. Ramsey-Musolf, Phys. Rev. C 65, 045502 (2002)

[2] J. L. Friar and S. Fallieros, Phys. Rev. C 29, 1645 (1984)

[3] B. Desplanques, J. Donoghue, and B. R. Holstein, Ann. Phys. 124, 449 (1980)

(Invited) Spectroscopy of pear-shaped nuclei

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It is well established that nuclei with certain numbers of neutrons and protons are susceptible to octupole correlations which can lead to reflection-asymmetric pear-shapes. The extent of the pear shape depends on the strength of the octupole correlations; some nuclei are octupole vibrational, possessing an oscillating transient pear shape, but others are octupole deformed, having a permanent pear-shaped deformation in the ground state. The strongest octupole correlations occur in the light-actinide region with near ^{224}Ra ($Z=88$, $N=136$). Strong octupole correlations also occur in the neutron-rich lanthanides near ^{144}Ba ($Z=56$, $N=88$), and there are expectations of strong octupole correlations in the very neutron-deficient nuclei near ^{112}Ba ($N=56$, $Z=56$). Pear-shaped nuclei have characteristic spectroscopic features such as interleaving sequences of states with opposite parities and enhanced $E1$ transitions. In this presentation, the experimental evidence for octupole correlations will be reviewed and summarized, and some recent results will be presented. The presentation will also give some prospects for future experimental studies of pear-shaped nuclei.

(Invited) Nuclear Signatures from Binary Stars

Robert Izzard¹

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Like nuclear physicists, the most interesting stars like to get together and interact: many are found in binary, or higher-order multiple, systems. In binaries, nuclear physics shapes the yields and observable signatures. In this talk I will explore how binary interaction alters stellar nucleosynthesis, and how we model these processes today, from research codes to the classroom.

I will begin with accreting compact binaries. X-ray bursts on neutron stars and novae on white dwarfs are classic sites of rare-isotope production, seen both in their spectra and in presolar grains, and they provide excellent constraints on reaction rates in extreme conditions. In stellar astrophysics we aim to predict event rates, light curves and detailed isotopic yields of these events. I will discuss the computational tools we use, and how sensitive the results are to uncertainties in stellar evolution and nuclear physics.

I will then turn to thermally-pulsing AGB stars that merge with a companion during binary evolution. We recently found that such mergers can greatly alter the temperature and luminosity of these stars, and the number of thermal pulses they undergo, changing how much nuclear-processed material they eject. They may then be important sources of stable isotopes such as C12 and N14, and of radioactive species such as Al26. Finally, I will ask what happens when we combine the two scenarios: when a neutron star merges with a red giant, the result may be a Thorne–Żytkow object. TŻOs make heavy elements with no other known astrophysical production site: we just need to find them.

Posters

P1: Electrons for Neutrinos

Jhanzeb Ahmed¹

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One of the physics aims for the next generation of neutrino experiments, such as DUNE, is the determination of the neutrino oscillation parameters which govern the probability of neutrinos changing from one flavour to another. To determine these parameters, the incident neutrino's energy must be known. Since neutrino beams have a broad energy distribution, the neutrino's energy can only be reconstructed event-by-event through observation of fragments produced during the neutrino-nucleus interaction. This remains challenging and primarily relies on assumptions from nuclear physics models which are not well understood but play an essential role; these models are currently insufficiently constrained by appropriate nuclear physics data leading to significant uncertainties. This project will help solve this challenge by utilising existing electron scattering data collected at the US Jefferson National laboratory CLAS12 detector. Using Liquid Argon and Carbon targets to provide a useful benchmark and allow existing neutrino event generators to be tested, refined and improved, directly contributing to reducing the systematic uncertainties in neutrino oscillation measurement experiments. The York group plays a key role in the data analysis of the project and in developments to pass the leading theoretical models for electro- and neutrino- nuclear processes through the CLAS12 acceptance. The status of our analyses will be presented which encompass a broad range of hadron production channels from the suite of targets in the RGM programme, including the primary channel exploited in next generation neutrino facilities such as DUNE (1p0pi).

P2: Beta-delayed gamma-ray Spectroscopy of ^{225}Fr to ^{225}Ra

Abdulrahman Alshammari^{1,2}, S2011 Collaboration S2011 Collaboration

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The onset of permanent octupole-deformed nuclear shapes such as in the nuclei located between radon ($Z=86$) and uranium ($Z=92$) with $N \approx 138$ have generated intense interest. Odd-mass actinides in particular, offer a promising ground for revealing new physics through the search for an atomic electric dipole moment (EDM). The presence of nuclear octupole-deformation enhances the effect. The even-odd ^{225}Ra nucleus is a good candidate for measuring an electric dipole moment (EDM), therefore an experiment was conducted in 2022 at TRIUMF, using the GRIFFIN spectrometer located at ISAC-I. The aim of this experiment is to measure the excited states of ^{225}Ra populated by β decay of ^{225}Fr . Precise measurements of the intensities of γ rays and conversion electrons will aid future Coulomb excitation studies. In addition, branching ratios, multipolarities and D° values will be extracted.

Preliminary analysis of this experiment will be presented featuring initial work to extract branching ratios and the half-life of unidentified candidate γ rays which will be compared to literature listed in NNDC. In addition, newly identified transitions, energy

levels and angular correlation will also be presented.

P3: Development of an isotopic inventory model for cross section measurements made at the National Ignition Facility

James Benstead^{1,2}, Daniel Pitman-Weymouth¹, and Brian Appelbe³

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The National Ignition Facility (NIF) laser at the Lawrence Livermore National Laboratory is capable of producing a plasma environment with temperatures ~ 10 keV, particle densities $\sim 10^{32} \text{ m}^{-3}$, and neutron fluxes of up to $10^{34} \text{ m}^{-2} \text{ s}^{-1}$. The plasmas at the NIF are produced by using the laser to compress capsules containing deuterium or deuterium-tritium fuel on timescales of ~ 1 ns, resulting in a neutron source of $\sim 100 \mu\text{m}$ in diameter and duration ~ 100 ps. These features make it uniquely suitable for carrying out experiments to investigate plasma and nuclear physics, including plasma-nuclear interactions.

A NIF experiment has been commissioned to measure the neutron capture cross section of ^{171}Tm at a neutron energy of 2.45 MeV, with the neutron field being generated from deuterium-deuterium fusion within the target capsule.

Further experiments will follow which aim to measure additional cross sections and also investigate the effects of plasma-nuclear interactions on reactions which proceed via isomeric states. In order to support these experiments an isotopic inventory model has been created which utilises the activation/inventory code FISPACT, developed by the UKAEA.

Given the conditions of the NIF plasma, some very short-lived (lifetime < 1 ns) excited nuclear states may be considered isomeric relative to the timescales of the experiment, i.e. may undergo neutron-induced reactions as a target nucleus. Studies have been made using the FISPACT model where nuclear data have been included for additional isomeric states to determine whether or not the presence of these states is important.

P4: Measurement of λ_b production in pp collisions with ALICE

Chris Carr¹, David Evans¹, and Martin Völkl¹

¹University of Birmingham, UK

Λ_b^0 baryons can be used to probe the additional heavy-flavour hadronisation mechanisms found in proton-proton (pp) collisions that are not present in e^+e^- collisions, which the fragmentation functions that describe hadronisation are parametrised from. In this poster, a Λ_b^0 invariant mass peak is observed for the first time in pp collisions at a centre-of-mass energy of $\sqrt{s} = 13.6$ TeV with the ALICE experiment at the LHC. As the Λ_b^0 is neutral, it cannot be detected directly - consequently, it is reconstructed by measuring the charged hadrons that it decays into with the tracking and particle identification capabilities of ALICE. For this analysis the $\Lambda_b^0 \rightarrow \Lambda_c^+ \pi^- \rightarrow (p K^- \pi^+) \pi^-$ decay channel is used. Monte Carlo datasets are employed to validate the analysis.

P5: Hyperon Nucleon Interactions at CLAS

Joshua Bryce¹, and Mikhail Bashkanov¹

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Hyperon-Nucleon interactions are expected to play an important role in the dynamics of Neutron Stars, as well as the quark-hadron transition and cooling which occurred in the early universe. In particular the so-called 'Hyperon Puzzle', wherein accounting for Hyperons in neutron star equations of state (EoS) lead to a disagreement with astronomical observations, shows a need for a better understanding of such interactions. However, due to the short lifetime of Hyperons, probing such interactions is difficult and efforts to place theoretical and experimental constraints on them remains one of the foremost areas of research in the field. Recent results from analysis of Jefferson Lab data, presented for the first time, provide new insights into interactions which are expected to occur deep within neutron stars. In particular the lesser understood Σ^-p interaction which, according to some models, is expected to appear at lower densities and pressures than the better understood ΛN interactions and thus plays an incredibly significant role in the neutron star EoS. In this study, a novel method where Sigma baryons are produced in a clean and controlled environment with electromagnetic probes.. This analysis technique significantly reduces the systematic errors, the dominant part of uncertainty in all previous studies.. These results aim to further shed light upon the nature of YN interactions, and provide further basis to understand physics of the high energy environments in which they play a role.

P6: Lifetime Measurement of the 2+ Excited State in ⁷⁸Y

Cameron Cassells¹

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An unexplained staggering of B(E2: 2+ → 0+) values has been seen between odd-odd and even-even nuclei along the N=Z line. This effect is most pronounced in ⁷⁸Y, which has only been studied a few times [1, 2]. The first level structure study used recoil beta tagging (RBT) for channel selection in a fusion-evaporation reaction at JYFL with JUROGAM2 which identified the (2+) state [1]. The level scheme was later extended up to the (10+) state in a later fusion-evaporation reaction at JYFL [3]. The second experiment was carried out at NSCL, pre-FRIB, using a knock-out reaction [2]. In this study the lifetime of the 2+ state was measured via line shape analysis, resulting in an unexpectedly low B(E2) value. To confirm this result, a fusion-evaporation reaction ⁴⁰Ca (⁴⁰Ca, pn) ⁷⁸Y was carried out at the Argonne Tandem Linac Accelerator system (ATLAS) with the integrated Cologne Argonne plunger setup (iCAPS) and Gammasphere in March 2024. Channel selection was done using Neutron Shell and Microball. The goal of the analysis is to measure the lifetime of the (2+) state using the differential decay-curve method (DDCM) and possibly a gate on an in-flight decay of a feeding transition. In my presentation, I plan to present preliminary results for level structure and the lifetimes of the 2+ state in ⁷⁸Y.

[1] Bondili, S.N.S. et al., Phys. Rev. C 75, 061301(R) (2007)

[2] Llewellyn, R.D.O. et al., Phys. Rev. Lett. 124, 152501 (2020)

[3] Zimba, G.L. et al., Phys. Rev. Lett. 134, 022502 (2025)

P7: Prompt and delayed spectroscopy of ^{196}At – installation of the novel detector SIGMA in the focal plane

Dr Sneha Das¹, P Aden², J Ahokas², K Auranen², V Bogdanoff², A.D. Briscoe¹, T Grahn², K Green¹, P Greenlees², L. J. Harkness¹, A Herzán³, H Hilton¹, B Hogg⁴, D.T Joss¹, D.S Judson¹, R Julin², J Keatings⁴, H Kokkonen², N Landsman², D Lazzarretto², J Ojala², R.D Page¹, J Pakarinen², P Rahkila², E Richardson¹, E Rintoul¹, P Ruotsalainen², J Sarén², J.F Smith⁴, P Spagnoletti¹, C.M Sullivan¹, E Uusikylä², and J Uusitalo²

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The neutron-deficient nuclei in the region above Pb, offer a solid ground to study various nuclear-structure phenomena such as shape coexistence, magnetic rotation bands and isomers. The study of odd-mass At ($Z = 85$) and Bi ($Z = 83$) nuclei reveal a change of nuclear shapes from spherical to deformed with decreasing neutron number from the shell closure towards the mid-shell. Exploring the structures of odd-odd neutron-deficient nuclei in this region becomes more challenging due to the difficulties in the population and several possible configurations arising from the multiparticle - multihole couplings. For the odd-odd ^{196}At nucleus - only one isomeric state ($5+$) has been reported above the $3+$ ground state so far.

An experiment using RITU gas-filled separator has been performed in the Accelerator Laboratory of the University of Jyväskylä to populate ^{196}At via the reaction - $^{165}\text{Ho}(^{36}\text{Ar}, 5n)^{196}\text{At}$ at a beam energy of 186 MeV. The focus of the experiment was to investigate the level structures of ^{196}At above the $3+$ ground state and the ($5+$) isomeric state using the JUROGAM 3 array and FPGe (Focal Plane Germanium) detectors.

In this experiment, the SIGMA (Segmented Inverted-coaxial GerMANium) detector was installed in place of a Broad Energy Germanium Detector at the focal plane. The detector provides the added capability to detect and track the spatial origin of gamma-rays which can be used to correlate and/or veto events, along with the other detector systems to enhance the experimental output. The results obtained from this experiment will be presented.

P8: Alpha-particle condensation in diluted neutron-rich oxygen nuclei

Miriam Davies¹, Esra Yüksel¹, Jean-Paul Ebran^{2,3}, Elias Khan^{4,5}, and Paul Stevenson¹

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Nuclear matter generally exhibits the properties of a quantum liquid; however, in certain cases finite nuclei display molecular-like behaviour, forming structures composed of correlated clusters of protons and neutrons. The study of such cluster phenomena provides an exciting opportunity to investigate various behaviours within atomic nuclei and nuclear matter. Recently, it has been established that ^{16}O undergoes a Mott-like transition at a critical density, transitioning from a homogeneous to a localised configuration characterised by alpha-particle clustering [1]. It has also

been shown that there is a nontrivial interplay between the onset of this localisation under dilution and the suppression of deformation and clustering with increasing temperature [2].

In this work, we investigate clustered configurations in neutron-rich oxygen isotopes, focusing on 18-24O, using the multi-constrained finite-temperature relativistic Hartree-Bogoliubov model with DD-ME2 interaction. Motivated by the emergence of molecular-like states in nuclei with excess neutrons, where valence neutrons can stabilise clustered configurations [3][4], we examine the spatial distribution of valence neutrons in dilute nuclear systems and assess their impact on cluster survival as a function of density and temperature. This represents a first step towards understanding the role of excess neutrons in stabilising clustered configurations in dilute nuclear environments.

[1] J-P. Ebran, M. Girod, E. Khan, R.D. Lasserri, P. Schuck, Phys. Rev. C 102,014305 (2020)

[2] M. Davies, E. Yüksel, J.-P. Ebran, E. Khan, P. Stevenson, Phys. Rev. C 112,014311 (2025)

[3] C. Beck, Clusters in nuclei, 1. Springer (2010).

[4] W. Von Oertzen, HG. Bohlen. Comptes Rendus Physique 4:465–74 (2003).

P9: LiquidO opaque scintillator radiation detectors for particle tracking

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LiquidO is an innovative scintillator-based radiation detector concept whose core principle is the self-segmentation of the detector volume via stochastic light confinement in an opaque medium. Light produced in the scintillator is confined near its creation point due to the short scattering length of the material and efficiently collected by a lattice of wavelength-shifting optical fibres routed to silicon photomultipliers.

This presentation will explore two recent prototypes implementing the LiquidO technology: a 64-fibre cube and a 256-fibre planar detector. The detectors are filled with a wax-based opaque scintillator, characterised by a sub-millimetre scattering length. When traversed by cosmic-ray muons, the stochastic confinement of scintillation light produces the characteristic LiquidO "light cylinder", enabling reconstruction of the muon track position and direction.

The 3-cm cube LiquidO prototype obtains a 450-micron position resolution per row of fibres, achieved with fibres instrumented along a single direction. The 256-fibre planar LiquidO detector consists of eight layers of fibres arranged in two perpendicular directions with a 5-mm spacing, each fibre read out at both ends, with an active volume of 1.5 litres of scintillator.

The results obtained with these prototypes represent an important step toward applying LiquidO in a range of contexts, including nuclear-reactor monitoring with neutrinos, imaging of gammas and neutrons for nuclear non-proliferation, medical imaging, and will contribute to the wider development efforts of the LiquidO consortium.

P10: The KLong Experiment in Hall D at Jefferson Lab

Stuart Fegan¹, Mikhail Bashkanov¹, Daniel Watts¹, and Nick Zachariou¹

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The KLong Experiment in Jefferson Lab Hall D will use a secondary beam of neutral kaons and the GlueX experimental setup to perform strange hadron spectroscopy. By achieving a flux on the order of 1×10^4 KL/sec, this experiment will allow a broad range of measurements that improve the statistics of previous world data by several orders of magnitude.

The experiment will measure both differential cross sections and self-analysed polarisations of the produced Λ , Σ , Ξ and Ω hyperons spanning the mass range $W = 1490$ MeV to 2500 MeV. KLong data will significantly constrain partial wave analyses and reduce model-dependent uncertainties in the extraction of the properties and pole positions of the strange hyperon resonances, as well as establish the orbitally excited multiplets in the spectra of the Ξ and Ω hyperons. The experiment will also explore the strange meson sector through measurements of the final state $K\pi$ system up to 2 GeV invariant mass, and with the addition of nuclear emulsion detectors for high-resolution tracking, contribute to studies of hypernuclei.

In this talk, I will give an overview of the KLong Experiment, including UK contributions to project leadership and development of the flux monitor apparatus, current status of the project, then demonstrate its prospects for impact in strangeness spectroscopy via simulations of various KLong interactions, with a focus on $KL p \rightarrow \Xi^0 p$.

P11: Exploring and Developing an Analysis Framework for the Application of the Trojan Horse Method to Radiative Neutron Capture Reactions for Fusion

Patrick Galvin¹, Dr Jack Bishop¹, Prof. Tzany Kokalova^{1,2}, Prof. Carl Wheldon¹, and Dominik Stajkowski¹

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Cross-section data for (n,γ) reactions are an essential component in the development of planned nuclear fusion reactors, in order to accurately predict activation properties of materials under neutron irradiation. However, for many reactions of interest the need for specialist facilities presents a challenge in obtaining these data. The Trojan Horse Method (THM) is a more accessible, indirect route to measuring nuclear reaction cross-sections at low energies, utilising a clustered nucleus taking part in a three-body reaction. Kinematic conditions are selected such that one component of the cluster dominates the interaction, allowing its two-body cross-section to be measured at energies below that of the whole cluster.

The University of Birmingham's MC40 Cyclotron Facility will be used to test the THM's capability for (n,γ) cross-sections, extending initial measurements of the $^{27}\text{Al}(n,\gamma)^{28}\text{Al}$ reaction to a heavier target, in $^{93}\text{Nb}(n,\gamma)^{94}\text{Nb}$, which is of particular relevance to fusion applications.

An all-digital, digitiser measurement setup is used. This greatly increases flexibility compared to an equivalent analogue setup, but necessitates new analysis tools. An end-to-end analysis toolkit,

tailored for the THM, has been developed for online event sorting, reconstruction, and fine-tuning of post-measurement analysis for the calculation of THM reaction cross-sections, and is discussed in the context of the initial $^{27}\text{Al}(n,\gamma)^{28}\text{Al}$ measurements.

P12: Coulomb Excitation of 50-54Ca: E2 strength beyond N = 28

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We report on the progress of a systematic study of E2 transition strengths in neutron-rich Ca isotopes, namely 50–54Ca, using the intermediate-energy Coulomb excitation method. This study aims to provide key insights into the shell structure along the Ca isotopic chain on the neutron-rich side and to supply critical experimental information regarding the magicity of 60Ca. Furthermore, the neutron sub-shell gaps of 52Ca and 54Ca have been reported, yet the large charge radii of 50,52Ca suggest the possibility of core-breaking proton excitations in the isotopic chain, thereby questioning the magicity of 52Ca. Through this study, the transition strength to the 2+ state is expected to be systematically probed, with the goal of providing decisive information about the shell structure and benchmarking theoretical calculations.

The experiment was carried out at RIBF using the BigRIPS separator, the ZeroDegree spectrometer, and the DALI2+/HYPATIA array. The neutron-rich Ca beams were produced via the fragmentation of a 70Zn primary beam at 345 MeV/A. Two BigRIPS settings were tuned to study 50,51Ca and 52-54Ca separately. The neutron-rich Ca beams were transported to a 1-mm Au target to induce the Coulomb excitation. The contributions of the nuclear excitation were measured on a 6-mm Be target. In this contribution, I will present the status of the analysis and preliminary results.

P13: Interpolation of Lutetium Neutron Optical Model Potential Parameters using Bayesian Monte-Carlo Analysis

Adam Giambrone¹

¹University of Surrey, UK

In this talk, I will be presenting investigations into the neutron-induced reactions on lutetium (Lu) isotopes, using the nuclear reaction code TALYS, focusing on exploring methods for the derivation of Optical Model Potential (OMP) parameters in regions where experimental data is scarce. Bayesian Monte Carlo analyses were performed for the anchor nuclei 169Tm and 181Ta, yielding posterior distributions and optimal values for five key KD03 OMP parameters (r_v , v_1 , d_1 , a_w , and r_{vd}). From this uncertainty propagation and covariance matrices for both isotopes were constructed. Linear interpolation between these anchors provided new parameter sets for the intermediate isotopes 173–176Lu. The newly obtained OMP parameters were then validated using Maxwellian-average cross section data for radiative neutron capture from KADoNiS. With additional comparisons to recent experimental values from the Los Alamos National Laboratories using the DANCE detector system. Nuclear level density models were varied to investigate their additional impact, finding all produced cross sections within an order of magnitude, but limited by

the scope of parameters tested. Finally, the effects on the s-process relevant isomeric productions of $^{175,176}\text{Lu}$ were investigated using these newly obtained OMP parameter values and seeing as much as 33% deviations in isomeric ratios from default.

P14: Investigating the Low Lying Nuclear Structure of ^{40}Ar using Coulomb Excitation

Adam Giambrone¹

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Nuclear quadrupole deformation is a ubiquitous phenomenon across the nuclear chart. The experimental quantities most intrinsically related to nuclear deformation are reduced transition probabilities, $B(E2)$, and spectroscopic quadrupole moments, Q_s , respectively. These quantities derive from the matrix elements that describe the strength of interaction between nuclear states via the electromagnetic quadrupole (E2) operator. Measurements of $B(E2)$ and Q_s therefore provide crucial tests of nuclear theories and often highlight deficiencies in models that are not apparent from other data. This work will present results from a recent low-energy Coulomb excitation experiment on ^{40}Ar performed at the ATLAS facility in Argonne National Laboratory.

P15: Investigation of Octupole Collectively in Light Actinides via Multinucleon Transfer Reactions with AGATA-PRISMA.

Henry Hilton¹

¹University of Liverpool, UK

The light actinide region serves as a distinctive area of study in nuclear structure physics, because of the transition from reflection-symmetric to pear-shaped nuclei, owing to the presence of enhanced octupole correlations. These nuclei allow us to challenge and progress cutting-edge nuclear theory, whilst also offering insights into fundamental CP-violating physics. Experimental information for the excited states in this mass region remains sparse, largely because of the difficulty of producing neutron-rich isotopes via standard reaction mechanisms with stable beams. For this reason, the use of AGATA-PRISMA is uniquely advantageous, due to the reduction in the Compton background from gamma-ray tracking algorithms in AGATA, and high-resolution mass and charge identification in PRISMA. In combination, these two detectors allow for “event-by-event” discrimination, allowing weakly populated states at high angular momentum to be distinguishable.

In this work, we present preliminary results from the ongoing analysis of an experiment performed using the AGATA+PRISMA setup at Laboratori Nazionali di Legnaro (LNL). Light actinides in the $A \sim 226$ region were produced via multinucleon-transfer reactions, utilising a ^{129}Xe beam, bombarding a ^{232}Th target. The recoil velocity of the light (beam-like) transfer products is reconstructed on an event-by-event basis using the PRISMA magnetic spectrometer. By calculating the full kinematics of the reaction, we perform precise Doppler correction for the gamma-rays emitted by both the beam-like and target-like fragments. This approach will enable the

construction of updated level schemes to investigate the evolution of octupole collectively in neutron-rich actinides.

P16: Identification of excited states in Ba-114 using recoil-decay tagging

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Octupole collectivity is present in atomic nuclei which adopt a reflection-asymmetric shape, said to resemble that of a pear. Enhanced octupole correlations are expected to occur in the neutron-deficient $N = Z = 56$ region of the nuclear landscape, close to Ba-112. Negative-parity states and enhanced E1 transitions characteristic of octupole deformation have been observed in Xe-112, Xe-114 and Ba-118. Theoretical predictions propose that octupole correlations are larger for $Z = 56$ than for $Z = 54$, however, there is no spectroscopic information known amongst the even-even neutron-deficient barium nuclei with $A < 118$. Although the $N = Z$ nucleus Ba-112 is out of reach in gamma-ray spectroscopy experiments, new techniques suggest that the identification of excited states in the $N = Z + 2$ Ba-114 nucleus is possible. For that reason, an experiment has been carried out at the Accelerator Laboratory at the University of Jyväskylä. The experiment used a beam of Ni-58 with an intensity up to 10 pnA on Ni-58 targets. The Jurogam-3 spectrometer detected prompt gamma rays around the reaction site. Recoiling evaporation residues were transported by the vacuum-mode recoil-separator MARA and were implanted into a double-sided silicon-strip detector behind the MARA focal plane. The identification of Ba-114 has been achieved by using the alpha-decays and beta-delayed proton decays of the implanted nuclei using the recoil-decay tagging method. Gamma-ray transitions have been tentatively assigned to Ba-114.

P17: Lifetime measurements in ⁵³V

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A study of the low-lying excited state structure of the $N=30$ nucleus ⁵³V was performed using the ⁵¹V(¹⁸O,¹⁶O)⁵³V transfer reaction. A 35~MeV beam of ¹⁸O was delivered by the tandem accelerator at the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH) in Bucharest. The aims of this work were to confirm and expand the existing knowledge pertaining to the structure of ⁵³V, in addition to measuring lifetimes for the most strongly populated excited states. The experiment was conducted in two parts; the first focused on fast-timing measurements and the second on Doppler-shift attenuation method (DSAM) measurements. In the first experiment, gamma rays were detected using ROSPHERE [1] in a configuration of 10 High Purity Germanium (HPGe) detectors and 15 LaBr₃ detectors for fast-timing. In the second experiment ROSPHERE was used in a configuration of 25 HPGe detectors in conjunction with the silicon detector array SORCERER [2] for particle selectivity at backward angles. The deduced level scheme and excited state lifetimes will be discussed and interpreted with regards to the Shell model.

[1] D.Bucurescu et al., NIM A, 837 1-10 (2016)

[2] T. Beck et al. NIM A, 951:163090 (2020).

P18: In-situ spectral analysis for strontium-90/caesium-137 discrimination in contaminated land

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An analysis method is demonstrated on spectra obtained in-situ with a cerium bromide scintillator in blind tubes at the Magnox Swarf Storage Silo at Sellafield to determine depths of strontium-90 and yttrium-90 arising. Land contaminated by strontium-90 can pose radiological concerns due to its radiotoxicity and mobility in groundwater. Monitoring such contamination to determine its activity, concentration and migration behaviour is important because strontium tends to migrate more readily than caesium, due to the latter's strong fixation characteristics on clay rich soils and yields the high-energy emitting daughter isotope yttrium-90. In-situ spectroscopy is complicated by strontium-90 being a pure beta emitter and its emissions being attenuated strongly with in-situ spectra comprised mostly of caesium-137. Hypothetically, counts in regions of interest having photon energies lower than the full-energy caesium line are expected to comprise of a predictable percentage of Compton scatter from the 662 keV gamma-ray emission peak from the de-excitation of barium-137, scaled by the number of counts in aforementioned peak, and the potential for weak contributions of direct beta and/or bremsstrahlung-related contributions from strontium and yttrium. The spectral counts were compared to the theoretically expected level. Nearest-neighbour analysis applied to these data shows clusters in the data and the data arising from the number of counts in the caesium peak. Separation between the corresponding clusters is used to imply the presence of strontium-90/yttrium-90 or otherwise. Theoretical estimates for bremsstrahlung contributions from strontium-90 and yttrium-90, accounting for real-world attenuation, are also presented.

P19: Determination of absolute gamma ray emission intensities and the half-life of Ho-166m

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Holmium-166m is a long-lived radioisotope with a half-life of 1133 (8) years. It decays by β^- to the seventeen excited levels of Er-166 and has a complex decay scheme, with 54 gamma transitions, and characterised by high internal conversion coefficients. Most decay events populate two distinct excited nuclear states: 1.827 MeV and 1.786 MeV, with corresponding intensities of 17.2 % and 74.8 %, respectively. Due to these physical characteristics, Ho-166m has been identified as an alternative for Ra-226 as a quality control source for secondary standard ionisation chambers due to its long half-life and absence of decay progeny. It also has

characteristic gamma rays from its decay that make it useful as a full-energy peak detection efficiency calibration source for high-purity germanium gamma-ray spectrometry.

As a result, there is a need to improve the precision of the half-life and the absolute gamma-ray emission intensities. As part of the CCRI.RI(II)-K2-Ho-166m international comparison, NPL determined new values for the absolute gamma-ray emission intensities utilising the absolute activity standard of Ho-166m realised using primary liquid scintillation counting techniques and a well characterised HPGe gamma-ray spectrometer. The half-life of Ho-166m has been determined by inductively coupled plasma mass spectrometry of the absolute activity standard. In this presentation we will present details of the measurement campaign and the results of these new determinations.

P20: The effect of non-locality on the (p,t) transfer reaction applied to surrogate reaction modelling

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Neutron capture (n,γ) reactions play a crucial role in nuclear energy applications, medical isotope production and nucleosynthesis in stellar environments. However, direct measurements of (n,γ) cross sections are often impractical due to the short lifetimes of neutrons and/or target nuclei. The surrogate reaction method provides an indirect approach by forming the same compound nucleus through an alternative reaction (a surrogate) by combining experimental techniques with theoretical modelling. Originally developed for use in (n,f) reactions, the surrogate method can be used for other reactions such as (n,γ). Traditionally, the (p,d) or (d,p) reaction was used as a surrogate for (n,γ), but (p,t) offers a better match to the compound nucleus spin-parity distribution, making it a promising alternative.

Previous attempts at using the (p,t) reaction as a surrogate relied on local optical potentials, however, transfer reactions are sensitive to the internal nuclear region of the wave function. Since the underlying nucleon-nucleus interaction is non-local, incorporating non-local optical potentials may lead to more realistic descriptions of the transfer cross section and improve surrogate reaction modelling.

In this work, the effect of non-locality on the (p,t) transfer reaction is investigated. Calculations are performed with non-local, local-equivalent and local optical potentials using reaction codes (TwoFNR, FRESKO and a custom code). The resulting cross sections are compared, preliminary results suggest that the non-locality has a noticeable impact on the angular distributions, indicating that non-local effects should be considered in future surrogate reactions studies using (p,t).

P21: Probing shape coexistence in the neutron-deficient mercury isotopes with the Coulomb-excitation technique

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Shape coexistence in the neutron-deficient lead region around $N \approx 104$ has been discovered in different nuclei especially in the mercury isotopes, where a staggering effect was found between even- and odd-mass nuclei using charge radii measurements [1]. In addition, the study of the even-even $^{182-188}\text{Hg}$ isotopes via various reactions showed a mixing of weakly oblate and more prolate deformed configurations which coexists at low excitation energies [2]. To investigate collective behaviour of low-lying states on top of the $(1/2^-)$ ground-state in ^{185}Hg and the different deformed $(13/2^+)$ isomeric state as well as in the even-even ^{184}Hg neighbour, Coulomb-excitation experiments were performed at HIE-ISOLDE. The separation of the isomer and ground state in ^{185}Hg using RILIS offers a unique opportunity to study shape coexistence in this nucleus. The Hg beams were accelerated with an energy of 4 MeV/u. The emitted γ rays were detected in Miniball in coincidence to the scattered particles measured in the DSSSD detector. The SPEDE detector is combined with the array to investigate the transition between states of the same spin and parity. Preliminary results of excited states of the mercury isotopes will be shown. Excited states in ^{185}Hg were populated and identified up to a spin of $25/2^-$. The signature partner band of the ground-state band was observed and established for the first time. Comparisons with neighbouring odd-mass Hg and Pt isotopes reveal similar band structures.

[1] B. Marsh et al. Nature Physics 14, 1163 (2018)

[2] K. Wrzosek-Lipska et al. EPJA 55, 130 (2019)

P22: Fault-Tolerant Quantum Algorithms for Complex Nuclear Systems

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Quantum computing is an attractive method for solving problems that are otherwise intractable with classical computing, such as the inclusion of three-body forces within nuclei. Due to the exponential scaling of the Hilbert space as we linearly increase the number of qubits, we can use quantum computing to simulate complex nuclear systems.

We explore the pionless effective field theory (EFT) at leading order and perform ab-initio computations of nuclei on a lattice. The exponential quantum Hilbert space growth allows us to represent the pionless EFT with dramatically less resources than a classical counterpart. This field theory approximates the nucleon interactions by integrating out pion exchange and from it we can compute two-body and three-body interactions and solve the Schrödinger equation with just a laptop.

Further, we explain how to encode the nuclear Hamiltonian onto a quantum computer, analyse several quantum algorithms, and discuss their efficiency. We therefore demonstrate how quantum computers can be effective in simulating and understanding complex nuclei.

P23: Generalising the Formalism of Electroproduction with Polarised Targets by Implementing Moments Analysis

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The Electron Ion Collider (EIC) is a proposed future collider in which the next generation of hadron spectroscopy experiments are set to take place. During electroproduction, resonances are produced through the exchange of a virtual photon, which gives greater detail on different production mechanisms compared to that of a real photon. The EIC will also have access to polarised electron and proton beams, providing the opportunity to investigate the physics of resonances by using the polarisation information to access otherwise inaccessible observables, such as cross-sections. To accommodate this, we will have to update the current electroproduction formalism to include a generalized moments analysis, taking into account the possibility for the target to be polarised.

First, a review of the current electroproduction formalism (Schilling and Wolf) and generalised moments analysis formalism (JPAC) for photoproduction is presented. Next, the generalisation of electroproduction to moments analysis, as well as the inclusion of a polarised target, is shown. Finally, this will be finished with some preliminary conclusions and an outline for the future of this project.

P24: MuDirac 1.2.5: A Sustainable Software Tool for Calculating Ground State Nuclear Properties Using Muonic X-Ray Measurements

Leandro Liborio¹, Milan Kumar¹, Subindeev Devadasan¹, Philip Jones², Martin Plummer¹, Adrian Hillier³, and Albert Bartok²

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The nuclear charge radius is one of the most fundamental quantities of the atomic nucleus. It can be deduced from a combination of the experimental measurements of muonic X-ray transition energies and the modelling of those energies. In this work we present MuDirac (1.2.5), which is a publicly available, sustainable and computationally efficient software tool that will be put at the disposal of the muon community. With MuDirac (1.2.5), the community will be able to accurately and efficiently estimate nuclear properties, such as the nuclear charge radius, by assuming a 2-parameter Fermi distribution of the nuclear charge.

P25: Dosimetric Characterisation of a Reproducible Helium Ion Beam at the MC40 Cyclotron

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Helium ion therapy is an emerging modality in particle therapy, offering a favourable depth–dose distribution and higher linear energy transfer (LET) than protons. The MC40 cyclotron at the University of Birmingham is capable of producing 29 MeV alpha particles, providing a unique platform for preclinical research. To enable future radiobiological studies, helium ion beams must be delivered reproducibly and characterised with high dosimetric accuracy.

This work describes the development of a reproducible helium irradiation setup at MC40 and its dosimetric characterisation. A beam-flattening filter was implemented to improve lateral dose uniformity, and Bragg peak measurements were performed to characterise the depth–dose distribution of the beam. These measurements were repeated over multiple beam days to assess delivery reproducibility.

Good agreement was observed between repeated measurements, with the Bragg peak position reproduced to within 5 μm of aluminium. These results demonstrate the stability and reliability of the MC40 helium beam. The poster will present the experimental setup, the methods used to achieve reproducible Bragg peak measurements, and the implications of this work for future radiobiological experiments using helium ions.

P26: The performance of the μ -RWELL MPGD at low pressures using the TACTIC test chamber

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Measuring small reaction cross-sections at low-energy ranges is an ongoing challenge in experimental nuclear astrophysics. The TACTIC (TRIUMF Annular Chamber for Tracking and Identification of Charged particles) active target detector has the ability to harness differential energy loss properties for alpha-induced charged particle reactions in a cylindrical geometry for full angular coverage. This study used the TACTIC test chamber, of planar geometry, to study the capabilities of the μ -RWELL electron amplification stage at low pressures. The response of the μ -RWELL at low pressures is currently not well characterised, and determining its optimal operating conditions will enable measurements of improved centre of mass energy resolution for accurate charged particle identification. For this study, the test chamber has been operated at 200mbar, the lowest pressure test yet, with a P10 gas mixture ($\text{Ar}:\text{CH}_4$) using a spectroscopic triple- α source (^{239}Pu , ^{241}Am , ^{244}Cm). This presentation will cover initial data analysis and results achieved, with emphasis on optimising our current methods of track reconstruction at low pressures.

P27: The optimisation of neutron production from the d-Li reaction

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The University of Birmingham's High-Flux Accelerator-Driven Neutron Facility (HF-ADNeF), the most intense neutron source of its kind in the world, currently operates using the p-7Li reaction. However, the accelerator could feasibly accelerate deuterons onto the lithium target instead, producing high-energy neutrons covering the D-T fusion neutron spectrum peak at 14.1 MeV. This talk will present the motivation, current progress, and outlook towards establishing the d-7Li capability of the facility, enabling the production of high-energy, quasi-mono-energetic neutrons at high flux for a range of exciting applications.

P28: Precision Measurements of MeV scale Quantum Entanglement and decoherence at TRIUMF

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The quantum entanglement of optical photons is currently underpinning a modern technological revolution. However our understanding of photonic entanglement at the MeV scales appropriate to nuclear physics is only recently starting to develop. The York Nuclear Physics group has led recent advances in our understanding of the quantum entanglement of the two-gamma final states produced following positron annihilation, including establishing their promising benefits in next generation PET imaging. Our recent work revealed that their entanglement is surprisingly robust when the gamma's interact with their environment. The dominant interaction with their environment is through Compton scattering and single scatter processes having polar angles below ~50 degrees were shown to not significantly diminish the entanglement.

However, the question of how higher order processes affect the entanglement (such as where both gamma scatter, or one scatters more than once introducing an immediate angle) is an open question for the field. Detecting and characterising such processes with the necessary detail is challenging and requires detectors with exquisite position resolution and which are thin enough that multiple scattering effects do not diminish the entanglement information. This will be achieved in a new experiment using the GRIFFIN high purity germanium (HPGe) detector surrounding a close to hermetic Silicon strip detector cube at TRIUMF. Early results from simulated studies using a virtual detector, as well as first experimental data will be presented.

P29: A Unified Quantum-Geometric Framework for Generalized Artificial Neural Networks

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We present a unified framework integrating Loop Quantum Gravity (LQG) and Quantum Field Theory (QFT) to model abstract Artificial Neural Networks (ANNs). Existing ANNs lack a physical basis for higher-order cognition, self-reference and general intelligence, motivating an LQG- and QFT-based framework. We model neurons as quanta of space at LQG spin-network nodes, neuron states as quantum states in Hilbert space and edges labeled by spins serving as complex spin-weights defining the network topology. Information processing is described as quantum-state evolution governed by Hamiltonian constraints of LQG, where learning consists of discrete, unitary, energy-conserving updates, reducing curvature and encoding information as geometric deformation. QFT-based input and output layers are modeled as continuous field excitations that interact coherently with the discrete spin-network geometry. Spin transitions yield gradient-like updates linking optimization to curvature flow in quantum geometry. Higher-order dynamical feedback states emerge that encode both external data and the network's own evolution, enabling self-referential computation. Conserved excitations interacting as particles in QFT drive the unitary evolution that sustains memory, suggesting a unified ANN framework.

P30: Constraining the Neutron Skin of ^{120}Sn via Dipole Polarizability and Charge Exchange Reactions

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The neutron skin thickness (ΔR_{np}) of heavy nuclei is a critical observable linking nuclear structure to astrophysical phenomena, such as the neutron star equation of state. This study presents a novel, multi-method analysis to constrain ΔR_{np} in the stable isotope ^{120}Sn . We combine results from high-resolution (p,p') measurements of the isovector giant dipole resonance (IVGDR) at the Example Laboratory, which provide a direct constraint on the dipole polarizability (α_D), with newly evaluated cross-sections from the charge-exchange $^{120}\text{Sn}(^3\text{He,t})^{120}\text{Sb}$ reaction. The α_D is extracted via a Lorentzian multipole decomposition of the (p,p') data, yielding a model-independent value. Concurrently, the Gamow-Teller strength distribution from the charge-exchange reaction is used to inform energy density functional (EDF) calculations, specifically tuning the symmetry energy slope parameter (L). A consistent Bayesian analysis framework is applied to both datasets, allowing us to derive a combined constraint on ΔR_{np} with significantly reduced uncertainty compared to single-method approaches. Our preliminary result suggests a ΔR_{np} for ^{120}Sn of 0.15 ± 0.02 fm. This work demonstrates the power of cross-experiment synthesis to pin down fundamental nuclear parameters and provides a crucial benchmark for advancing theoretical EDFs used in neutron star modeling.

P31: Isomers, Masses, and Half-lives in Neutron Rich Nuclei at the GSI Experimental Storage Ring

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$N=116$ is the critical point for a prolate to oblate phase/shape transition in the $A\sim 180$ region of neutron-rich nuclei [1]. Mass/lifetime measurements of isomers and ground states in the surrounding area will help to improve nuclear structure models. Many isomers in the region are known and more are predicted [2].

Combined Schottky + Isochronous Mass Spectrometry (S+IMS) was established at the GSI experimental storage ring (ESR) in an experiment in 2021, allowing the revolution frequency of every stored ion to be determined within a few milliseconds [3]. In another experiment in 2024, nuclei with half-lives as short as 3ms were measured. These properties, and the ESR's ability to store a broad range of A/Q ratios for extended periods, make it ideal for examining neutron-rich projectile fragments for known and unknown isomers, and new ground state masses.

The experiment that provides the data for this work took place from April 3rd to April 9th 2025 using a ^{208}Pb beam on a ^9Be target. Two settings were used, one centred on ^{186}Hf and one on ^{188}Hf in which there is predicted to be an exceptionally long lived, prolate $K=18+$ isomer. Fragments have been identified between $N=107$ and $N=127$, therefore covering deformed and spherical nuclei. Preliminary results will be presented.

[1] D. Bonatsos et al., Phys. Scr. 99, 062003 (2024)

[2] M. W. Reed et al., Phys. Rev. C 86, 054321 (2012)

[3] D. Fernandez et al., Phys. Rev. Lett. 133, 022502 (2024)

P32: Modelling In-Plasma Nuclear Reactions with FISPACT

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Several nuclear reaction studies have taken place at the National Ignition Facility in the last few years. Now, with the experimental method proven, both the NIF RadChem and (n,Gamma)Plasma collaborations are looking to study more exotic reactions. Accurate experimental design requires a modelling capability to predict the outcome of the many reactions which may occur in a plasma environment, to enable correct capsule doping.

This poster demonstrates the ability to accurately model such an experiment using FISPACT, by matching the results of two $^{89}\text{Y}(n,2n)$ shots from 2023/24.

P33: Preliminary Studies of Charged Pion Electroproduction on Deuterium

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Accessing the internal structure of mesons is central to hadron physics, providing insight into nonperturbative QCD dynamics and the origin of hadronic mass. The Sullivan process offers a unique experimental approach by treating the meson cloud of the nucleon as an effective hadronic target. In this work, the Sullivan mechanism is investigated through exclusive π^+ and π^- electroproduction on a liquid deuterium (LD_2) target, where the weak nucleon binding enables a spectator interpretation of pion exchange. Preliminary results from precision longitudinal-transverse (L/T) separated pion electroproduction data from the Hall C PionLT experiment are used to test pion-pole dominance, isospin behavior, and the role of longitudinal photon contributions at low momentum transfer. By examining these effects in an LD_2 environment, the kinematic conditions under which near-on-shell pion exchange dominates can be identified and the Sullivan picture is valid, while also quantifying the onset of non-Sullivan background contributions.

P34: Hybrid Classical-Quantum Non-Perturbative Simulation of Nucleon-Nucleon Scattering

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We introduce a hybrid quantum-classical framework providing an efficient way to describe the full time propagation of two interacting nucleons (one proton and one neutron) and avoiding the usual approximations implied by standard scattering theory. This is achieved by splitting the time propagator over a short time interval, following the Trotter formula, in a piece evolving the relative coordinates and a piece evolving the spin/isospin state. Nucleons interact via a regulated short-range potential that incorporates spin-dependent interactions including one-pion-exchange. The relative coordinate is evolved in time by the Crank--Nicolson method across 14 coupled channels. The spin-angular evolution would instead be simulated by a quantum computer operating on a quantum register including all the relevant components. Such process was simulated including quantum noise by solving the Lindblad equation over the same short time interval at a value of the proton-neutron distance sampled at each time step according to the time evolved spatial wavefunction. The latter is in turn propagated including in the potential a state-dependent term sampled from the probability of finding the nucleons in a relative spin-angular state.

Such wave function evolution shows key features of nuclear dynamics, including wave-packet spreading, interference effects arising from superposed momentum components, and partial localization showing bound states, thereby covering both elastic and unelastic channels.

Future work will extend this framework to multi-nucleon systems and explore real-time simulations on actual quantum computing platforms.

P35: Investigation of a Novel Segmented Point-Contact BEGe Detector

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The Segmented Inverted Coaxial Germanium (SIGMA) detector is a p-type, large-volume High Purity Germanium (HPGe) detector designed for gamma-ray tracking and imaging. SIGMA and other highly segmented germanium detectors are well-suited to applications ranging from spectroscopic gamma-ray imaging for nuclear decommissioning to deployment in portable detector arrays at international accelerator laboratories for studies in nuclear structure and nuclear astrophysics. However, when a multi-interaction event, in which an incident photon deposits energy at multiple spatial locations, occurs within the detector, the analysis complexity increases with finer electrode segmentation.

In this work, a future, simplified SIGMA-like design has been developed to reduce technical risk, optimise future manufacturing yield, and maintain outstanding precision performance. A novel segmented point-contact (SPOT) Broad Energy Germanium (BEGe) detector has been designed, simulated, and analysed to provide proof of concept. The AGATA Detector Library (ADL), a simulation package used to model semiconductor detectors, specifically electric and weighting potentials, was utilised. Simulated charge signals in ADL are produced by combining these potentials with charge-transport simulations. A simulated database of SPOT signals was generated across the entire detector volume, also referred to as a basis. Finally, the sensitivity of the SPOT detector, or the difference in signal shape between signals within the simulated basis, was evaluated and compared with that of a standard BEGe detector to provide an initial measure of SPOT's position resolution and to assess potential performance.

P36: BUTTON at Boulby - a testbed for monitoring the anti-neutrino flux from nuclear reactors

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Antineutrino detection serves as a valuable technology for nuclear non-proliferation efforts and the broader field of nuclear forensics e.g. by providing a means to remotely monitor nuclear reactors. The Boulby Underground Technology Testbed for Observing Neutrinos (BUTTON) is a 30-tonne technology demonstrator designed to advance the capabilities of water-based hybrid detectors for such applications. Located 1.1 km underground at the Boulby Laboratory, the detector's environment provides a cosmic ray attenuation of one million and exceptionally low radiological backgrounds, crucial for detecting the low-energy signals characteristic of neutrinos.

The detector comprises a 3.6 m diameter stainless steel tank containing ninety-six 10-inch Hamamatsu PMTs encapsulated in watertight acrylic housings. This design allows for operation with various media, including gadolinium-doped water or Water-based Liquid Scintillator (WBLS), to enhance detection efficiency. Data is acquired using CAEN V1730 digitizers and processed with the ToolDAQ framework.

This presentation will provide an overview of the Button-30 detector's design, construction, and material radioassay program. We will discuss its relevance and potential as a scalable technology for the remote monitoring of nuclear activities.

P37: In-Beam Gamma-Ray Spectroscopy of Neutron Rich Calcium isotopes

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The calcium isotopic chain provides a key testing ground for the evolution of nuclear shell structure far from stability with previous studies showing new shell gaps emerging in ⁵²Ca and ⁵⁴Ca. In this contribution, I will report on a new experiment performed at the RIBF facility in RIKEN to study 1n, 2n and 1p knockout reactions from ⁵⁰Ca. The aim of this work is to study the proton and neutron shell evolution in the Ca isotopic chain beyond the N=28 shell closure. In particular, the discrepancy between the theoretical and measured strength of the 1f_{7/2} neutron hole reported in previous literature will be revisited. The experiment made use of the STFC-funded HYPATIA array using the utilising modules composed of the novel scintillator materials CeBr₃ and GAGG. These results aim to provide new constraints on the underlying nuclear interactions governing shell evolution in this region.

P38: Exploring the Use of the Trojan Horse Method for Radiative Neutron Capture Reactions

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Cross section data for (n,γ) reactions are needed for nuclear physics applications, such as fusion, and fundamental research. These data are challenging to obtain via direct neutron irradiation, as it requires specialised facilities and techniques, such as having neutron time-of-flight capability. The Trojan Horse Method (THM) is proposed as a more accessible alternative for obtaining these data.

The THM uses the clustered nature of nuclei and a quasi-free mechanism to investigate reactions at low (often sub-Coulomb) energies. So far, the method has been successfully applied to nuclear reactions of astrophysical relevance [1]. The THM has also been used to study neutron-induced reactions in light isotopes, such as ³He(n,p)³H via the ²H(³He,pp)³H reaction [2] and investigations of neutron-induced reactions on heavier (A~28) species [3]. This technique can also be used to obtain radiative capture cross sections, as was theoretically presented [4], although this has not yet been attempted experimentally.

To investigate the THM's capability for high-energy neutron (>8 MeV) radiative capture, the ²⁷Al(²H,pγ)²⁸Al THM reaction was used to measure the ²⁷Al(n,γ)²⁸Al cross section at the University of Birmingham MC40 Cyclotron Facility using a deuteron beam as a Trojan Horse.

An overview of the relevant theory, experimental considerations and results of preliminary investigations will be presented.

[1] A.Tumino, et al. Annu. Rev. Nucl. Part. Sci. (2021) 71:345-76.

[2] R.G. Pizzone, et al. Eur. Phys. J. A (2020) 56:199.

[3] R. Spartà et al. IOP Conf. Ser.: J. Phys. Conf. Ser.1308 (2019) 012022.

[4] A.M. Mukhamedzhanov et al. Phys. Rev. C 96, 045811.

P39: Producing covariances for fast neutron incident reactions on deformed isotopes using the TALYS code

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In this work, the Backward-forward Monte Carlo (BFMC) method was utilised as a nuclear data evaluation method to produce fast neutron incident reaction cross sections. This evaluation is constrained by EXFOR data, where available, but can also be used for isomers and isotopes where no experimental data exist. This method has been applied to the Z=70 region, where many isomeric states exist with no experimental reaction cross section measurements.

The BFMC method produces cross section uncertainties and allows covariances to be calculated. These covariances can be used to inform which experimental measurements may best constrain reaction cross sections at specific energies. Cross section covariances can also be used to produce an uncertainty quantification estimate for reaction rates using both the Total Monte-Carlo method and more traditional uncertainty propagation methods such as the sandwich rule.

Finally, a new evaluation process is proposed based on the BFMC method which makes use of integrated cross section measurements. This method utilises experimentally measured neutron spectrum and measured activation to simultaneously constrain collapsed cross sections and TALYS parameter space.

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P40: Bayesian calibration of optical potentials and propagation of uncertainties to compound nucleus reactions

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Applications of nuclear physics require high-quality, evaluated nuclear data libraries. The compilation of these evaluated libraries necessitates a realistic estimation of the uncertainties in our physics models. Bayesian statistics provides a powerful array of techniques for determining these uncertainties. However, assigning uncertainties to predictions can be challenging. An

example of this are compound nucleus (CN) reactions which are relevant for nuclear reactor physics. Describing these reactions theoretically requires many complex model inputs, one of which is an optical potential. Our work estimated the uncertainty in the optical potential using Bayesian calibration. The resulting uncertainty-quantified potential was then propagated through CN calculations, partially characterising the uncertainty of these reactions.

This work presents optical potential calibrations for zirconium and yttrium. The calibrations used data from across the isotopic chains of these elements. A modular code framework was developed to produce calibrations for further targets. We compare our calibrated potentials to already extant globally calibrated potentials, and demonstrate improved empirical coverage of nuclear scattering observables. These potentials and a globally-calibrated potential were then propagated through CN calculations. Our final results demonstrate the various degrees of sensitivity that different CN reactions have to optical potential inputs, e.g. inelastic scattering is strongly dependent, whereas radiative capture is not. This work also presents a comparison of CN response to our local-chain potentials versus extant global potentials.

P41: CeBr₃ scintillator development for HYPATIA: a next-generation hybrid gamma-ray detector array at the RIBF

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In-beam gamma-ray spectroscopy using fast rare-isotope beams is a powerful technique for probing the underlying structure and reactions of exotic atomic nuclei. The RIBF (Rare Isotope Beam Factory) has played a pivotal role within this field, with the DALI2+ array [1], based on NaI(Tl) scintillators, delivering decades of high-impact discoveries [2,3]. However, as the experimental landscape evolves, a next-generation spectrometer is essential to meet new challenges and drive future progress.

HYPATIA (HYbrid Photon detector Array To Investigate Atomic nuclei) is an ambitious project aimed at creating a cutting-edge scintillator array to gradually replace DALI2+ at RIBF. This hybrid detector system will incorporate over 1,000 high-performance scintillator crystals (384 HR-GAGG and 624 CeBr₃) in a configuration to deliver excellent energy resolution, peak-to-total and timing. Its modular design offers flexibility and reconfigurability, to accommodate a wide range of experimental setups.

This presentation will focus on the UK-led development of the CeBr₃ detector modules for HYPATIA. We report on recent progress at the University of York laboratories in the handling, assembly, and characterisation of these detectors, highlighting their excellent performance capabilities. Phased implementation of the array is underway, with recent in-beam tests demonstrating the impact of the CeBr₃ modules as a significant upgrade to the in-beam gamma-ray spectroscopy capabilities at the RIBF, opening new opportunities for the study of rare and exotic nuclei.

[1] S. Takeuchi et al. DALI2: A NaI(Tl) detector array for measurements of γ rays from fast nuclei. Nucl. Instrum. Meth. A, 763:596, 2014.

[2] <https://www.nishina.riken.jp/collaboration/SUNFLOWER/devices/dali2/pub.php>, 2024

[3] <https://www.nishina.riken.jp/collaboration/SUNFLOWER/experiment/seastar/pub.php>, 2024

P42: Machine Learning Enhanced Analysis of Silica Glass Jewellery Beads for Thermoluminescence Dosimetry Health Monitoring

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For personal radiological health monitoring, thermoluminescence dosimetry (TLD) provides a method to estimate the absorbed dose for an individual over a specified time interval. A dosimeter captures and traps ionised electrons, which, when heated, release the trapped electrons through an emission of light called a glow curve. For TLD, the material's composition, features and the readout heating parameters affect the glow curves' characteristics, which should be proportional to absorbed dose. With an ever-growing nuclear industry, new dosimetry materials and efficient analysis techniques remain an active research field.

The research presented, explores different applications of machine learning (ML) for advanced glow curve analysis, specifically advancing past work into the use of micro silica glass jewellery beads as retrospective body and extremity TL dosimeters. A seed training dataset is formed of glow curves with varying isotopes, doses, bead colours, sizes, shapes and various heating parameters. This is injected into three furnished machine learning (ML) frameworks: synthetic glow curve generation, glow curve correction and classification; each exploring several algorithms.

Future work aims to elucidate the relationship between the underlying material physics, physical kinematics and glow curve mathematical modelling using deconvolution. An ML model is envisaged to inform these complex kinematic parameters faster, more accurately and efficiently than current processes, exposing the hidden luminescence elements of a material under irradiation for the use of TLD. Providing an enhanced analysis of the glow curve structure and a more precise calculation of absorbed dose for individual health monitoring within the nuclear sector.

P43: Moments of Angular Distribution of K+K- with CLAS12

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Since the prediction of the meson in 1935, facilities and institutions worldwide have contributed to the discovery of over 200 distinct types, including the pions, kaons, and J/ψ . Meson spectroscopy involves understanding the properties of the mesons, allowing for the classification of this vast family of hadrons to be improved, which is particularly important for the discovery of new or exotic mesons – those forbidden in the naive quark model. In this endeavour, determining the spin of a meson is vitally important. A set of quantities known as moments of angular distributions provides information on the spin of a meson, which can be extracted from the angular distributions of its decay products. Jefferson Lab, located in Virginia, USA, is a high-

luminosity, multi-GeV electron beam facility and is home to the CLAS12 detector, which is used to study the electro- and photo-production of meson resonances. This talk will present preliminary results and novel analysis techniques developed for extracting the moments of angular distributions of meson resonances decaying into a pair of oppositely charged kaons. These techniques involve improved particle identification based on the time-of-flight, cuts in longitudinal phase space to remove baryon resonances and the application of an MCMC-based algorithm. Preliminary moments of angular distributions will be shown, and properties of the resonances will be discussed.

P44: Benchmarking SRO Performance of CAEN Digitizers

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The CAEN x2740/x2745, x2730, and x2751 digitizers belong to the Digitizer 2.0 family and are designed to meet the high data rate requirements of modern nuclear and particle physics experiments, medical imaging systems, and large-scale detector readouts. These platforms support both triggered acquisition and continuous streaming readout, integrating high-speed Flash ADCs, FPGA-based real-time processing, large DDR4 buffers, and native USB 3.1, 1 GbE TCP, and 10 GbE UDP connectivity. This work provides a performance evaluation of the readouts architectures. Hardware benchmarks were performed employing triggered and streaming readout firmware in order to investigate saturation behavior and identify throughput limitations. In triggered readout with raw waveform transmission over 10 GbE UDP, data rates close to 1.1 GB/s were achieved with no packet loss. In list-mode streaming readout with onboard processing, the maximum event rate is limited by internal FPGA event-sorting algorithm rather than by network bandwidth. Software benchmarks using CAEN FELib and the CoMPASS DAQ software highlight additional decoding and processing bottlenecks.

P45: Coulomb Excitation of 200,202Hg

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The previous measurements of the spectroscopic quadrupole moment (Q_s) and the $B(E2; 0^+ \rightarrow 2^+)$ of 200,202Hg are incompatible with a rigid axial rotor, a key framework for nuclear structure physics. The Q_s is too large for the $B(E2)$. This motivated a remeasurement via a Coulomb excitation experiment at Argonne National Laboratory in December 2023 to probe whether more exotic nuclear deformation beyond quadrupole is occurring, or if there is a problem with the pre-existing data. The experiment was performed in inverse kinematics, with natural Ti and 120Sn targets used with both mercury beams. Recoils and ejectiles were detected with a downstream S3 dual-sided silicon strip detector. Coincidences in the Gammasphere HPGe array allowed gamma-ray yields to be found and used in a GOSIA analysis. An overview of the analysis methods and preliminary results (EM matrix elements, Q_s , $B(E2)$), would be presented which covers all efforts to date in resolving the introduced issue.

P46: Pulse Shape Discrimination Plastic Scintillators for the Detection of Radioactive Materials

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The ability to detect radioactive materials is critical for national security, particularly for the detection of special nuclear materials like enriched uranium. Current radiation portal monitors typically use large area scintillators to detect gamma radiation, and helium-3 proportional counters for neutron detection. However, the global helium-3 shortage has motivated the development of alternative neutron detection methods.

Pulse shape discrimination (PSD) plastic scintillators are a promising solution, with the capability of distinguishing between neutron and gamma induced interactions by utilising their differing scintillation light decay times. The use of PSD scintillators removes the need for separate neutron and gamma detectors, with plastic based scintillators having far easier handling and lower flammability than their liquid counterparts.

A key challenge of radiation portal monitors is ensuring long term durability under varying environmental conditions. Previous PSD plastics have exhibited limited functional lifetimes of only 1-2 years, whereas newly developed plastics report far greater durability.

This work presents an initial investigation into the uniformity of new PSD plastic scintillators, and optimal wrapping technique for detector construction. This forms the first stage of a wider investigation into the long term performance of PSD plastics.

P47: "Engineering Spin-Dependent Potential Barriers for Enhanced Neutron Flux Filtration in the neV Energy Regime"

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In the ultra-cold (neV-scale) neutron regime, precise control of spin polarization is crucial for advanced instrumentation and detector applications. I present a theoretical study of engineered spin-dependent potential barriers that selectively filter neutron spin components via quantum tunneling. Using one-dimensional quantum scattering calculations (solving the Schrödinger equation for a spin- $\frac{1}{2}$ neutron), we compute spin-specific tunneling transmission probabilities and show that transmission can be made strongly spin-selective. In such barriers (magnetically or structurally tailored), the Zeeman interaction creates a spin-split potential: one spin projection sees a barrier while the other sees a well.

By tuning barrier parameters (magnetic field strength, barrier thickness, layer structure, etc.), one spin component of the neutron flux can be probabilistically suppressed while the other is preferentially transmitted. These results are grounded in rigorous quantum mechanics and quantify how engineered barriers can filter neutrons by spin. We discuss implications for neutron optics and ultra-cold neutron experiments: tailored spin filters could improve beam polarization, enhance spin-echo or interferometry measurements, and reduce systematic spin-dependent

backgrounds in detectors. This approach complements existing neutron polarization techniques (e.g. polarized ^3He filters) by offering tunable, non-absorbing spin selection. Our work, situated in applied nuclear physics and neutron instrumentation, is motivated by the need for refined control of ultra-cold neutron transport and detection in precision experiments.

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