P1: Electrons for Neutrinos

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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 225Fr to 225Ra

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The onset of permanent octuple-deformed nuclear shapes such as in the nuclei located between radon (Z=86) and uranium (Z=92) with N ≈ 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 octuple-deformation enhances the effect. The even-odd 225Ra 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 225Ra populated by β decay
of 225Fr. 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

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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 ~10^{32} m^{-3}, and neutron fluxes of up to 10^{34} m^{-2} 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 ~100 µm 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 171Tm 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 < 1ns) 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

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Λ^{o}_{b} 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^{o}_{b} 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^{o}_b 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 Λ^{o}_{b} -> Λ_{c}^{+} π^{-} -> (p K^{-} π^$^{+}$) π^$^{-}$ decay channel is used. Monte Carlo datasets are employed to validate the analysis.

P5: Hyperon Nucleon Interactions at CLAS

Joshua Bryce[1], and Mikhail Bashkanov[1]
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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 $\Sigma^{-}p$ 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 ^{78}Y

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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 196At – installation ofthe novel detector SIGMA in the focal plane

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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 196At 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 196At via the reaction - 165Ho(36Ar, 5n)196At at a beam energy of 186 MeV. The focus of the experiment was to investigate the level structures of 196At 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

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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 16O 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. Lasseri, 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 Fegan[1], Mikhail Bashkanov[1], Daniel Watts[1], and Nick Zachariou[1]
[1]University of York, UK

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 Kπ 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 → Ξ^0p.

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

Patrick Galvin[1], Dr Jack Bishop[1], Prof. Tzany Kokalova[1,2], Prof. Carl Wheldon[1], and Dominik Stajkowski[1]
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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 27Al(n,γ)28Al reaction to a heavier target, in 93Nb(n,γ)94Nb, 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 27Al(n,γ)28Al 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 Giambrone[1]
[1]University 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 175,176Lu 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 40Ar using Coulomb Excitation

Adam Giambrone[1]
[1]University of Surrey, UK

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, Qs, 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 Qs 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 40Ar 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 Hilton[1]
[1]University 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 ~ 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

Calum Jones[1]
[1]University of Surrey, UK

A study of the low-lying excited state structure of the N=30 nucleus ^{53}V was performed using the $^{51}V(^{18}O,^{16}O)^{53}V$ transfer reaction. A 35~MeV beam of ^{18}O 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 ^{53}V, 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 $LaBr_3$ 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

Kate Williams[1], Manuel Bandala[1], Frank Cave[2], Heather Chouman[3], Soraia Elisio[1], James Graham[4], John Heneghan[3], and Malcolm Joyce[1]

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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 arisings. 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

Javier Kenyon-Reyero[1,2], Natalia Timofeyuk[1], Matteo Vorabbi[1], and James Benstead[2]
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Neutron capture (n,ɣ) reactions play a crucial role in nuclear energy applications, medical isotope production and nucleosynthesis in stellar environments. However, direct measurements of (n,ɣ) 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,ɣ). Traditionally, the (p,d) or (d,p) reaction was used as a surrogate for (n,ɣ), 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, FRESCO 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 ≃ 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}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 an 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 CalculatingGround State Nuclear Properties Using Muonic X-RayMeasurements

Leandro Liborio[1], Milan Kumar[1], Subindev Devadasan[1], Philip Jones[2], Martin Plummer[1], Adrian Hillier[3], and Albert Bartok[2]
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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 (Ar: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

John Murphy[1], Carl Wheldon[1], Jack Bishop[1], Tzany Kokalova[1], and Simon Rice[2]
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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

Nicholas Michaelides[1]
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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

Muhammad Nawaf Nafi[1]
[1]Bangladesh Air Force Shaheen College Dhaka, Bangladesh, [2]American Physical Society, USA

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 120Sn via Dipole Polarizability and Charge Exchange Reactions

Amritpal Singh Nafria[1]
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The neutron skin thickness (ΔRnp) 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 ΔRnp in the stable isotope 120Sn. 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 (αD), with newly evaluated cross-sections from the charge-exchange 120Sn(3He,t)120Sb reaction. The αD 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 ΔRnp with significantly reduced uncertainty compared to single-method approaches. Our preliminary result suggests a ΔRnp for 120Sn 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~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 208Pb beam on a 9Be target. Two settings were used, one centred on 186Hf and one on 188Hf 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

Owen Wildboar[1], James Benstead[1], and Daniel Pitman-Weymouth[1]
[1]AWE, UK

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 89Y(n,2n) shots from 2023/24.

P33: Preliminary Studies of Charged Pion Electroproduction on Deuterium

Kathleen Ramage[1]
[1]University of Glasgow, UK

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

Saba Rani[1,2], Yang Mengyao[3], Sofia Quaglioni[3], Kyle A. Wendt[3], Alessandro Roggero[1,2], Francesco Pederiva[1,2]
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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 spatcial 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

Emily Richardson[1]
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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

Bjoern Seitz[1], and William Hopkins[1]
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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

Joshua Sharpe[1], Ting Gao[1], Sidong Chen[1], and Marina Petri[1]
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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 1f7/2 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

Dominik Stajkowski[1], Carl Wheldon[1], Jack Bishop[1], Tzany Kokalova[1,2], Neil Curtis[1], and Patrick Galvin[1]
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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.

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: $CeBr_3$ scintillator development for HYPATIA: a next-generation hybrid gamma-ray detector array at the RIBF

Luke Tetley[1], Gao Ting[1], Josh Sharpe[1], Stefanos Paschalis[1], and Marina Petri[1]
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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 $CeBr_3$ 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

Charlie Velasquez[1]
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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

Yuri Venturini[1], Matteo Bianchini[1], Giovanni Cerretani[1], Alberto Potenza[1], and Carlo Tintori[1]
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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

Greg Willmott[1]
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The previous measurements of the spectroscopic quadrupole moment (Q_s) and the B(E2;0+->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-½ 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 ^{3}He 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.