Technical Meeting on (alpha,n) Reaction Nuclear Data Evaluations and Data Needs

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Virtual

Book of Abstracts

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Experimental study of thick target yield from the 13C(α,n0)16O reaction

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The thick-target neutron spectra from the 13C(α,n0)16O reaction were measured for the energy range of 3.0-6.5 MeV at 10 angles in the laboratory angle interval of 0-150°. The thick target yield was determined by integration of the neutron spectra over the neutron energy range corresponding to the 13C(α,n0)16O reaction followed by integration of the obtained angular distribution of the differential thick target yield over the solid angle 4pi. The content of 13C atoms in the target was determined by ion beam analysis with accuracy of <1%. The obtained thick target yield values support the calculated ones based on the 16O(n,α0)13C reaction cross-section evaluation from the ENDF/B-VIII.0 library.

2

Updates to the NeuCBOT tool for (alpha, n) calculations

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NeuCBOT, the Neutron Calculator Based On TALYS, is a program for calculating (α,n) yields for arbitrary materials given some radioactive contamination. The backbone of the code uses TALYS to calculate (α,n) cross sections, SRIM stopping power calculations, and ENDF nuclear decay data. Recent updates to the code include an updated TALYS cross section database, the option to draw cross sections from JENDL-5 instead, and the ability to calculate (α, nγ) partial yields. A webapp user interface for NeuCBOT is also under development, planned to released in the near future. This talk will present an overview of the NeuCBOT software, validation and comparisons with other calculations, and a discussion of recent and upcoming updates.

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Neutron production yield in alpha induced reactions on CaF2 and 27Al

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Low energy (α,n) reactions are important for reactor applications and low background experiments. In both cases α-particles, typically of a few MeV, originated from actinides decay present either in reactor fuel and/or in surrounding materials due to the elemental natural abundance. The emitted thus α-particles can induce nuclear reactions on nuclei of wide range of materials introduced in the given experimental environment such as ^{13}C, ^{19}F, ^{16}O, ^{18}O, ^{27}Al, ^{29}Si, ^{30}Si, etc. Because of the considerable cross-sections in the indicated energy range, up to barns, the resulted neutron yield is significant and should be properly taken in the consideration.
Neutron detector systems based on proportional ^{3}He counters provide high efficiency and almost full angular coverage which makes it the ideal candidate for reaction cross-section measurements, including (α,n) reactions. The ELIGANT-TN [1] array constructed at Extreme Light Infrastructure-Nuclear Physics (ELI-NP), Măgurele, Romania was originally aimed at (γ, n) cross-section studies. It consists of 28 ^{3}He counters arranged in three rings in the high-density polyethylene matrix, shielded by a cadmium layer from background neutrons, in a way to reach a flat efficiency of ∼37% up to ∼5 MeV neutron energy. One more advantage of such a detector is the possibility to measure the average neutron energy by the ring ratio technique.
Lately, ELIGANT-TN was installed at the experimental hall of the 3 MV Tandetron facility of Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN-HH) Măgurele, Romania [2]. The accelerator provides intense low-energetic charged particles beams. In our first experiments the cross-sections of ^{19}F(α,n), ^{13}C(a,n) and ^{27}Al(α,n) in the ∼3–7 MeV energy range were investigated. Moreover, recently, in November 2023, an experiment to measure the ^{19}F(α,n) and ^{13}C(α,n) cross-sections up to 17 MeV was undertaken. α-beam was delivered by the 9 MV Pelletron Tandem Accelerator (IFIN-HH) [3].
In the talk it will be presented the design and performance of the ELIGANT-TN array. The preliminary experimental results/questions of our experiments and future perspectives will be discussed.

3

Refining the low energy R-matrix fit of ^{13}C$(\alpha,n)^{16}$O

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Recent measurements of the differential cross section of the ^{13}C$(\alpha,n)^{16}$O reaction have been made at the University of Notre Dame's Nuclear Science Laboratory over an incident laboratory alpha-particle beam energy range from 0.7 to 6.5 MeV. For nuclear astrophysics application, the cross section is desired at ≈150˜keV and, while the present data is at higher energy, I've shown previously that the differential data has a substantial impact on reducing the extrapolation uncertainty. However, there remain some issues with the fitting that need to be resolved including a larger increased normalization factor for the simultaneously fit n+^{16}O total cross section data, energy calibration

inconsistencies, and poorer agreement with the fits in regions of low cross section. I'll discuss recent progress in resolving some of these issues, which has resulted in a significantly more consistent fitting across the different data sets.

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Uncertainty quantification in R-matrix analyses using Bayesian methods

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Bayesian methods provide a unifying and powerful framework to quantify uncertainties. Their recent application to R-matrix calculations of nuclear reactions has lent a new level of rigor to R-matrix analyses, accessing new information about R-matrix parameters and assessing the impact of experimental systematics on both estimates of those parameters and R-matrix predictions.

I will begin by reviewing Bayesian methods within the specific R-matrix context. I will argue, using examples, that sampling of the full Bayesian posterior for the R-matrix parameter vector $\vec{\theta}$ provides insights into the formulation of the R-matrix model that are difficult to obtain within a frequentist approach. I will then explain how, with that posterior in hand, it is straightforward to obtain predictions for as-yet-unmeasured reaction data.

Bayesian methods also permit straightforward modeling of experimental imperfections. I will show recent examples of Bayesian R-matrix analyses that treated experimental systematics such as acceptance effects at specific (lab.) angles [1], beam-energy shifts [2] and that examined the impact of inflating the point-to-point uncertainties of different data sets [3].

If time permits I will close by touching on the treatment of theory imperfections within a Bayesian approach.

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[1] S. N. Paneru et al., Phys. Rev. C (accepted), arXiv:2211.14641.
[2] D. Odell, C. R. Brune, D. R. Phillips, R. J. deBoer, and S. N. Paneru, Front. Phys. 10:888476 (2022), doi: 10.3389/fphy.2022.888476.
[3] D. Odell, C. R. Brune, D. R. Phillips, Phys. Rev. C 105, 014625 (2022).

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Direct measurement of the low-energy cross section of 22Ne(a,n)25Mg

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The reaction plays a crucial role in the nucleosynthesis of heavy elements, in both the main and the weak s processes. In addition, its stellar reaction rate (and that of the competing channel

22Ne(a,g)26Mg) determine the ratio of the Mg isotopes that can be directly observed in stellar atmospheres. To provide input for stellar and nucleosynthesis models, the cross section needs to be known between the neutron threshold at 565 keV and about 800 keV. Due to the very low experimental rates (counts/h) it has so far been impossible to measure directly besides at one resonance at E_a = 830 keV.
The ERC-funded project SHADES aims at measuring the reaction directly in the stellar energy range by exploiting the strong background suppression of the deep underground Gran Sasso national laboratory (LNGS) in Italy and a high-current beam from the new MV accelerator at the Bellotti Ion Beam facility. Limited energy sensitivity by using a combination of 3He counters and EJ-309 scintillators will help identify possible beam-induced backgrounds. The aim is to cover the entire energy range from threshold to and including the 830 keV resonance with an increased sensitivity over the state of the art by at least two orders of magnitude. The setup has been installed at the LNGS and we will present the current status of the experiment.

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Improved evaluation of the 17O system

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What we would like to present in this meeting are the results of the latest evaluation of the ¹⁷O system. In the calculation of the RAC program, we have added several new sets of integral cross section data and differential cross section data for the ¹³C(α,n)¹⁶O reaction on the basis of the original data. The newly added data also include the latest measurements by the Peking University. The newly added data are shown below:
Integral cross section
1.P.S.Prusachenko+ 2022
2.G.F.Cian+ 2021
3.B.Gao+ 2022
Differential cross section
1.M.Febbraro+ 2020
2.E.M.Gazeeva+ 2020
3.P.S.Prusachenko+ 2022
We are still in the process of adjusting the parameters in the RAC program calculations based on the latest added data to get a better result. We will present the latest fitting results at the meeting.

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Overview of the (alpha,n) reaction measurements on light nuclei

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I will present an overview of the new project to measure the (α,n) reactions on light elements, such as ⁷Li, ^{10,11}B, ¹³C, and ¹⁹F. As an experimental campaign for next 5 years, this study will provide partial, total reaction cross sections, neutron spectra, and gamma- and charged- particle yields. The experiment end station is composed of two different types of neutron detector arrays (deuterated liquid scintillators and stilbene scintillators), High Purity Ge detectors located at multiple angles, and two sets of silicon detector telescopes ($\Delta E1 - \Delta E2 - \Delta E3$) at forward and backward angles. The experiment will be performed at the Institute for Structure and Nuclear Astrophysics at the University of Notre Dame using the FN tandem and the 5U accelerators to cover the alpha energy from 2 to 9 MeV. Including the multi-channel R-matrix analysis on the data we obtain, we also plan to assess the impact of the updated (α,n) nuclear data for the interest of nuclear applications.

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Status of and perspectives for the study of (alpha,n) reactions at CNA HISPANOS by means of activation and time-of-flight

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For the MANY collaboration.

Neutrons emitted from (alpha,n) reactions play an important role in several fields such as nuclear technology, nuclear astrophysics or underground (low background) physics. However, the current knowledge of the neutron yields and neutron energy spectra from (alpha,n) reactions is neither complete nor accurate; which has triggered a renewed interest in studying such reactions.
In this context, several Spanish research groups has established the MANY Collaboration that aims at measuring (alpha,n) reactions by means of activation, neutron counting and time-of-flight at the CNA HISPANOS (Seville) and CMAM facilities (Madrid).
The preliminary results of the recent experiment carried out at CNA HISPANOS for the study of the ²⁷Al(alpha,n) reaction by means of activation (using LaBr3 detectors) and by time-of-flight (using a pulsed beam and a Ej301 liquid scintillator module from the MONSTER array) will be presented. Then, the prospects for upgrades and future measurements will be discussed.

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Neutron yield calculation for (α,n) reactions with SOURCES4

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The sensitivity of underground experiments searching for rare events such as dark matter, proton decay, neutrinoless double-beta decay, and low-energy neutrino physics is often limited by the background caused by neutrons from spontaneous fission and (α,n) reactions.
Neutron yields and energy spectra due to these reactions can be calculated by using a variety of codes. Here we present the cross-sections of (α,n) reactions and the transition probabilities to excited states calculated with TALYS 1.96 [1] and EMPIRE 3.2.3 [2] nuclear reaction codes considering different optical model parameters and the comparison with the experimental data where available.
Furthermore, we present the calculations of neutron production using the modified SOURCES4 code with recently updated cross-sections for (α,n) reactions and the comparison of the results with experimental ones from thick target neutron yields obtained with alpha beams and radioactive decay chains. The cross-sections for (α,n) reactions in SOURCES4 [3,4] have been taken from reliable experimental data where possible, and complemented by the calculations with EMPIRE 3.2.3, TALYS 1.96 and JENDL-5 [5] where the data were scarce or unavailable.

[1] A. Koning, et al., Eur. Phys. J.A 59 (6) (2023) 131.
[2] M. Herman, et al., Nucl. Data Sheets, 108 (2007) 2655-2715.
[3] W. B. Wilson, et al., Radiation Protection Dosimetry, 115 (2005) 117–121.
[4] W. B. Wilson, et al., Technical Report LA–13639-MS (1999).
[5] T. Murata et al., JAEA-Research 2006-052.

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Status and perspectives of thick target measurement of (alpha,n) reactions using the miniBELEN detector

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The MANY (Measurement of Alpha Neutron Yields and Spectra) collaboration is a coordinated effort aiming to conduct measurements of (alpha,n) production yields, reaction cross-sections, and neutron energy spectra. MANY relies on the alpha beams generated by the accelerator facilities at CMAM (Madrid) [1] and CNA (Sevilla) [2]. The miniBELEN-10A neutron counter [3] is one of the detection systems available within MANY. This work reports the commissioning experiment carried out at CMAM using natural aluminum targets. Specifically, we present the results from measurements of the 27Al(alpha,n)30P thick target production yields using the miniBELEN-10A detector. Based on the commissioning results, the potential upgrade of miniBELEN is discussed. Finally, the future perspectives for measurements using this detector are outlined.

REFERENCES
[1] A Redondo-Cubero et al. Eur Phys J Plus 136 (2021) 175
[2] J Gómez-Camacho et al. Eur Phys J Plus 136 (2021) 273N
[3] Mont-Geli et al. EPJ Web of Conferences 284 (2020)

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(α, n) neutron yields for rare-event search experiments: a collaborative effort to understand the backgrounds.

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Accurate assessments of (α, n) neutron production rates, energy spectra, and associated gamma-rays play a crucial role in understanding the underlying backgrounds in experiments dedicated to rare-event searches. This presentation discusses the importance of the radiogenic neutrons within the context of low-background experiments, shedding light on the challenges presented by (α, n) neutrons in this specific field and presenting the methodology employed to calculate this articulated background. An integral aspect of our efforts involves the establishment of a new (α, n) Working Group, a collaborative initiative that brings together members from high particle (mainly dark matter and neutrino) and nuclear physics communities. This collective endeavor signifies a shared commitment to addressing the main challenges inherent in the study of (α, n) neutrons and their impact on experiments, aiming to tackle challenges collectively and advance in the understanding of backgrounds. We offer insights into the group's comprehensive plans for finalizing a white paper on this subject.

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Preliminary study of uncertainties on (alpha,n) cross sections with TALYS

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Short presentation of modernised Stopping Power Database

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Global R-matrix analysis of the 19F(α,n) reaction

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In this work we report on the progress in the R-matrix analysis of the ¹⁹F(α,n)²²Na reaction at energies above the neutron threshold in the resolved resonance region, using the R-matrix code AZURE2. This reaction has been chosen for re-evaluation because of its importance in applications such as nonproliferation, nuclear astrophysics and low-background experiments. We present the progress of the multichannel multilevel R-matrix analysis of the ²³Na system and address the difficulties that arise mainly due to lack of level information in the energy of interest.

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Measurement of ^{27}Al(α,nγ)^{30}P thick-target yields and total ^{27}Al(α,n) yields by activation

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Reactions induced by alpha particles on stable elements play a relevant role in several scientific fields, from nuclear technologies and nuclear astrophysics, to dark matter searches and neutrino physics. Data on neutron yields from the interaction of α-particles with nuclei via (α,n) reactions are of particular interest in this context, both due to the inconsistency of the available experimental data in the literature and to the need for new measurements with higher precision [1].

In this work we focus on reactions induced by alpha particles on stable aluminium undertaken at the recently commissioned beam line at the CMAM laboratory in Madrid [2], Spain. The experiment was performed in the framework of a wider effort by the Spanish MANY collaboration, whose ultimate goal is the measurement of (α,xn) production yields, reaction cross-sections and neutron energy spectra.

The ^{27}Al(α,n) reaction has been proposed as a benchmark to inter-compare measurements and cross check experimental techniques. Firstly we present measurements of ^{27}Al(α n) reaction yields by activation and gamma counting for energy ranging from the reaction threshold to 15 MeV. Secondly, we address ^{27}Al(α,nγ) production yields. The experiment was carried out using an array of LaBr$_3$(Ce) FATIMA-type [3] detectors placed at selected angles in the laboratory frame. The gamma spectroscopy measurements allow to determine the total reaction yield from the decay of the activation products and the (α,nγ) yield from the de-excitation of the states in the target nuclei. The setup was complemented by a neutron monitoring unit based on a 3He-filled neutron proportional counter embedded high-density polyethylene, and a high-resolution HPGe detector to aid gamma-ray identification.

The activation results are in remarkable agreement with direct neutron measurements, and can be compared with the literature. This makes it possible to commission the of the detector system and the new experimental beam line via the previously measured ^{27}Al(α,n)^{30}P reaction. The (α,nγ) gamma measurements provide information for the first time on the thick-target production yields of γ rays from ^{30}P in the reaction and their angular distributions.

[1] S. Westerdale et al., Tech. Report INDC (2022) NDS-0836
[2] A. Redondo-Cubero et al., Eur. Phys. J. Plus 136 (2021) 175
[3] V. Vedia et al., Nucl. Instrum. Methods A 857 (2017) 98

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Preliminary results from thick target measurements of the 27Al(alpha,n)30P reaction cross-section using miniBELEN-10A

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The miniBELEN-10A detector is a modular and transportable moderated neutron counter with a nearly flat detection efficiency up to 8 MeV [1]. It is one of the detection systems available for the MANY collaboration (Measurement of Alpha Neutron Yields and Spectra), a Spanish project designed to conduct measurements of (alpha,n) production yields, reaction cross-sections, and neutron energy spectra. miniBELEN-10A has recently undergone commissioning by measuring 27Al(alpha,n)30P thick target production yields at various alpha energies. This work presents preliminary results from the first physics experiment using miniBELEN-10A. The cross-section of 27Al(alpha,n)30P is derived from thick target measurements for alpha energies near the reaction threshold up to 8 MeV. The experiment is introduced, and the status of the data analysis is discussed.

[1] Mont-Geli et al. EPJ Web of Conferences 284 (2020)

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Determination of the stopping power for alpha particles in carbon using resonant scattering

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It is important to have a correct stopping power of the charged particle in a target. Because it directly affects experiments for thick target neutron yield measurements. The experimental stopping power for alpha particles in many substances can have discrepancies of up to 10% according to the database which was created by H. Paul [1]. These discrepancies can be significantly greater in Bragg‘s peak region. The transmission method, which always is used to measure stopping power, has several limitations. These limitations are accuracy of target thickness measurement, the manufacturing of self-supporting films, target uniformity. We used a different approach based on the resonant scattering of charged particles on target nuclei [2]. This method requires thick targets. Thus its eliminates thickness inhomogeneity. In addition, the accurate value of the resonance energy is not important for this method. We obtained the stopping power for alpha particles in carbon to carry out a benchmark experiment to measure thick target neutron yield from 13C(α,n)16O reaction [3].

1. Claudia Montanari, P. Dimitriou. The IAEA stopping power database, following the trends in stiopping power of ions in matter // Nuclear Instruments and methods in physics research Section B. 408:50-55
2. T.L. Bobrovskiy et al. Determination of stopping power for light ions using resonance backscattering // Nuclear Instruments and methods in physics research Section B. 4 august 2023

3. P.S. Prusachenko et al. Experimental study of thick target yield from the 13C(α,n)16O reaction // Nuclear science and engineering. 9 august 2023.

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Innovative analysis technique of neutron time-of-flight spectra, validation, and first results in (α, n) reaction studies

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An innovative methodology has been developed for the procurement of neutron energy distributions from neutron time-of-flight (TOF) measurements with neutron spectrometers. The methodology is based on the accurate determination of the response of the neutron spectrometer via Monte Carlo simulation and an iterative Bayesian unfolding technique for the analysis of the TOF data. The methodology has been validated first with the analysis of a virtual experiment and second with experimental data coming from the ^{85}As β-delayed neutron measurement performed at the IGISOL facility of JYFL-ACCLAB with the MOdular Neutron time-of-flight SpectromeTER (MONSTER).

Several modules of MONSTER were shipped in 2023 to the Centro Nacional de Aceleradores (CNA) in Seville, Spain, and used in a test measurement of the ^{27}Al$(\alpha, n)^{30}$P reaction. The results from the analysis of the data will be presented and plans of future measurements will be discussed.