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NUCLEAR LEVEL DENSITIES

Summary Report of the IAEA Consultants' Meeting
IAEA Headquarters, Vienna, Austria
26 – 28 June 2023

Prepared by

Mathis Wiedeking
iThemba LABS
Cape Town, South Africa
Lawrence Berkeley National Laboratory
Berkeley, California, USA

Paraskevi Dimitriou
International Atomic Energy Agency
Vienna, Austria

February 2024

IAEA Nuclear Data Section
Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria

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Nuclear Data Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna
Austria

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Contents

1. INTRODUCTION

Nuclear level densities (NLDs) are used to describe statistical properties of the excited nucleus at energies where the nuclear levels are overlapping. Nuclear level densities are important ingredients in the statistical model of nuclear reactions which describes the excitation of the nucleus at temperatures and energies beyond the low-lying discrete levels. As such, they are fundamental input parameters for theoretical calculations and evaluations of nuclear reaction cross sections for basic science and a wide range of nuclear energy and non-energy applications.

Nuclear level density models are generally divided into two types, phenomenological and microscopic. The widely used phenomenological models are based on the macroscopic concepts of a Fermi gas or an isolated system with constant temperature, with additional external parameters to account for shell effects, pairing and parity distributions. The more sophisticated microscopic models, on the other hand, rely on a microscopic description of the structure of the nucleus based on the single-particle level scheme, and include short-range (pairing effect) and long-range (collective) interactions consistently. Whether phenomenological or microscopic, NLD models rely heavily on the existence of suitable experimental data for the fine tuning of the model parameters.

The Nuclear Data Section has coordinated three international research projects (CRPs) dedicated to developing, testing, and recommending the main input parameters used in theoretical models of nuclear reactions at low energies up to the pion production threshold. Nuclear level densities were among the parameters that were studied and recommended in the main output of the CRPs, namely the Reference Input Parameter Library (RIPL):

- RIPL-1: Handbook for calculations of nuclear reaction data (Reference Input Parameter Library), IAEA-TECDOC-1034 (1998), https://www-nds.iaea.org/publications/tecdocs/iaea-tecdoc-1034.pdf
- RIPL-2: Handbook for calculations of nuclear reaction data (Reference Input Parameter Library-2), IAEA-TECDOC-1506 (2006), https://www.iaea.org/publications/7129/handbook-for-calculations-of-nuclear-reaction-data-ripl-2
- RIPL-3: RIPL – Reference Input Parameter Library for Calculation of Nuclear Reactions and Nuclear Data Evaluations, Nuclear Data Sheets 110/12 (2009) , https://doi.org/10.1016/j.nds.2009.10.004

Since the publication of the third RIPL Handbook in 2009 (RIPL-3), a wealth of experimental data and new models on level densities has been published showcasing the significant development and progress that has been made in both measurement techniques and theoretical models of nuclear level densities in the past 15 years. It is, therefore, time to (i) revise the RIPL-3 segment on nuclear level densities, considering the new and improved experimental data and models available now, (ii) update the recommendations accordingly, and (iii) disseminate this information using modern user-friendly interfaces and web APIs. These objectives will be addressed by a new IAEA Coordinated Research Project on Updating and Improving Nuclear Level densities for Applications that is planned to commence in 2024.

A Consultant's Meeting on Nuclear Level Densities was organized by the IAEA Nuclear Data Section, 26 – 28 June 2023, at the IAEA Headquarters in Vienna to lay the groundwork for this new Coordinated Research Project and to discuss the scope and program of the work envisaged. Six experts on measurements and modeling of nuclear level densities attended the meeting: Stephane Goriely (Belgium), Magne Guttormsen (Norway), Mike Herman (USA), Milan Krtička (Czech R.), Alexander Voinov (USA), Mathis Wiedeking (S. Africa) together with three IAEA staff, Roberto Capote Noy, Paraskevi Dimitriou, and Arjan Koning. The meeting was hybrid to accommodate the remote participants.

The meeting opened with a welcome address by A. Koning, Head of the Nuclear Data Section, which was followed by an introduction on the scope and goals of the meeting by P. Dimitriou (Project

Officer). It continued with presentations by the participants and technical discussions that resulted in a concise and comprehensive work plan for the newly proposed CRP. Summaries of the presentations are given in Section 2 while the technical discussions are summarized in Section 3, followed by conclusions and recommendations in Section 4. The meeting agenda and participants list are found in Annexes 1 and 2, respectively.

2. PRESENTATION SUMMARIES

2.1. Recent theoretical developments in nuclear level densities, S. Goriely (Université Libre de Bruxelles)

Nuclear level densities (NLDs) play a key role in many nuclear applications. To go beyond the usual particle-independent approximation, a conceptually new approach based on the boson expansion (BE) of QRPA excitations has been proposed recently [1]. The calculated nuclear level densities are shown to follow an energy dependence close to a constant-temperature formula at energies above a few MeV but present a rather narrow spin distribution. They are shown to provide quite a remarkable agreement with s-wave resonance spacings and Oslo data, at least for the 48 even-even nuclei considered in the study. At present, this so-called QRPA+BE approach is restricted to even-even systems but will in the future be extended to nuclei with an odd number of nucleons. Since these systems break the time-reversal symmetry but also the boson nature of the QRPA excitations, they should be treated with special care. Similarly, special attention will be given to nuclei heavier than Pb for which some truncations may need to be imposed to the QRPA calculation to remain tractable. These species will be the subject of a forthcoming study. While a long-term goal will be to improve the interaction to accurately describe the QRPA excitations, some refined systematics regarding their energy renormalization can, in the meantime, provide a phenomenological approach to further increase the accuracy of NLD predictions. A large-scale calculation of QRPA+BE NLDs for applications is also foreseen for the future.

In parallel, we extended the reach of the Hartree-Fock-Bogoliubov (HFB) calculations based on the Brussels-Skyrme-on-a-Grid (BSkG) family [2] of models to NLDs by way of combinatorial modelling. To do so, we incorporated for the first time the effects of axial symmetry breaking. Our microscopic approach to triaxial deformation leads to several observations that were already anticipated in more empirical models: a modified excitation energy dependence and wider spin distributions. We document the effect of triaxial symmetry breaking, which (contrary to what is sometimes claimed in the literature) does not always lead to an increase in level density: while the collective correction becomes larger, the average single-particle density can become smaller in triaxial calculations compared to axial ones. The balance between both effects can swing either way.

References:

[1] S. Hilaire, S. Goriely, S. Péru, et al., Phys. Lett. B **843** (2023) 137989.
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2.2. Testing nuclear level density formulas on Oslo data, S. Goriely (Université Libre de Bruxelles)

For the last two decades, experimental information on nuclear level densities for about 60 different nuclei has been obtained based on the Oslo method. While each of these measurements has been typically compared to one or a few level density models, a global study including all the measurements has been missing.

A systematic comparison [1] has been performed between Oslo data and six global level density models for 41 nuclei for which s-wave resonance spacings are also available. As is well known, the nuclear level density cannot be extracted from the Oslo method uniquely but needs to be normalized to the total level density estimated from low-lying states and s--wave resonance spacings. The latter introduces a model dependency through the spin-distribution model, which is usually not well known experimentally. We apply a coherent normalization procedure to the Oslo data for each of the six different models, all being treated on the same footing.

The analysis shows that the constant-temperature and mean-field plus combinatorial models present the best global description of the Oslo data, but that it remains difficult to favour one of these two models. Both models may present a different excitation-energy dependence that cannot be differentiated at this stage, mainly due to the unavoidable model-dependent nature of the renormalization procedure.

The other models considered here are shown to provide less accurate predictions, though it remains hard to exclude some of them as long as the renormalization procedure is casting doubt on the absolute slope of the experimental level densities. In this respect, the newly proposed shape method can, in principle, improve the situation since it provides an absolute estimate of the excitation-energy dependence of the measured level densities. Such an analysis remains to be performed for the bulk of data for which the shape method can be applied to the Oslo measurements before drawing conclusions on the general quality of a given nuclear level density model.

References:

[1] S. Goriely, A.-C. Larsen, D. Mücher, Phys. Rev. C **106** (2022) 044315.

2.3. A short introduction to the Oslo method, M. Guttormsen (University of Oslo)

The Oslo method measures the nuclear level density (NLD) and γ-ray strength function (γSF) simultaneously, in one and the same experiment. These NLD data bridge the energy gap between discrete known levels at low excitation energy and the NLD extracted from neutron capture level spacings (D_0) at around the neutron separation energy S_n.

Typically, the experimental set-up for the Oslo method includes particle-gamma coincidences from light-ion reactions on stable enriched target foils with only one charged ejectile. The raw coincidence data are organized in an $R(E_\gamma,E_x)$ matrix, where particle ΔE-E telescopes (SiRi) determine the type of outgoing particle (p, d, t, ^{3}He, and ^{4}He) and its energy that is translated to excitation energy E_x by using the reaction kinematics. The gamma energy (E_γ) is measured with 30 LaBr3 detectors (OSCAR) mounted 16 cm from the target. The $R(E_\gamma,E_x)$ matrix is unfolded by the γ-ray response functions and stored in the $U(E_\gamma,E_x)$ matrix. Then, from this unfolded matrix, we obtain the energy distribution of the first-generation g-rays, which is called the primary matrix $P(E_\gamma,E_x)$. With some assumptions, this 2-dimensional landscape can be fitted by multiplying two vectors: the NLD and transmission coefficient T. The various steps of the Oslo method and its assumptions will be explained and more details on the method given in Refs ([1] – [4]).

For low E_x, the NLDs are characterized by fluctuations due to nuclear structures like levels based on vibration and rotation. However, for higher E_x where Cooper pairs start to be broken ($E_x > 2\Delta$), the excitation energy goes into breaking these pairs without increasing the nuclear temperature of the nucleus (analogue to the melting of ice). This mechanism is reflected in the Oslo NLDs that take the form of a constant temperature NLD in the energy gap $2\Delta < E_x < S_n$. Several experimental NLDs will be shown that obey a constant nuclear temperature behaviour. New KSHELL calculations are presented that reveal excellent descriptions of the experimental Oslo data.

The Oslo group may contribute with more than a hundred experimental NLDs in the upcoming CRP on Updating Nuclear level densities for Applications.

References:

[1] M. Guttormsen, T.S. Tveter, L. Bergholt, et al., Nucl. Instrum. Methods A **374** (1996) 371.
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[4] A.C. Larsen, M. Guttormsen, M. Krtička, et al., Phys. Rev. C **83** (2011) 034315.

2.4. NLD issues for the new Coordinated Research Project, M.W. Herman (LANL)

Some of the obvious tasks that need to be undertaken by the new CRP are:

- Update the observed s-wave neutron resonance spacings (D_{obs});
- Refit the current systematics of D_0;
- Correct the Gilbert-Cameron (GC) and Generalised Superfluid Model (EGSM) systematics that used vibrational enhancement of the same order as rotational in RIPL-3;
- Consider the Mengoni systematics for Gilbert and Cameron NLDs;
- Estimate reliable uncertainties on fitted parameters.

Key challenges that need to be faced:

- Damping of collective enhancements: it is still unknown how the damping mechanism works.
    - EGSM assumes that vibrational enhancements fall to about half at temperatures equivalent to 1 MeV;
    - Some experimental data suggest they do not disappear with increasing energy;
    - New theoretical developments should be investigated.
- Parity distributions: although cross sections are not sensitive to parity distributions, other observables are, such as:
    - Discrete gamma transitions (un-natural parity states);
    - Isomeric cross sections;
    - D_0 for a single (ground state) parity;
    - Microscopic calculations could be used to derive (Z, N, β ,E) trends and so could AI methods.

- Microscopic approaches: even if they cannot yet compete with the phenomenological models, the goal of the theoretical effort is to determine accurate and reliable microscopic models of NLDs because they provide a better understanding of the underlying physics, insight into the spin and parity distributions and potentially into the damping of the collective effects phenomenon, and they have predictive power for nuclei far from the stability line.
- New phenomenological approaches: a new model has been implemented into the EMPIRE code though with limited testing and validation so far. It combines the constant temperature GC model with the Fermi Gas model and adopts the damping of collective enhancements from the EGSM model. The matching of the two models is performed at the BCS critical energy. Below the critical energy the NLDs vary between the GC and EGSM values.
- Experimental opportunities: many different types of experimental data can be used to extract information, such as
    - Oslo Method measurements;
    - D_0 measurements;
    - Gamma spectra from inelastic scattering (discrete gamma lines) to extract spin and parity distributions;
    - Reaction cross sections measurements;
    - Neutron spectra.

2.5. Status of measurements of average s-wave spacing (D_0), M. Krticka (Charles University of Prague)

The presentation addressed various problems we face in the analysis of neutron resonance data. We showed what we can really observe in the present time-of-flight experiments and then pointed out how the information obtained from those experiments influences the determination of resonance spacing, specifically the so-called D_0 - spacing of s-wave resonances. It was stressed that for some isotopes we can determine spin and parity of resonances only for a very restricted number of them. A method for the determination of D_0 which has been used at the n_TOF experiment during the last years was presented. It is based on the Monte-Carlo approach and can be applied not only in cases where the resonance strength ($g\Gamma_n$) is known from neutron transmission data but also for nuclei lacking this information. However, in the latter case, one must rely on measurements that usually determine (in addition to resonance energy) only the radiative capture kernel. To determine $D_{0,}$ one then needs additional information on radiative widths, spins and parity distributions of resonances.

We also discussed a possibility to use the long-range correlations of positions of resonances with the same spin and parity predicted by the Random Matrix Theory to determine the value of D_0 with smaller uncertainty.

In the last part of the presentation, we mentioned some relatively new methods for spin determination of s-wave resonances (for nuclei with target spin J>0). We showed that the knowledge of the spins of s-wave resonances (for J>0) can be used for testing the spin dependence of nuclear level density models (by determining the ratio of the densities for the two spins).

2.6. Viewpoint of a level-density end user, A.J. Koning (IAEA)

The nuclear model code TALYS is using nuclear level densities as one of its most important ingredients. A quality-improved and more complete set of level densities will therefore benefit many applications, ranging from (hopefully) improved cross section analyses to nuclear data libraries. Some ideas for the coming years are:

- The option to have extensive level density tables for all models, including the analytical ones;
- Well-established parameter tweaking possibilities, for the exponential rise (‘*a*’), the pairing (‘P’) and the spin distribution (‘J’), building forth on what is already available in TALYS;
- A general and user-friendly level density API allowing the user to extract level densities for direct use in e.g., a nuclear model code;
- A generally accepted method for the determination of the lowest and highest discrete level to be used for matching, and the possibility to complete the discrete level scheme up to e.g., 200 levels with all quantum numbers, using a level density model;
- An automated scheme should be set up to validate the level density spin distribution to isomeric production cross sections and discrete gamma ray transitions like (n,n’γ);
- A new consolidated D_0 and D_1 database, this time including all information, with both the accepted and rejected values for the final recommendation. the total number of different estimates made in all compilations. A new MACS and Gamma-gamma database would be helpful.

2.7. Nuclear Level Densities: experimental data status and problems, A.V. Voinov (Ohio University)

Main sources of the current LD model uncertainties:

The main source of uncertainty in the current level density (NLD) models is the very limited experimental information on which the models are based. This information mainly consists of data on s-wave neutron resonance spacings (D_0), which are known within limited spin and excitation energy intervals. These limited data do not allow for the constraint of both the shape of the level density functions and the level density values for spins other than those of neutron resonances. The current data on p-wave resonance spacings (D_1) does not appear to be consistent with the model parameterizations based on s-wave resonance spacings. Further research on this subject is needed to understand the reason for this inconsistency.

Suggestions for reducing NLD uncertainties in the RIPL database:

a) Revise the data on D_0 and D_1 values, documenting how these values are obtained and estimating realistic uncertainties. Incorporate both D_0 and D_1 values into NLD model parameterizations.
b) Utilize experimental information other than D_0 and D_1 to better constrain NLD models. Specifically, the technique based on particle evaporation spectra measurements would be helpful in constraining the NLD in an excitation energy range from the ground state up to the neutron separation energy and across a wide range of spins. This technique involves special measurements that utilize the compound mechanism of nuclear reactions, with a beam energy of <3-5 MeV/A, and where particle spectra are measured at backward angles. The shape of such spectra is highly sensitive to the level densities of the product nuclei. The level density models can be tested against these spectra using Hauser-Feshbach cross section calculations, or the level density excitation energy function can be extracted and directly compared with NLD model calculations.
c) Create a database of level densities extracted by means of the particle evaporation technique. These NLD data should be evaluated and used to constrain and improve NLD models. A reliable set of level density functions could be established by applying a cross validation procedure according to which the NLDs derived from D_0 values are compared with other independent NLD data, obtained from particle evaporation and/or Oslo method measurements.
d) Use the Oslo method data to constrain the shape of the level density function arising from the different models, such as constant temperature, Fermi-gas, and microscopic models.

2.8. The Shape Method for measuring NLDs, M. Wiedeking (iThemba LABS, LBNL)

The Oslo method [1] has been very successful in simultaneously extracting the Nuclear Level Densities (NLDs) and Photon Strength Functions (PSF) for nuclei across the nuclear chart [2]. At low excitation energies, the slope of the NLD and PSF is obtained by fitting to known discrete states while at the neutron separation energy (S_n), it is determined using the total NLD derived from the neutron resonance spacing D_0. The extrapolation from the measured data to S_n is typically performed using NLD models such as the Constant Temperature, Back-Shifted Fermi Gas, or microscopic models [1]. When D_0 is not available, which is generally the case for any nuclide more than two neutrons away from the last stable isotope, an estimation of D_0 is performed based on systematics or model input. However, no approach appears to be consistently applicable for any nucleus across the nuclear chart.

The Shape method was developed to provide a prescription that is applicable to a wide range of nuclides [3]. The method relies on the unambiguous identification of the excitation energy from which the primary transitions originate and the low-lying levels that are fed by the primary transitions. The primary transitions from the same excitation energy region to two different discrete levels contain information on the functional form of the PSF and, hence, also the slope of the NLD. The Shape method draws on concepts from Average Resonance Proton Capture (ARPC), the Ratio as well as the $\chi 2$ methods. The ARPC has been applied to at least 23 nuclei [1], while the Ratio and $\chi 2$ approaches were developed, tested, and applied over the last decade [4,5,6].

The Shape method was initially applied to obtain the slopes of the PSFs for ^{56}Fe, ^{92}Zr, and ^{164}Dy, and it was shown that the slopes are consistent with those obtained from the Oslo methods when D_0 is available. Interestingly, at high gamma-ray energies where the Oslo method reaches its limitations, the Shape method continues to be robust. At low gamma-ray energies, the Shape method may be limited due to Porter Thomas (PT) fluctuations, particularly for light or close-to-spherical nuclei where the NLDs are low. The increasing influence of PT fluctuations at low energies has been investigated for the ^{120,124} Sn isotopes [7].

Most recently, the Shape method has been applied to constrain the slope of the NLD, as demonstrated on stable ^{76}Ge, and then been applied to ^{88}Kr measured in a radioactive ion beam experiment [8]. To date, the Shape method has been applied to at least 20 nuclei by several research groups, including ^{93}Sr [9], various Nd isotopes [10], and $^{97,100}Mo$ [11].

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[1] A.C. Larsen, M. Guttormsen, M. Krtička, et al., Phys. Rev. C **83** (2011) 034315.
[2] S. Goriely, P. Dimitriou, M. Wiedeking, et al., Eur. Phys. J A **55** (2019) 172.
[3] M. Wiedeking, M. Guttormsen, A.C. Larsen, et al., Phys. Rev. C **104** (2021) 014311.
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[5] M. Krtička, M. Wiedeking, F. Bečvář, et al., Phys. Rev. C **93** (2016) 054311.
[6] M.D. Jones, et al., Phys. Rev. C **97** (2018) 024327.
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[11] J.E. Linnestad Larsson, M.Sc. thesis “Statistical properties of Mo-96 and Mo-100”, University of Oslo (2023).

3. SCOPE, OBJECTIVES, AND OUTPUT

Participants discussed the overall and specific NLD data needs that have emerged in the past 15 years, agreed on the scope of the CRP, proposed goals and identified research objectives that would accomplish those goals within the CRP.

The aim of the CRP is to provide updated and improved NLDs for basic nuclear science and applications such as fission and fusion energy generation, waste management, nonproliferation, nuclear medicine, and nuclear astrophysics. The focus will be on ground-state and fission saddle-point NLDs but will not cover particle-hole NLDs. There will be an exchange between the experts of this new CRP and the ongoing CRP on Recommended Input Parameter Library (RIPL) for Fission Cross Section Calculations (https://www.iaea.org/projects/crp/f41033) regarding the impact of the new recommended NLDs on fission cross sections.

The CRP will cover experimental data, models, and theories. The output will include compilations of measured and evaluated NLDs as well as global models for use in applications. Theoretical developments will also be considered.

The data will be disseminated online through a user-friendly interface and the results of the CRP will be published in a peer reviewed journal.

The following specific activities are proposed for the CRP:

3.1. Experimental nuclear level densities

1) Low-lying states
    a) Update low-lying states in the RIPL database; It should be noted that the low-lying levels file in RIPL is maintained by the IAEA (M. Verpelli). The file is updated regularly by combining the latest ENSDF data with complementary information from the most recent NUBASE release.
    b) Empirical determination of completeness of levels;
    c) Investigate the possible assignment of spin and parities for unknown cases;
    d) Review the method to assign spin-cutoff on low-lying states.

2) Resonance spacing data
    a) Comprehensive compilation of all D_0 and D_1 that have been determined and published;
    b) Evaluation of compiled D_0 and D_1 values and recommendation of best values with associated uncertainties – including documentation of how the values were determined;
    c) Comparison of different methods to determine resonance spacing data and related uncertainties for selected cases if not all;
    d) Provide D_0 for (l+1/2) and D_0 for (l-1/2) if available and possible.
3) Compilation and evaluation of derived experimental data for NLDs
    a) Compilation of derived experimental NLDs
        i. Oslo, beta-Oslo, inverse-Oslo Methods;
        ii. Shape Method;
        iii. Evaporation Method;
        iv. (p,p');
        v. To be considered: gamma self-absorption, (α,α'), (γ,γ'), Ericson fluctuations.
    b) Evaluation of derived experimental NLD data
        i. Comparison of results from different measurement techniques;
        ii. Comprehensive uncertainty analysis (including model uncertainties);
        iii. Review of the existing data (e.g., re-adjust to updated normalization data, assign quality indicator);
        iv. Recommendation of experimental data.
4) Listing, sorting and compilation of independent validation data
    a) Reaction data (e.g. standards, (n,n'), (n,p), neutron spectrum, prompt fission -spectra);
    b) Isomeric cross section ratios and (n,n'γ) cross section data;
    c) Multi-step cascade gamma spectra;
    d) Average radiative widths;
    e) Maxwellian-Averaged Cross Sections (MACS);
    f) To be considered: D_0 for (l+1/2) and D_0 for (l-1/2).

3.2. Models for nuclear level densities

1) Provide global models (microscopic and phenomenological) that satisfy certain requirements (shell, pairing, collective effects, damping, spin and parity distribution). Some of the models to be considered are:
    a. Constant Temperature + Fermi Gas model;
    b. Enhanced Generalised Superfluid Model;
    c. Hartree-Fock-Bogoliubov + combinatorial model;
    d. Quasi-Random Phase Approximation + Boson Exchange;
2) Assess and select suitable NLD models based on the description of D_0, the cumulative number of levels and derived experimental data;
3) Validate NLD models using the above-listed validation data (define qualitative and quantitative validation criteria) for recommendation;
4) For validated NLD models:
    a. Provide renormalization parameters on low-lying states and D_0;
    b. Provide global calculations (global tables) for recommended models;
    c. Provide adjustment procedure for tabulated NLDs for practical calculations.

3.3. Theories to guide global NLD models

The focus should be on the description of damping of collective and shell effects, spin distribution, parity distribution by the following theoretical approaches:

a. Shell model (SM) (Monte Carlo, deformed SM);
b. Others (e.g. Moments method).

3.4. Dissemination

1) Creation of a database of experimental and calculated NLDs;
2) Development of a modern online user interface (including web-based APIs), available on multiple platforms (Android, iPhone, PC);
3) Publication of the work, results, and deliverables in a peer-reviewed journal.

3.5. Participation

The CRP should involve experts from Member States capable of contributing to the listed topics. Priority should be given to participants from countries actively engaged in research on these topics.

4. CONCLUSION

The meeting focused on a new Coordinated Research Project to address the evolving data needs for nuclear level densities and update the RIPL-3 NLD segment. Participants engaged in detailed discussions on the essential components of the project and proposed a work plan with three main elements:

1) Updated experimental compilation and assessment;
2) Development and recommendation of new models and advanced theories;
3) Creation of a modern web interface and web APIs for dissemination.

The consensus reached during this meeting highlights the commitment to advancing research on and addressing the data needs for nuclear level densities through a holistic approach that combines updated experimental data, improved theoretical models and user-friendly interfaces and web tools for easily retrievable data.

ANNEX 1

IAEA Consultancy Meeting on Nuclear Level Densities

26 – 28 June 2023
IAEA, Vienna
MOE03

PRELIMINARY AGENDA

Monday, 26 June

09:00 - 09:15	**Opening of the meeting**, A. Koning / NDS Section Head
	Welcome and Introduction, P. Dimitriou / Scientific Secretary
	Election of Chair and Rapporteur(s), Adoption of Agenda
09:15 – 13:00	**Presentations (max. 45'+15')**
	- NLDs: experimental methods and data (A. Voinov) - Introduction to the Oslo method (M. Guttormsen) - NLDs: resonance data and other related issues (M. Krtička) - NLDs: how can we improve them? (R. Capote)
20' – 30'	*Coffee break as needed*
13:00 – 14:00	*Lunch break*
14:00 – 18:00	**Presentations cont' (max. 45'+15')**
	- NLD models for practical applications (S. Goriely) - Testing the quality of NLD models on Oslo data (S. Goriely) - NLDs from a user's perspective (A. Koning) - NLD issues for the new CRP (M. Herman)
20' – 30'	*Coffee break as needed*

Tuesday, 27 June

09:00 – 13:00	**Presentations cont' (max. 45'+15')**
	- New CRP on NLDs: Points for discussion (P. Dimitriou)
	- The Shape Method (M. Wiedeking)
	Roundtable discussion
20' – 30'	*Coffee break as needed*
13:00 - 14:00	*Lunch break*
14:00 – 18:00	**Roundtable discussion cont'**
20' – 30'	*Coffee break as needed*
19:00	***Dinner at a Restaurant downtown***

Wednesday, 28 June

09:00 – 13:00	**Drafting of the meeting summary report / recommendations**
20' – 30'	*Coffee break as needed*
13:00 - 14:00	*Lunch break*
14:00 – 16:00	**Drafting of the meeting summary report / recommendations cont'** **Closing of the meeting**

ANNEX 2

Consultancy Meeting on Nuclear Level Densities
Vienna, Austria
26 to 28 June 2023
IAEA, Vienna, Austria

PARTICIPANTS

Country / Organization		Name	Surname	Affiliation	Email
BELGIUM		Stephane	GORIELY	Université Libre de Bruxelles	stephane.goriely@ulb.be
CZECH REPUBLIC		Milan	KRTICKA	Charles University Prague	krticka@ipnp.mff.cuni.cz
NORWAY		Magne	GUTTORMSEN	University of Oslo	m.s.guttormsen@fys.uio.no
SOUTH AFRICA		Mathis	WIEDEKING	iThemba Labs	m.wiedeking@ilabs.nrf.ac.za
				Lawrence Berkeley National Laboratory	mwiedeking@lbl.gov
USA		Alexander	VOINOV	Ohio University	voinov@ohio.edu
	🎧	Michal	HERMAN	Los Alamos National Laboratory	mwherman@lanl.gov
INT. ORGANIZATION		Paraskevi (Vivian)	DIMITRIOU	International Atomic Energy Agency	p.dimitriou@iaea.org
		Arjan	KONING	International Atomic Energy Agency	a.koning@iaea.or
	🎧	Roberto	CAPOTE NOY	International Atomic Energy Agency	roberto.capotenoy@iaea.org

Nuclear Data Section	E-mail: nds.contact-point@iaea.org
International Atomic Energy Agency	Fax: (43-1) 26007
Vienna International Centre, P.O. Box 100	Telephone: (43-1) 2600 21725
A-1400 Vienna, Austria	Web: http://www-nds.iaea.org