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NEANSC WORKING PARTY ON INTERNATIONAL EVALUATION COOPERATION

SUBGROUP 12: NUCLEAR MODEL VALIDATION

OBJECTIVES AND ORGANIZATION OF SUBGROUP 12 ON NUCLEAR MODEL VALIDATION

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Introduction

At the 5-th meeting of the NEANSC working party on International Evaluation Cooperation (IEC), held at Aix-en-Provence, France, 16-th and 17-th June 1993, new subgroup activities have been established, one of which is subgroup 12 on NUCLEAR MODEL VALIDATION (SNMV) (Monitor: C. Dunford; Coordinator: G. Reffo).

According to the intentions of the Iternational Evaluation Working Party [as outlined in the document NEA/NSC/WPEC(93)2, IEC-80], subgroup 12: " should cooperate closely with the IAEA coordinated development of a data base of nuclear model parameters. It should also coordinate the collection of nuclear models, indicating the range of applicability of each and produce a well-tested transportable system of computer programs to be used by the nuclear data community. All this activities should be well documented ".

In the following the necessity for establishing an international effort on nuclear model and code assessments is discussed. In particular actions are proposed to address the above indications of the IEC working party.

1. NEED FOR NUCLEAR MODEL VALIDATION AND INTERNATIONAL COOPERATION FRAMEWORK.

1.1. Necessity for a strong international cooperative effort in nuclear modelling assessments and developments for nuclear data production.

Low and intermediate energy nuclear physics has become a mature science and is well oriented for applications. Scientific developments in the field of both pure and applied physics are

demanding nuclear data of higher and higher quality in an increasing range of masses, of reaction-types and of energies.

In the past, the bulk of nuclear data needed for technological applications was mainly provided by experimental measurement programmes. With increasing computer capabilities and availability, theoretical developments of nuclear physics have been greatly facilitated so that we start having available nuclear models and codes, as well as nuclear modelling methodologies, allowing the production of reliable nuclear data at a cost uncomparably lower than measurements.

The trend of declining funding for low and intermediate energy nuclear physics has particularly affected measurements activities, and there does not seem to be any prospect of change in the forseeable future. It will never be possible, however, to rely completely, solely, on theoretical model predictions, this is why one has to strongly support some experimental activities. Even a few measurements, in fact, could be sufficient to benchmark model assumptions, by comparison of model predictions with measurements performed in particularly critical cases, suitably selected.

In such a scenario one has to develop the capability to respond to the nuclear data demand exclusively by use of theoretical and computational tools.

A number of National Laboratories and Institutions have been very actively working in this directions in the last decade. Actually nuclear models and codes have been developed, which frequently rely on different physics, so that we are now faced with the necessity of clarifications. These may be achieved by means of a critical analysis and intercomparison of model results and particularly of model assumptions, as well as of the way they are used and coded.

This is a very necessary and important task which demands a strong international cooperative effort, as addressed by the IEC working party.

Indeed such an activity has already been initiated by means of extensive code intercomparisons, which will be a very useful starting point for the SNMV activities.

1.2. The link to the IAEA coordinated development of a REFERENCE LIBRARY OF NUCLEAR MODEL PARAMETERS for nuclear data evaluation.

The number of nuclear reaction channels open increases very rapidly with projectile energy, leading to the excitation of tens or even hundreds or residual nuclei. The tremendous effort needed for input preparation makes the evaluator community appreciate the strong necessity of having available, through direct code access, reliable standard parameter libraries.

The Nuclear Data Section of the IAEA, realizing the importance of this subject matter, since 1991, held a number of con-

sultants' meetings, in order to be advised on the subject contents, as well as on the opportunity to start a coordinated action aimed at the organization of reference parameter libraries for nuclear model codes.

The consultants' group indicated that actions should be taken on a list of 7 groups of major input parameters:

1. atomic masses and related data,

2. discrete level schemes,

3. average neutron resonance parameters,

4. optical model parameters,

5. level densities (total, partial, fission)

6. gamma-ray strength functions,

7. fission barriers.

Parameters 1,2,3 are model independent, whereas parameters 4, 5, 6, 7 are model dependent. In order to be able to decide which model parameters to be compiled, assessments achievable through critical intercomparisons of the physics underlying the different models must be made. This makes the two efforts being started by the NEANSC of OECD and by the NDS of IAEA, respectively, very much complementary, strictly interdependent, and mutually supportive.

2. NUCLEAR MODEL VALIDATION EFFORT OBJECTIVES AND ORGANIZATION

2.1. Tasks and objectives of the subgroup on Nuclear Model Validation (SNMV).

According to the indications of the NEANSC IEC, the SNMV should consider all reaction mechanisms taking place below about one hundred MeV incident energy. One may suggest the pion production threshold as a more proper dividing line, in view of the implications of elementary particle production, a complication which requires different theoretical treatment. The energy domain so defined, typically involves reactions induced by light projectiles.

This energy domain is dominated by compound nucleus, preequilibrium, and direct reaction mechanisms, for particle reactions, whereas for particle capture one has to further consider

collective capture, as well as the mechanisms describing gamma ray deexcitations beyond the Giant Resonance. Induced fission events also occur in this energy interval, which need to be carefully considered in view of the importance of fission in waste burning applications. Furthermore attention should be paid to reactions induced in light nuclei due to their importance in advanced medical applications, among other things. Finally a very special note has to be made of the overall importance of the role played by optical models and level densities.

The task of the SNMV is to provide an assessment of the validity range and of the capabilities of different approaches. Models considered should be provided, eventually, with detailed formalisms, as well as manuals for their use and test cases.

Once a thorough critical intercomparisons of models has been carried out, another important task for the SNMV is to validate the corresponding codes which have been made available. To this end it appears that the work carried out in the frame of all nuclear model code intercomparisons promoted by the NEA will be very useful. In addition to them, some other intercomparison will be necessary in order to focus on specific model assumptions by means of comparison with selected measurements.

Eventually codes should be tested on different platforms (like SUN, VAX, IBM mainframe and RISC) and released with proper documentation.

2.2. Organization and strategy of the SNMV

A few organization aspects should be mentioned, because they appear to be very essential to the success of the effort being undertaken.

There is the necessity that involved specialists be able to meet periodically, in order to compare their respective experiences and view points, and carry out critical discussions and anything else which cannot be performed individually at home laboratories. This is an essential aspect of the effort, which has to be properly considered, in view of the fact that, as of now, one cannot foresee many chances of funding for such meetings. Important contributions may be lost from specialists who may not be able to have support from their home institutions.

In order to avoid large unmanageable groups, a limited number of specialists should be involved which can offer major contributions. These are expected to be those who have contributed significantly either to model and/or code developments.

The SNMV should be split, in turn, into small groups, each for the different subjects (like level density models, preequilibrium models, optical models, fission models etc.). Each group in turn should be addressed and guided by one person to be nominated by the participanting specialists and which should report to the

subgroup coordinator and to plenary sessions of the subgroup.

2.3. Expected participants to the SNMV

Major contributions to nuclear model and code developments and to nuclear modelling methodologies have been produced by a number of laboratories both in OECD e in non-OECD countries.

It is the task of the SNMV coordinator to contact the various groups, in order to illustrate the effort established in the frame of NEANSC activities and to invite them to contribute to the realization of such an important objective.

Given below is a preliminary list of laboratories which have been actively contributing in the past to pertinent subjects and that one hopes will be interested and available to continue within the aim of the present SNMV.

1. OECD - Austria: IRK Vienna

- France: CEN Bruyere-le-Chatel

- Germany: KFA Julich
  : Tu Dresden
  : KFK Karlsruhe
  : Max Planck Institut Heidelberg

- Italy: ENEA Bologna
  INFN University of Milano
  INFN University of Messina

- Japan: JAERI Mito

- Netherlands: ECN Petten

- UK: Oxford University

- USA: LANL Los Alamos
  LLNL Livermore
  ORNL Oak Ridge
  ANL Argonne
  Duke University

2. Non-OECD - Brasil: IAEV Sao Jose' Dos Campos
  University of Sao Paulo

- China: IAE Beijing

- India: BARC Bombay

- Poland: INR Warsaw

- Russia: FEI Obninsk

- Romania: IPNE Bucarest

- Slovakia: IP SAS Bratislava

Long standing collaborations already exist among different groups which could offer a useful and appropiate reference platform in support of the SNMV activities.

One of these collaborations involves Livermore, Los Alamos and Bologna, with widely used code packages (GNASH, ALICE, IDA) and expertise covering a considerable portion of the spectrum of models (MSC-MSD a' la FKK; MSC a' la Weidenmuller, MSD a' la Tamura-Udagawa-Lenske, Exciton models, Hybrid model, microscopic shell model-BCS level densities, R-matrix shell model-calculations for reactions induced in light elements, fission models etc.). Experts from these laboratories already work together and meet on a fairly regular basis, so that they should be able to ensure the continuity of this effort, offering a standing platform for wider collaboration involvements.

2.4. Meetings

The most obvious opportunities for specialists getting together at a low additional cost are offered at the occasion of conferences, symposia, IAEA meetings etc.

Accordingly one should seriously consider the forthcoming Gatlinburg conference on "Nuclear Data for Science and Technology" as a very good occasion to hold the first meeting of subgroup 12 specialists.