Nuclear Physics & Astrophysics at CERN - NuPAC

Report of Contributions

https://indico.cern.ch/e/422434

Contribution ID: **4** Type: **Invited oral contribution**

Nuclear physics for explosive nucleosynthesis

Monday 10 October 2005 14:50 (25 minutes)

Presenter: Prof. LANGANKE, Karlheinz (GSI & TU Darmstadt)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **5** Type: **Invited oral contribution**

Old metal-poor stars: observations and implications on the GCE

Monday 10 October 2005 14:00 (25 minutes)

I summarize recent observational progress on measurement of the elemental abundances of early generation stars, which have recorded (and preserved) the first episodes of nucleosynthesis in the Galaxy. I discuss two major recent surveys, one just completed, one just beginning. The first, the Hamburg/ESO R-process-Enhanced Star (HERES) survey has obtained "snapshot" high-resolution spectroscopy of nearly 400 giants with [Fe/H] < -2.0, and is providing strong constraints not only on elemental abundance patterns for metal-poor stars, but also on the absolute frequency of various patterns, which must be accounted for in models of Galactic Chemical Evolution. The second survey, the Sloan Extension for Galactic Understanding and Exploration (SEGUE) will obtain medium-resolution spectroscopy of some 250,000 stars in the Milky Way, and is likely to detect some 20,000 stars with [Fe/H] < -2.0.

Primary author: Prof. BEERS, Timothy (MSU)

Presenter: Prof. BEERS, Timothy (MSU)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **6** Type: **Invited oral contribution**

Stellar evolution and the need of nuclear physics

Monday 10 October 2005 14:25 (25 minutes)

Primary author: Prof. THIELEMANN, Friedrich-Karl (University of Basel)

Presenter: Prof. THIELEMANN, Friedrich-Karl (University of Basel)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **7** Type: **Invited oral contribution**

ISOLDE experiments and astrophysics implications

Monday 10 October 2005 15:15 (25 minutes)

A variety of astrophysical processes contribute to the synthesis of heavier elements in nature. The characteristics of the processes are governed by the astrophysical environment and details of the nuclear processes involved. Experiments performed at ISOLDE have played a central role in developing understanding of these processes. In this presentation, highlights to be discussed include: the beta decay of 12B, which resulted in the revised rates for the triple alpha -process; spectroscopic studies along the rapid proton capture process path and decay studies in the vicinity of the rapid neutron capture process path. In addition, an important contribution of precision atomic mass measurements performed at ISOLTRAP will be reviewed with particular emphasis on nuclear astrophysical consequences.

Primary author: Dr JOKINEN, Ari (University of Jyvaskyla)

Presenter: Dr JOKINEN, Ari (University of Jyvaskyla)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **8** Type: **Invited oral contribution**

RIB physics in astrophysics worldwide

Monday 10 October 2005 16:35 (25 minutes)

As pointed out by Willie Fowler, the goals of nuclear astrophysics are to understand the mechanism of Nucleosynthesis and the process of energy generation in stellar environments. While a good deal is now known on what occurs in quiescent stellar burning, much less is known about pathways to heavy element production in explosive scenario. The former is largely dominated by nuclear reactions involving stable nuclei over long time scales, but the latter occur on much shorter time scale (seconds) and involve radioactive nuclei. With recent technological breakthroughs, it is now possible to measure rates of key nuclear reactions involving short-lived reactants in novae, X-ray bursts and type I supernovae. Such sub-coulomb barrier reactions exhibit very low cross sections, usually involve hydrogen, and are difficult to measure at temperatures in stellar environments. This talk will review how these challenges have been met around the world with the production of intense radioactive beams of low velocities to provide both direct and indirect measurements of the key parameters, namely level resonance strengths. A number of laboratories are now capable of measuring rates of reactions involving radioactive reactants and helping to clarify the mechanism of explosive stellar phenomena. ISOLDE is the benchmark world facility for producing intense beams of radioactive nuclei and can play an important role in such studies; a role that could be unique in the world. Examples of such studies around the world will be presented and discussed in the context of the future of ISOLDE.

Primary author: Prof. D'AURIA, John (Simon Fraser University)

Presenter: Prof. D'AURIA, John (Simon Fraser University)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **9** Type: **Invited oral contribution**

Branchings, neutron sources and poisons: evidence for stellar nucleosynthesis

Monday 10 October 2005 16:10 (25 minutes)

The first evidence of the occurrence of nucleosynthesis in stars was provided in the 1950s by the detection of the unstable heavy element technetium in the atmospheres of stars on the Asymptotic Giant Branch (AGB), a late evolutionary phase of stars of low mass. Technetium can be produced by slow neutron captures (the s process) and thus its detection requires that neutron source reactions are activated in these stars, triggering the production of heavy element. The best candidates as sources of neutrons have been identified in the C13(alpha,n)O16 and Ne22(alpha,n)Mg25 reactions. The C13(alpha,n)O16 reaction appears to be responsible for the production of most of the neutrons, while the Ne22(alpha,n)Mg25 reaction is important for the activation of branching points on the s-process path. Detailed evidence of the operation of branching points is shown by recent measurements of the isotopic composition of heavy elements in meteoritic silicon carbide (SiC) grains that originated from AGB stars. Interesting examples that will be discussed are the Ba134/Ba136, Kr86/Kr82 and Zr96/Zr94 ratios. During the s process, elements lighter than iron represent “neutron poisons”, stealing neutrons from the production of heavy elements. Nevertheless, neutron captures on light elements are of much interest in triggering secondary nucleosynthesis path. For example, the activation of the N14(n,p)C14 reaction on one hand can strongly inhibit the production of heavy elements by the C13(alpha,n) source, on the other hand it leads to the production of fluorine, which is observed to be enhanced in AGB stars.
Neutron-capture reactions on the isotopes of Mg, Si and Ti are also of great interest as they change the composition of these elements, which are also recorded in meteoritic grains.

Primary author: Dr LUGARO, Maria (University of Cambridge)

Presenter: Dr LUGARO, Maria (University of Cambridge)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **10** Type: **Invited oral contribution**

Neutron cross sections for reading the abundance history

Monday 10 October 2005 17:00 (25 minutes)

In the last decades considerable effort in experimental nuclear astrophysics, stellar modelling, and observations led to an improved understanding of various nucleosynthesis scenarios. This is particularly true for the main s process in low-mass AGB stars, which is largely responsible for the production of about half of the elemental abundances in the mass range $90 \leq A \leq 209$. The weak s process, which produces elements with $A \leq 90$, however, is much less understood. Since this process operates in massive stars it is ultimately linked with the abundance contributions of explosive nucleosynthesis in supernovae (SN II). In this field more accurate neutron capture cross sections in the mass range $56 \leq A \leq 90$ are indispensable for meaningful comparisons of model predictions with observational data. The abundant light elements with $A < 56$ play an important role, since they act as neutron poisons and affect the stellar neutron balance. The essential role of the time of flight facility n_TOF at CERN for determining the important key neutron capture reactions will be discussed.

Primary author: Dr HEIL, Michael (FZK Karlsruhe)

Presenter: Dr HEIL, Michael (FZK Karlsruhe)

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **11** Type: **Invited oral contribution**

Nuclear theory for astrophysics applications

Monday 10 October 2005 17:25 (25 minutes)

Important effort has been devoted in the last decades to measure reaction cross sections. These measurements are fundamental to put the nuclear astrophysics models on a sound basis. However, despite such effort, many nuclear applications, and most particularly nuclear astrophysics, still require the use of theoretical predictions to estimate experimentally unknown cross sections. Most of the nuclear ingredients in the calculations of reaction cross sections need to be extrapolated in an energy or/and mass domain out of reach of laboratory simulations. In addition, some applications often involve a large number of unstable nuclei, so that only global approaches can be used. For these reasons, when the nuclear ingredients to the reaction models cannot be determined from experimental data, it is highly recommended to consider preferentially microscopic or semi-microscopic global predictions based on sound and reliable nuclear models which, in turn, can compete with more phenomenological highly-parametrized models in the reproduction of experimental data.
The latest developments and improvements made in the prediction of ground-state properties, nuclear level densities, gamma-ray strength functions and fission properties within global microscopic models are reviewed. The direct as well as indirect experimental data available to test these models are discussed. It is shown to what extent previous and future experiments can bring new constraints or insights on the existing models.

Primary author: Dr GORIELY, Stéphane

Presenter: Dr GORIELY, Stéphane

Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics

Contribution ID: **12** Type: **Invited oral contribution**

Decay studies

Tuesday 11 October 2005 08:30 (40 minutes)

For nuclei far from stability the differences in isobaric masses increases quadratically and the binding energy of the last nucleon decreases dramatically making beta-delayed particle emission the dominant decay channel at the drip lines.

Beta decay is a well understood process and allows for a wide variety of spectroscopic information to be extracted from experiment: level energies, widths, spins, isospins and level densities. Via this process and detailed studies of the particle emission our understanding of nuclear structure and nuclear dynamics can be tested even in rare drip line nuclei. Some phenomena, such as multi-particle emission, are unique to these very exotic nuclei.

The key nuclei to understand how a complex system can be constructed from a few ingredients are often the very neutron or proton rich, since such exotic systems allow to isolate and amplify specific aspects of the nucleonic interactions. For instance, some of them uniquely display the physics of loosely bound quantal systems governed by the strong interaction. Decay studies can be performed with very low yields and the very selective rules they obey make them a powerful and unique tool in such nuclear structure studies.

In this presentation some key nuclei will be presented and it will be shown how the combined use of pure beams from ISOLDE, a selective and clean probe - the beta decay- and state of art detection system has allowed to answer some of the questions mentioned above. Some possibilities for future studies of this type will be outlined.

Primary author: Dr GARCIA BORGE, Maria Jose (IEM-CSIC)

Presenter: Dr GARCIA BORGE, Maria Jose (IEM-CSIC)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **13** Type: **Invited oral contribution**

Spins, moments and radii: probing changes in the nuclear shell structure

Tuesday 11 October 2005 09:10 (25 minutes)

In this presentation, we show how nuclear ground state properties like spins, magnetic dipole and electric quadrupole moments, and nuclear charge radii can provide us with detailed information about the nuclear structure and how systematic studies of these observable towards the driplines can help to test the validity of newly developed nuclear models and interactions.
This will be illustrated by showing recent results of studies performed mainly at ISOLDE-CERN over the past decade. The wide variety of experimental methods that has been developed and improved continuously by different international collaborations, has allowed systematic studies on a wide variety of elements and for very exotic isotopes. While some methods are extremely sensitive (allowing studies on beams of only tens/s), others allow investigating the ground state moments and radii up to an extremely high precision. Like this, new phenomena such a nuclear halo's, can be probed in great detail or new regions of structural changes (erosion of the shell structure, disappearing shell gaps) can be established and studied in great detail.

Primary author: Dr NEYENS, Gerda (KU Leuven, IKS)

Presenter: Dr NEYENS, Gerda (KU Leuven, IKS)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **14** Type: **Invited oral contribution**

Masses and nuclear structure

Tuesday 11 October 2005 09:35 (25 minutes)

Primary author: Prof. BOLLEN, Georg (Michigan State University)

Presenter: Prof. BOLLEN, Georg (Michigan State University)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **15** Type: **Invited oral contribution**

Bound and continuum states in one framework

Tuesday 11 October 2005 10:30 (25 minutes)

Primary author: Dr PLOSZAJCZAK, Marek (GANIL)

Presenter: Dr PLOSZAJCZAK, Marek (GANIL)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **16** Type: **Invited oral contribution**

Reaction experiments approaching the driplines

Tuesday 11 October 2005 10:55 (25 minutes)

Our picture of the structure of nuclei is undergoing dramatic changes when systems far away from the line of stability are studied. Established landmarks in the nuclear landscape like the magic numbers are weakened or displaced, and the nuclear spin-orbit interaction appears to diminish. In the most extreme nuclear systems that can be experimentally studied today, various types of exotic clustering become evident when approaching the drip-lines. Major theoretical efforts are undertaken to understand these nuclei, which partially lie in a domain gradually coming within reach of ab-initio calculations.

Low-energy nuclear reactions constitute an excellent tool for studying these phenomena. The beams from REX-ISOLDE permit few-nucleon transfer experiments in inverse kinematics using an unprecedented range of radioactive species. These reactions are well-proven close to stability with a long-standing knowledge how to disentangle detailed nuclear structure information from the reaction mechanism. This constitutes the starting point when approaching the driplines, with the additional complexity of loosely bound states and/or coupling to the continuum.

REX-ISOLDE is, and will be playing a major role in increasing our experimental knowledge of nuclei in the vicinity of the driplines. The first-generation experiments have only started to show the potential of the device with its associated detector systems and a rich scientific output can be envisaged for the future.

Primary author: Dr NILSSON, Thomas (Chalmers University of technology and TU Darmstadt)

Presenter: Dr NILSSON, Thomas (Chalmers University of technology and TU Darmstadt)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **17** Type: **Invited oral contribution**

Theoretical perspectives

Tuesday 11 October 2005 11:20 (40 minutes)

The position and even the existence of a neutron and a proton drip lines are among the great, still unresolved, questions of nature.
In this talk first I will state the problem of Physics at the proton and neutron drip lines in general terms of understanding the structure of the matter. Then I will specialize on Nuclear Physics theoretical issues.
A "roadmap" for future research will be suggested on the basis of the present understanding of unbound nuclei, resonance and threshold phenomena and of few- and many-body problems of strongly interacting systems. The project involves an understanding of certain theoretical aspects of the nuclear interaction which can be only deduced from experiments with unstable beams of very low energy.
The key importance of the Isolde facility activity in this respect will be stressed.

Primary author: Dr BONACCORSO, Angela (INFN-PISA)

Presenter: Dr BONACCORSO, Angela (INFN-PISA)

Session Classification: Physics at the proton and neutron drip lines

Track Classification: Physics at the proton and neutron drip lines

Contribution ID: **18** Type: **Invited oral contribution**

Superallowed Nuclear Beta Decays and CKM Unitarity

Tuesday 11 October 2005 13:30 (30 minutes)

A new method for computing hadronic effects on electroweak radiative corrections to low energy semileptonic weak interaction processes is described. Applying this approach to the extraction of the quark mixing matrix element Vud, Alberto Sirlin and I find from superallowed nuclear beta decay Vud = 0.97377(27).
Combining that result with recent determinations of Vus from kaon decays provides a precision test of CKM unitarity and constraint on new physics effects.. Prospects for further improvements are briefly discussed.

Primary author: Dr MARCIANO, William (BNL)

Presenter: Dr MARCIANO, William (BNL)

Session Classification: Standard model tests

Track Classification: Standard model tests

Contribution ID: **19** Type: **Invited oral contribution**

Precision mass measurements, experimental aspects

Tuesday 11 October 2005 14:00 (20 minutes)

Like few other parameters, the mass of an atom, and its inherent connection with the atomic and nuclear binding energy is a fundamental property, a unique fingerprint of the atomic nucleus. Each nuclide comes with its own mass value different from all others. For short-lived exotic atomic nuclei the importance of its mass ranges from the verification of nuclear models to a test of the Standard Model, in particular with regard to the weak interaction and the unitarity of the Cabibbo-Kobayashi-Maskawa quark mixing matrix. In respect to the later application the most important recent results on the measurement of decay energies Q but also on the study of half-lives T1/2 and branching ratios R will be discussed.

Primary author: Dr BLAUM, Klaus (Univeristy of Mainz)

Presenter: Dr BLAUM, Klaus (Univeristy of Mainz)

Session Classification: Standard model tests

Track Classification: Standard model tests

Contribution ID: **20** Type: **Invited oral contribution**

Beta-decay correlation measurements

Tuesday 11 October 2005 14:20 (30 minutes)

Precision measurements of correlation observables in nuclear beta decay constitute a sensitive tool to search for signatures of new physics beyond the standard electroweak model. Over the past decade, measurements in nuclear and neutron decays provided new constraints on the possible presence of exotic weak couplings as well as new tests of maximal parity violation and time reversal invariance. This presentation reviews recent achievements in the field and presents current efforts aiming to reach new levels of sensitivity.

Primary author: Dr NAVILIAT-CUNCIC, Oscar (LPC)

Presenter: Dr NAVILIAT-CUNCIC, Oscar (LPC)

Session Classification: Standard model tests

Track Classification: Standard model tests

Contribution ID: **21** Type: **Invited oral contribution**

Introduction to solid state physics at ISOLDE

Tuesday 11 October 2005 15:30 (15 minutes)

Primary author: Prof. WICHERT, Thomas (Saarland University)

Presenter: Prof. WICHERT, Thomas (Saarland University)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **22** Type: **Invited oral contribution**

High-lights of solid state physics at ISOLDE

Tuesday 11 October 2005 15:45 (25 minutes)

Solid state physics at ISOLDE aims at the study of the structural, electrical, optical, magnetic and transport properties related to impurities in a variety of technologically and fundamentally relevant materials, including semiconductors, metals, high-Tc superconductors and ceramic oxides.

Rather than providing an extensive overview of the complete solid state physics activities at ISOLDE, this contribution focuses on some of the high-lights of the current research, including
- the lattice location of dopants and impurities in wide band gap semiconductors by means of emission channeling,
- the identification of the chemical identity of optical centers in semiconductors using photoluminescence studies of radioactive impurities,
- the study of the structural and magnetic properties of Fe in semiconductors by means of the Moessbauer effect,
- the understanding of magnetic hyperfine fields at impurities on metal surfaces and within the bulk obtained by means of perturbed angular correlation (PAC),
- the configuration of excess O and F dopants in Hg-based High-Tc superconductors,
- the probing of charge ordering effects in phase transitions of colossal magneto-resistive oxides.

The talk also includes examples that illustrate the benefit of combining results from several nuclear methods that characterize the same system.
It will be shown that this is a particular strength of the solid state research undertaken at ISOLDE and has lead to a significantly better understanding in a number of cases.

Primary author: Dr WAHL, Ulrich (Instituto Tecnológico e Nuclear)

Presenter: Dr WAHL, Ulrich (Instituto Tecnológico e Nuclear)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **23** Type: **Invited oral contribution**

New developments in solid state physics using radioactive ions

Tuesday 11 October 2005 16:10 (25 minutes)

Radioactive probe atoms in solids have proven to be unique sensors for internal magnetic and electrical fields and markers to study diffusion phenomena, impurity lattice sites and optical properties of impurity atoms. In contrast to conventional solid state methods applied to study magnetism and structural properties, the use of radioactive probes as sensors of internal fields is unique since the sensor size shrinks to the size of an atomic nucleus, about 10-5 of a typical crystal lattice constant. Moreover the use of radioactive nuclei circumvents sensitivity limitations due to reaction cross sections and thus radioactive probe techniques are among the most sensitive techniques in solid state physics.
A variety of technical developments will lead to a much more versatile and efficient use of radioactive probe techniques in the future. Examples are (i) the fast digital data acquisition for perturbed angular correlation (PAC) with a time resolution below 100 ps in conjunction with (ii) next generation ultrafast scintillation detectors based on rare earth silicates, (iii) detectors for angle resolved conversion electron Mössbauer spectroscopy, (v) high sensitive position resolving semiconductor pixel detectors for imaging decay electron angular distributions and (v) high sensitivity CCD sensors and compact UV lasers for efficient photoluminescence studies.
In this contribution some possible areas of research are outlined where radioactive probe techniques may provide new insights into solid state physics problems with a selectivity and sensitivity not achievable with conventional techniques. Among the examples discussed will be the application of Mössbauer spectroscopy and PAC to thin film magnetism, the possible application of PAC to study future high k dielectric materials, the application of emission channeling to high precision impurity atom lattice location and the application of radioactive probe techniques for investigating nanomaterials, surface and interface properties and advanced metallic alloys such as MAX phases.

Primary author: Prof. HOFSÄSS, Hans Christian (Georg-August-Universität Göttingen)

Presenter: Prof. HOFSÄSS, Hans Christian (Georg-August-Universität Göttingen)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **24** Type: **Invited oral contribution**

Life sciences at ISOLDE

Tuesday 11 October 2005 16:35 (25 minutes)

The understanding of the function of metalloproteins and metal-containing enzymes is usually based on the detailed knowledge of the structure of these macromolecules obtained by X-ray diffraction. In many cases, crystals of sufficient quality are not available and one has to rely on spectroscopy such as, e.g., Nuclear Magnetic Resonance (NMR) or Electron Paramagnetic Resonance EPR). Another particularly interesting technique is Time Differential Perturbed Angular Correlation of -Rays (TDPAC) which has the highest possible sensitivity due to the use of radioactive - emitters. Experiments under physiological conditions with picomolar concentrations are feasible.
The nuclear quadrupole interaction (NQI) turns out to be an extremely sensitive tool to study, e.g., the structure and dynamics at metal ion binding sites, protein-protein interactions in solutions, and the metal binding site structure during catalytic action. The basic reason for this sensitivity is the strong inverse cubed dependence of the NQI on nearest-neighbour distance. Very subtle changes in rigidity/flexibility in isomorphous replacements of metal ions are detectable.
A drawback is the fact that only a limited number of suitable radioisotopes is available which happen to be rather short-lived. In all cases an extremely high specific activity is required. Therefore an on-line isotope separator such as ISOLDE is indispensable.
Examples from recent work at ISOLDE and from the group of the late Rogert Bauer in Copenhagen will be presented. Future applications such as, e.g., the combination of freeze-quench techniques with TDPAC for the study of enzymatic reactions will be discussed.

Primary author: Prof. BUTZ, Tilman (University of Leipzig)

Presenter: Prof. BUTZ, Tilman (University of Leipzig)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **25** Type: **Invited oral contribution**

Medical Applications of radioactive ion beams

Tuesday 11 October 2005 17:20 (25 minutes)

Primary author: Dr BEYER, Gerd (HUG)

Presenter: Dr BEYER, Gerd (HUG)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **26** Type: **Invited oral contribution**

Link between fundamental and applied research in the field of nuclear data

Tuesday 11 October 2005 18:35 (25 minutes)

Recently, a large number of applications involving high-energy neutrons have become important. Accelerator-driven systems (ADS) for transmutation of spent nuclear fuel and nuclear weapons materials, fast-neutron cancer therapy, dose effects to the crew onboard aircraft due to cosmic-ray neutrons, as well as electronics failures induced by atmospheric neutrons have all got increasing attention.

In this talk, I will give some examples of recent achievements in the field, and outline experimental opportunities at the CERN NTOF facility in a near future, as well as possibilities at the future CERN beta-beam facility under consideration.

Primary author: Prof. BLOMGREN, Jan (Uppsala University)

Presenter: Prof. BLOMGREN, Jan (Uppsala University)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **27** Type: **Invited oral contribution**

Nuclear data needed to develop new nuclear systems, role of n_TOF facilities to measure resonance cross sections and nuclear data needs of thorium fuel cycle

Tuesday 11 October 2005 17:45 (25 minutes)

The development of Accelerator Driven Sub-critical Systems proposed by Carlo Rubbia and others require significant amount of new nuclear data in extended energy regions and significant improvement of the presently available nuclear data. The ADSS concepts have given a fresh look at the use of thorium fuel cycle in a lead-bismuth coolant environment. The nuclear data of isotopes of thorium fuel cycle need new measurements to bring their status to at least to a level on par to those of U-Pu cycle. The talk will present a number of illustrative examples. The Indian participation in the n_TOF programmes stands to benefit not only in her ADSS studies for thorium utilization but also because there is a considerable overlap between the Advanced Heavy Water Reactor (AHWR) and Compact High Temperature Reactor (CHTR) Indian programmes with respect to thorium as a fuel and the on-going international efforts to develop innovative, inherently safe, proliferation-resistant and long-life-cores, with features using thorium such as in INPRO and Generation IV systems.

Reliable design and operator's manual, based upon accurate knowledge of nuclear data, for each stage of the nuclear fuel cycle of the ADSS and other advanced concepts will help in safe use of nuclear energy by providing proper guidance on safety precautions and behaviour under all system conditions. For multiple recycled fuels, the quality of nuclear data of higher isotopes of plutonium, minor actinides (e.g., isotopes of Am and Cm) and fission products need to be brought on par to that of main fissile and fertile nuclei. The role of n_TOF measurements to meet the demands on accurate nuclear data in the extended resolved resonance region that affect plant safety related feedback coefficients such as Doppler and coolant void reactivity effects as a function of burn-up for advanced systems are high. The experimental validation efforts in critical facilities can never exactly verify the simulated states of higher burn-up. Improved nuclear data are therefore essential for fission products and minor actinides in developing advanced reactor systems, such as actinide burner systems and to reduce the number of costly integral experiments.

Preliminary research for the Energy Amplifier concept proposed by Carlo Rubbia and others in the world use existing nuclear data developed for thermal, fast and fusion reactors and those generated towards fundamental physics understanding of the nucleus and applications such as in astrophysics. The quality assurance in design and safety studies in nuclear energy in the next few decades and centuries require new and improved nuclear data with high accuracy and energy resolution that is possible only with the facilities such as the CERN n_TOF. Carefully planned measurements with facilities such as n_TOF are essential as the existing strength of the state-of-the-art nuclear databases in use for various applications is highly commendable but inadequate to meet the nuclear data needs of new reactor concepts as different neutron energy spectra and materials and compositions are involved. As a general rule, the generation of new nuclear data by the international community should continue to be encouraged as more intense neutron sources, purer elemental/isotopic target samples, more efficient detectors and better electronics evolve. Required scientific activities also are extensive follow up of experimental

data generation with a comprehensive compilation, critical evaluation, production of new ENDF/B formatted libraries extending to higher energies, and quality assured nuclear data processing activities to provide the designers/users/ of innovative systems with “ready to plug-in”processed data, that are integrally validated, for use in applications.

Primary author: Prof. GANESAN, SRINIVASAN (Bhabha Atomic Research Centre)

Presenter: Prof. GANESAN, SRINIVASAN (Bhabha Atomic Research Centre)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **28** Type: **Invited oral contribution**

Neutronic requirements for fusion relevant reactor material irradiations

Tuesday 11 October 2005 18:10 (25 minutes)

The need to develop and qualify materials that can withstand the high radiation and heat loadings anticipated for a fusion reactor is a key problem in the development of fusion as a future energy source. No appropriate materials test facility is available at present to properly simulate a fusion neutron radiation field and investigate the effect of the resulting radiation damage and elemental transmutations on the material properties at conditions anticipated for a future fusion demonstration or power reactor. Various concepts for an intense high energy neutron source have been proposed in the past including plasma based volumetric D–T devices and accelerator driven facilities. Their suitability and feasibility was evaluated, key requirements were defined and recommendations for viable options were elaborated. The concept of an accelerator based source which utilises the Deuterium-Lithium (D-Li) stripping reaction for the neutron production was considered the best choice to fulfil the requirements within a realistic time scale. This led to the project for an International Fusion Materials Irradiation Facility (IFMIF) conducted under the auspices of the International Energy Agency (IEA).
The presentation will review the needs and requirements for fusion reactor material irradiations, address the question of the suitability of the accelerator driven D-Li source and then focus on the recent progress achieved with the IFMIF project.

Primary author: Dr FISCHER, Ulrich (Forschungszentrum Karlsruhe)

Presenter: Dr FISCHER, Ulrich (Forschungszentrum Karlsruhe)

Session Classification: Applications: material science, life sciences and nuclear technologies

Track Classification: Applications: material science, life sciences and nuclear technologies

Contribution ID: **29** Type: **Invited oral contribution**

Structures, shapes from gs properties

Wednesday 12 October 2005 10:00 (30 minutes)

The review will concentrate on the spin, charge radii and static moments measured by laser spectroscopic techniques and the physics question these studies can address.

In recent years most results have been obtained by high resolution laser spectroscopy using the collinear beams technique (for example by the COLLAPS collaboration at ISOLDE and a UK collaboration at the IGISOL facility, Jyvaskyla). Higher sensitivity is achieved with ion-source resonance ionization spectroscopy (RIS) but at reduced resolution.

The new ISOLDE ion cooler-buncher to be commissioned in 2006 will dramatically broaden the scope for measurements, it being able to work with considerably lower beam fluxes than has been usual at ISOLDE. It will also allow a collinear RIS technique to be used which keeps the sensitivity advantage but removes the Doppler broadening.

Primary author: Prof. BILLOWES, Jonathan (University of Manchester)

Presenter: Prof. BILLOWES, Jonathan (University of Manchester)

Session Classification: Evolution of nuclear structure, shapes, and fission

Track Classification: Evolution of nuclear structure, shapes, and fission

Contribution ID: **30** Type: **Invited oral contribution**

Structures, shapes from excited states

Wednesday 12 October 2005 09:30 (30 minutes)

Primary author: Prof. VAN DUPPEN, Piet (Katholieke Universiteit Leuven)

Presenter: Prof. VAN DUPPEN, Piet (Katholieke Universiteit Leuven)

Session Classification: Evolution of nuclear structure, shapes, and fission

Track Classification: Evolution of nuclear structure, shapes, and fission

Contribution ID: **31** Type: **Invited oral contribution**

Structures, shapes theory

Wednesday 12 October 2005 09:00 (30 minutes)

Modern nuclear structure theory is rapidly evolving towards regions of short-lived nuclei far from stability. The principal objective is to build a consistent microscopic theoretical framework that will provide a unified description of bulk properties, nuclear excitations and reactions. Stringent constraints on the microscopic approach to nuclear dynamics, effective nuclear interactions, and nuclear energy density functionals, are obtained from studies of the structure and stability of exotic nuclei with extreme isospin values, as well as extended asymmetric nucleonic matter.

Recent theoretical advances in the description of structure phenomena in nuclei far from stability are reviewed: applications of the global shell model approach and the self-consistent mean-field framework in the study of the evolution of shell structure with isospin and the disappearance of spherical magic numbers, the onset of deformation, shape transitions and shape coexistence, the microscopic description of the evolution of neutron skin and the low-energy multipole response in neutron-rich nuclei.

Primary author: Dr VRETENAR, Dario (University of Zagreb)

Presenter: Dr VRETENAR, Dario (University of Zagreb)

Session Classification: Evolution of nuclear structure, shapes, and fission

Track Classification: Evolution of nuclear structure, shapes, and fission

Contribution ID: **32** Type: **Invited oral contribution**

Highly deformed states, clusterization and fission in the actinide region

Wednesday 12 October 2005 11:00 (30 minutes)

The predicted variety of exotic nuclear shapes, and heavy clusterizations in the actinide region still represent big challenges for the contemporary experimental investigations.

Recently, the fission probability as a function of the excitation energy has been measured with high energy resolution using the (d,pf) reaction on different targets in order to study exotic nuclear shapes. The resonances could be described as being members of rotational bands with moments of inertia characteristic to super- and hyperdeformed nuclear shapes [1-4].

For the first time the depth of the third potential minimum was experimentally determined by applying a method of the statistical level density analysis of band head energies [2,4]. The method was tested in the case of the well known second potential minimum [3]. A rather deep third minimum was found in 234U (EIII=3.1(4) MeV) as well as in 236U (EIII=2.7(4) MeV) [4] in agreement with recent theoretical expectations [5].

The excitation energy of the lowest-lying hyperdeformed transmission resonance and the energy dependence of the fission isomer population probability allowed us to determine the height of the inner fission barrier and also its penetrability parameter for 236U. In this way the long lasting uncertainties in determining the height of the inner potential barrier in Uranium isotopes ('Thorium anomaly') was resolved in the picture of the triple-humped fission barrier [4].

The possibility of heavy clusterization in such highly deformed states was also investigated by measuring the mass and energy distributions of the ejected charged particles as a function of the excitation energy nearby the fission resonances corresponding to hyperdeformed nuclear states.

An overview of the field, our latest experimental results and future plans will be presented.

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[1] A. Krasznahorkay et al., Phys. Rev. Lett. 80 (1998) 2073.
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[4] M. Csatlos et al., Phys. Lett. B 615 (2005) 175.
[5] S. Cwiok et al., Phys. Lett. B 322 (1994) 304.

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Presenter: Prof. KRASZNAHORKAY, Attila (Institute of Nuclear Research, Atomki)

Session Classification: Evolution of nuclear structure, shapes, and fission

Track Classification: Evolution of nuclear structure, shapes, and fission

Contribution ID: **34** Type: **Invited oral contribution**

Potential future proton beam performance for HIE-ISOLDE, n_TOF phase 2 and EURISOL at CERN

Wednesday 12 October 2005 13:30 (35 minutes)

After analysis by the HIP working group [CERN-AB-2004-022], the number of protons that the existing accelerators can deliver after the year 2005 has been found to be insufficient for the needs of the LHC and the present generation of approved experiments. In the longer term (beyond ˜2010), the definition of the needs depends upon the LHC upgrade and the physics to be addressed.
Upgrades have been proposed and the situation for the experimental programme concerning the INTC will be described. Starting from the performance of the existing accelerators, the benefits of reducing the basic period to 900 ms and of building Linac4 will be quantified. The potential of a Superconducting Proton Linac (SPL) for addressing the needs of a “EURISOL-type” facility will be detailed.

Primary author: Dr BENEDIKT, Michael (CERN)

Presenter: Dr BENEDIKT, Michael (CERN)

Session Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Track Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Contribution ID: **35** Type: **Invited oral contribution**

The future of ISOLDE

Wednesday 12 October 2005 14:05 (35 minutes)

The HIE-ISOLDE project will provide beams of accelerated radioactive beams up to 10 MeV/u at CERN. The energy upgrade, carried out in two stages (the first stage will give beams of 5.5 MeV/u), will be accompanied by major developments to the Isolde target and front-end that will allow a 3-fold increase in the proton intensity anticipated from LINAC4 and a faster PSB cycling frequency. The HIE-ISOLDE project also demands development of the low-energy components of REX (charge breeder and beam injection) as well as improved mass separation from a modified HRS. These enhancements will allow the RIB facility at Isolde to be applied to a much wider programme in nuclear physics and astrophysics than at present, as well as benefiting the low energy programme (ground state properties and condensed matter applications).

Primary author: Prof. BUTLER, Peter (University of Liverpool and CERN)

Presenter: Prof. BUTLER, Peter (University of Liverpool and CERN)

Session Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Track Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Contribution ID: **36** Type: **Invited oral contribution**

The future of n_TOF

Wednesday 12 October 2005 14:40 (35 minutes)

Session Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Track Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Contribution ID: **37** Type: **Invited oral contribution**

The necessary safety requirements for the next generation n_TOF and ISOL facilities at CERN

Wednesday 12 October 2005 15:40 (25 minutes)

ISOLDE has been designed in 1990 for a maximum proton beam power which will be exceeded by up to a factor of five in HIE ISOLDE. The consequences for radiation protection will be described.
The n-TOF Ph2 facility shall be built from the outset according to radiation protection standards which will allow the use of sealed and unsealed radioactive targets and the full exploitation of neutron beam intensity in the new experimental area.

Primary author: Dr OTTO, Thomas (CERN)

Presenter: Dr OTTO, Thomas (CERN)

Session Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Track Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Contribution ID: **38** Type: **Invited oral contribution**

Protons at CERN: synergy with neutrino physics requirements

Wednesday 12 October 2005 16:05 (25 minutes)

I shall describe the benefits for neutrino physics of having at CERN a multimegawatt proton machine (SPL) and/or high intensity sources of radioactive ions (as envisioned in the Eurisol project).
The SPL machine would deliver very intense so-called neutrino superbeams of 300 MeV in energy which could be aimed at a megaton-class underground detector located in the Frejus tunnel, while radioactive ions (He6, Ne18 or others), after acceleration by PS and SPS, would be stored in a decay ring and produce so-called neutrino beta-beams aimed at the same detectors.
Superbeams and betabeams are complementary and would allow to determine the missing parameters of neutrino mixing with an unprecedented sensitivity.
The SPL is also a perfect proton driver for a future neutrino factory, which would produce high energy neutrino beams with even better performances.

Primary author: Dr BOUCHEZ, Jacques (CEA)

Presenter: Dr BOUCHEZ, Jacques (CEA)

Session Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Track Classification: Facilities at CERN: injectors, short and mid-term plans for n_TOF and ISOLDE

Contribution ID: **39** Type: **not specified**

Review talk 1

Tuesday 11 October 2005 19:00 (30 minutes)

Primary author: Prof. KLUGE, Juergen (GSI)

Presenter: Prof. KLUGE, Juergen (GSI)

Session Classification: Review talk 1

Contribution ID: **40** Type: **not specified**

Review talk 2

Wednesday 12 October 2005 16:30 (30 minutes)

Primary author: Prof. TANIHATA, Isao (Argonne National Laboratories)

Presenter: Prof. TANIHATA, Isao (Argonne National Laboratories)

Session Classification: Review talk 2

Contribution ID: **41** Type: **not specified**

Welcome address

Monday 10 October 2005 13:30 (10 minutes)

Session Classification: Introductory remarks

Contribution ID: **42** Type: **not specified**

In Memory of Prof. G Hansen, MSU, USA

Monday 10 October 2005 13:40 (5 minutes)

Presenter: Dr RIISAGER, Karsten (CERN)

Session Classification: Introductory remarks

Contribution ID: **43** Type: **not specified**

In Memory of Prof. D. Warner, Daresbury labs, UK

Monday 10 October 2005 13:45 (5 minutes)

Presenter: Prof. BUTLER, Peter (Liverpool University)

Session Classification: Introductory remarks

Contribution ID: **44** Type: **Invited oral contribution**

Review of some recent theoretical developments devoted to the fission process

Wednesday 12 October 2005 11:30 (20 minutes)

In the past few years, experimental studies have revealed many interesting features of the fission process, such as for instance
i) a transition between single and double-humped mass distributions with a triple-humped structure for some Thorium isotopes,
ii) a bimodality in the Total Kinetic Energy distributions of some fermium and transfermium isotopes.
From a theoretical point of view, fission is a very complicated process, in which many nuclear properties play a role, such as very deformed nuclear configurations, large amplitude motion, and the coupling between collective modes and /or between collective modes and intrinsic excitations.
In this talk, we will present a summary of some recent theoretical developments devoted to
i) fission barriers ii) fission fragment distributions iii) fission fragment properties such as deformation and spin and iv) the importance of the dynamics.

Primary author: Dr GOUTTE, Heloise (CEA)

Presenter: Dr GOUTTE, Heloise (CEA)

Session Classification: Evolution of nuclear structure, shapes, and fission