Neutron deficient exotic nuclei and the Physics of the ”proton rich side” of the nuclear chart

Report of Contributions

Contribution ID : **0** Type : **not specified**

In-gas cell laser spectroscopy of neutron-deficient silver isotopes

Monday, 21 February 2011 18:10 (25)

In-gas cell laser spectroscopy has been developed at the Leuven Isotope Separator On-Line (LISOL) set-up using heavy- and light-ion induced reactions. The recoiling reaction products are thermalised in a buffer gas cell filled typically with 300 to 500 mbar of argon. They are subsequently resonantly photoionized using a two step laser ionization scheme, extracted from the gas cell, injected into the front-end of LISOL, analysed according to their A/Q value and sent towards a detection station where their radioactive decay is observed [1,2]. By measuring the number of atoms arriving at the detection station as a function of the first step laser frequency, the atomic hyperfine structure of the atomic ground and/or excited state can be measured and charge radii, magnetic dipole and electrical quadrupole moments extracted. Recently the magnetic moment for a number of neutron deficient copper isotopes, including 57Cu (N=28), were determined [3].
In recent experiments a study of the neutron deficient silver isotopes produced via 92Mo(14N,pxn)AAg and 64Zn(36Ar,pxn)AAg reactions was pursued and the magnetic moments of a
number of them were obtained, including the semi-magic N=50 isotope 97Ag. These results will be presented and the gas cell performances to study indium and tin isotopes as well as heavier isotopes will be discussed. As an outlook, the opportunities of using this technique at the S3 facility at SPIRAL-2 GANIL will be presented.
[1] T. Sonoda et al., NIM B 267, 2918 (2009)
[2] Y. Kudryavtsev et al., NIM B 267, 2908 (2009)
[3] Th. Cocolios et al., PRL 103, 102501 (2009)., PRC 81, 014314 (2010)

Summary

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Session Classification : Monday February 21st, 2011. 17:30 - 19:00

Contribution ID : **1** Type : **not specified**

Early onset of deformation in the neutron-deficient polonium isotopes identified by in-source resonant ionization laser spectroscopy

Monday, 21 February 2011 18:35 (25)

The technique of resonant ionization spectroscopy is well known for its selectivity in the production of RIB at ISOL facilities. This feature is now also used for atomic spectroscopy on weakly-produced isotopes (<1 atom/s), otherwise not accessible by conventional laser spectroscopy techniques.

With two protons outside the lead (Z=82) closed core, the polonium isotopes (Z=84) exhibit shape coexistence on the neutron-deficient side of the nuclear chart. The influence of intruding deformed configurations on the ground state and long-lived isomers from 191Po up to the N=126 (210Po) shell closure and beyond has thus been investigated by means of in-source resonant ionization laser spectroscopy over two campaigns at CERN ISOLDE using the lsaer ion source. The isotope shifts between all the isotopes have been extracted and large-scale atomic calculations have been used to determine the electronic parameters necessary to deduce changes in the mean-square charge radii (mscr). The extracted changes in the mscr deviate much earlier than predicted by nuclear models and point towards a well-deformed ground state from 198Po downwards, much earlier than suggested by alpha-decay and in-beam studies of those isotopes.

After briefly introducing the technique and the challenges posed by the atomic calculations, we report in this contribution on the nuclear structure observables extracted (charge radii and electromagnetic moments) and their impact on our understanding of the shape coexistence phenomenon in this region of the nuclear chart.

Summary

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Session Classification : Monday February 21st, 2011. 17:30 - 19:00

Contribution ID : **2** Type : **not specified**

Welcome

Monday, 21 February 2011 09:00 (20)

Summary

Session Classification : Monday February 21st, 2011. 9:00 - 10:30

Contribution ID : **3** Type : **not specified**

Beta-delayed proton-emission, exotic decays in light nuclei

Monday, 21 February 2011 09:50 (40)

The beta decay process allows for understanding the interactions and behaviour of the nucleons inside the nucleus. The process is well understood and the interpretation of the data yields a wide variety of spectroscopic information: level energies, spins, parities, widths and level densities.

Often the key nuclei to understand how such a complex system can be constructed from a few ingredients are very neutron or very proton rich. Such exotic systems allow isolating and amplifying specific aspects of the nucleonic interactions, and uniquely display the physics of loosely bound systems governed by the strong interaction. Beta decay can also shed light on some fundamentals of the weak interaction, which it is the main contributor to the process.

Going far from stability the difference in isobaric masses increases quadratically and the binding energy of the last nucleon decreases dramatically, the beta-delayed particle emission becomes dominant near the drip lines. The beta transitions feed unbound excited states and they are followed by delayed particle emission. The high efficiency for the charged particle detection makes the study of the beta delayed particles a unique tool to understand the nuclear structure of very rare species through very exotic decay modes.

In this contribution recent achievements in particle decay studies will be presented. The different techniques developed to do high quality spectroscopy of very low produced exotic nuclei, will be revised.

Summary

Co-author(s) : G. BORGE, Maria José (Instituto de Estructura de la Materia, CSIC)

Presenter(s) : G. BORGE, Maria José (Instituto de Estructura de la Materia, CSIC)

Session Classification : Monday February 21st, 2011. 9:00 - 10:30

Contribution ID : **4** Type : **not specified**

Studies of Two Proton radioactivity

Monday, 21 February 2011 11:00 (40)

Extremely proton-rich nuclei with odd or even atomic numbers were predicted by V. Goldansky in 1960
to decay through one- or two-proton radioactivity, respectively. Two-proton (2p) radioactivity, a spontaneous decay of an atomic nucleus by emission of two protons, is the most recently discovered
nuclear disintegration mode. It has first been reported for 45Fe in 2002 with a half-life of about 4 ms,
which is 1000 times longer than the quasi-classical estimate of “di-proton” (or 2He) cluster emission.
Further observations of 2p radioactivity in 19Mg, 54Zn, 48Ni, 94mAg have confirmed unexpectedly large
half-lives of 2p precursors thus indicating regular existence of long-lived nuclei beyond the proton drip
line. The experimental methods used to produce, identify and detect new nuclear species via their 2p
decay will be reviewed. The up-to-date theoretical understanding of specific observables accessible in
the 2p decay measurements will be discussed with an emphasis on 2p-precursor’s nuclear structure.

Summary

Primary author(s) : MUKHA, Ivan (Helholzzentrum Gesellschaft fur SchwerIonenforschung (GSI))

Presenter(s) : MUKHA, Ivan (Helholzzentrum Gesellschaft fur SchwerIonenforschung (GSI))

Session Classification : Monday February 21st, 2011. 11:00 - 13:00

Contribution ID : **5** Type : **not specified**

Structure of proton emitting nuclei

Monday, 21 February 2011 11:40 (40)

We have performed theoretical calculations to describe the structure of nuclei at the extremes of stability, using the nonadiabatic quasiparticle approach. We reproduce the experimental half-life for proton radioactivity in 121Pr assuming J =7/2- as decaying state, showing for the first time clear evidence for partial rotation alignment in a proton emitting nucleus1.
Recent findings suggest the departure from axial deformation in the region of proton emitting nuclei. Our calculation for 145Tm2, giving the energy spectra of parent and daughter nuclei, half-life and fine structure, confirmed a large triaxiality. Similarly, we have studied decay of 141Ho 3, the only known nucleus for which fine structure in proton emission from both ground and isomeric states was observed. The interpretation of the data pointed out to the breaking of axial symmetry in this emitter.
The present studies provide new theoretical tools to access nuclear
structure properties far from the stability domain.

1 M. C. Lopes, E. Maglione, L. S. Ferreira, Phys. Lett.B 673(2009)15

2 P. Arumugam, L.S. Ferreira, and E. Maglione Phys. Rev. C78(2008) 041305

3 P. Arumugam, L.S. Ferreira, and E. Maglione Phys. Lett. B680(2009)443

Summary

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Presenter(s) : MAGLIONE, E. (INFN Padova)

Session Classification : Monday February 21st, 2011. 11:00 - 13:00

Contribution ID : **6** Type : **not specified**

New Vistas in Experimental Searches for Proton Radioactivity

Monday, 21 February 2011 12:20 (40)

The talk will consider where we currently stand in terms of the exploration of one proton radioactivity. Proton radioactivity provides a uniquely sensitive probe of nuclear shape and shell structure beyond the proton drip-line. This varied nuclear landscape in turn provides us with a laboratory in which to explore the dramatic influence of shape and shell structure on the proton quantum tunneling probability. The talk will explore new experimental approaches to the study of this fascinating phenomenon, including the exploration of new regions of the proton-drip-line, and regions of shape co-existence, where shape effects on tunneling would be probed in a uniquely sensitive manner.

Summary

Primary author(s) : WOODS, Philip J. (University of Edinburgh)

Presenter(s) : WOODS, Philip J. (University of Edinburgh)

Session Classification : Monday February 21st, 2011. 11:00 - 13:00

Contribution ID : **7** Type : **not specified**

Spectroscopy studies of N≈Z nuclei

Monday, 21 February 2011 15:00 (40)

The properties and structure of nuclei with equal number of protons and neutrons have been in the last decades an intense field of research, both experimentally and theoretically. The structure of these nuclei provide essential infomation, among other things, about the isospin symmetry of the nuclear force as well as on proton-neutron correlations. As an example, the isobaric analogue states in mirror nuclei have shed light on the presence of isospin non-conserving forces in nuclear matter. From the detailed studies of energy differences between those states, an important theoretical understanding of the nuclear force in the f p shell [1], has been achieved, recently extended to include the g9/2 [2, 3]. Furthermore, N = Z nuclei present enhanced correlations between neutrons and protons that occupy orbitals with the same quantum numbers. For heavier N = Z nuclei the T = 0 isoscalar correlations become more relevant than the usual T = 1 isovector pairing, giving rise to an unusual type of nuclear superfluidity [4].
Spectroscopy of excited states of these neutron-deficient nuclei has been demonstrated to be a powerful tool to understand in detail the nature of the nuclear force. This has been possible thanks to the advent, in the last decades, of large ɣ -ray arrays with the associated complementary detectors that allowed to access these very exotic N≈Z nuclei at high spins. Future studies of the exotic neutron-deficient nuclei will mainly require the use of reactions induced by intense radioactive heavy-ion beams as those provided by near-future facilities and in the future by Eurisol. This will allow an unprecedented study of the heaviest N = Z nuclei located even further from the line of beta stability. In this presentation, the isospin symmetry
and the proton-neutron correlations will be discussed with special attention to the perspectives offered by the new radioactive-ion beam facilities.
1. M.A. Bentley and S.M. Lenzi, Prog. Part. and Nucl. Phys. 59, 497 (2007).
2. R. Orlandi et al., Phys. Rev. Lett. 103, 052501 (2009).
3. K. Kaneko et al., Phys. Rev. C 82, 061301R (2010).
4. B. Cederwall et al., Nature 469 (2011).

Summary

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Presenter(s) : VALIENTE DOBON, J.J. (LNL-INFN)

Session Classification : Monday February 21st, 2011. 15:00 - 17:00

Contribution ID : **8** Type : **not specified**

Gamow-Teller Resonances in the beta decay and Charge-Exchange Reactions

Monday, 21 February 2011 15:40 (40)

Gamow-Teller (GT) transitions are caused by the most common weak interaction of spin-isospin ($\sigma\tau$) type with L = 0. Since spin and isospin are unique quantum numbers in nuclei, GT transitions represent very important nuclear response. GT transitions are studied by the β decay and charge-exchange (CE) reactions. The β decay has a direct access to the absolute GT transition strengths B(GT) from a study of half-lives, Q-values and branching ratios, but it can only access states at excitation energies lower than the decay Q-value. In contrast, the CE reactions, e.g. (3He,t) reaction, at intermediate beam energies and 0°, can selectively excite GT states up to high excitation energies in the final nucleus.
Although the study of GT strength in the β decay is restricted by the decay Q-value, unstable nuclei can have the Q-value of 12 MeV or larger, which, in principle allows the study of the central part of the GTR where the GT strength is concentrated. Possibility of observing GTR structures in β-decay studies will be discussed on the basis of the GTR studies by (3He,t) reactions assuming a good isospin symmetry of nuclear structure and transitions.

Summary

Primary author(s) : FUJITA, Yoshitaka (Department of Physics, Osaka University)

Presenter(s) : FUJITA, Yoshitaka (Department of Physics, Osaka University)

Session Classification : Monday February 21st, 2011. 15:00 - 17:00

Contribution ID : **9** Type : **not specified**

Superallowed Fermi decays: precise T1/2 and branching ratios measurements

Monday, 21 February 2011 16:20 (40)

Through the studies of Fermi transitions between 0+ analog states with T = 1 (superallowed transitions), nuclear physics provides a valuable test of the Standard Model of particle physics. These transitions depend only on the vector part of the weak interaction, and according to the conserved vector current (CVC) hypothesis, their strength Ft is a constant. Then this value is used to determine the Vud term in the CKM quark mixing matrix, that should be unitary.
The constant Ft strength determination requires very high precision measurement of the decay energy QEC (related to masses) and of the partial half-life of the transition (parent nucleus half-life T1/2 and branching ratio BR), but it also requires some theoretical corrections of the experimental values. Then, beside the search for "new physics" if deviations from the standard model are observed, such studies are a very sensitive test of the theoretical descriptions used to calculate those corrections.
In this presentation, I will give a general view of the landscape of nuclei of interest for those studies, with a focus on recent experimental results concerning the T1/2 and BR measurements that we performed at Jyväskylä university and ISOLDE at CERN : 26Si, 30S, 42Ti, 38Ca and 62Ga. These results have to be compared with other measurements that have been performed worldwide, showing the strong activity in this field. Finally, expectations and limitations for further studies will be addressed.

Summary

Primary author(s) : GIOVINAZZO, Jérôme (CENBG / IN2P3 / CNRS)

Presenter(s) : GIOVINAZZO, Jérôme (CENBG / IN2P3 / CNRS)

Session Classification : Monday February 21st, 2011. 15:00 - 17:00

Contribution ID : **10** Type : **not specified**

High Precision Q_EC Value Measurements of Superallowed beta decays

Monday, 21 February 2011 17:30 (40)

Precise measurements of beta decays between isobaric analog states of nuclear spin-parity 0+ and isospin T=1 provide important data for testing the electroweak interaction. These so-called superallowed beta decays provide the most precise value of V_ud, the up-down element of the Cabibbo-Kobayashi-Maskawa (CKM) quark-mixing matrix. The most stringent test of the CKM matrix is the top-row unitarity test, where V_ud contributes the most. Currently there are 13 superallowed transitions ranging from 10C to 74Rb that are determined accurately enough to contribute to the world average.

The three experimental quantities that are required to extract V_ud from a superallowed decay are the branching ratio (BR) of the superallowed 0+ to 0+ transition, the half-life (T_1/2) of the parent state and the decay energy (Q_EC). Additionally, a few theoretical correction terms are needed.

The JYFLTRAP Penning-trap setup at the University of Jyväskylä, Finland, has contributed to these studies mainly with high-precision Q-values. Since 2006, Q values of 15 different superallowed transitions, ranging from 10C to 62Ga, have been determined with high precision. Since JYFLTRAP is coupled to the IGISOL mass separator, any element is available. Simultaneus production enabled us to determine a Q_EC value by measuring the frequency ratio of the parent and daughter ions directly. Using this so-called doublet technique and utilizing state-of-the art methods, such as ion-motion excitation with time-separated oscillatory fields, we have reached precisions down to the 50-eV level.

In this contribution, the results and impact of the Q-value measurement program at JYFLTRAP will be presented.

Summary

Primary author(s) : ERONEN, Tommi (University of Jyväskylä)

Presenter(s) : ERONEN, Tommi (University of Jyväskylä)

Session Classification : Monday February 21st, 2011. 17:30 - 19:00

Contribution ID : **11** Type : **not specified**

Rp-process

Tuesday, 22 February 2011 09:00 (40)

Summary

Co-author(s) : MONTES, Fernando (NSCL)

Presenter(s) : MONTES, Fernando (NSCL)

Session Classification : Tuesday February 22nd, 2011. 9:00 - 10:20

Contribution ID : **12** Type : **not specified**

Explosive hydrogen burning studied with RIB

Tuesday, 22 February 2011 09:40 (40)

With the perspectiveof the development of new intense radioactive beams oflight proton-rich nuclei, I propose to go through several examples of experiments that can be performed and their astrophysical motivations(X-ray bursts, novae, gamma ray astronomy, meteorites). The important point is that direct measurement of nuclear reaction cross sections is certainly the most ambitious goal and the most necessary. Some alternative mechanisms of reaction, as the radiative capture of two protons, and exotic as the (p,gamma) reaction producing an unbound nucleus,will also be discussed.

Summary

Primary author(s) : OLIVEIRA, Francois (GANIL)

Presenter(s) : OLIVEIRA, Francois (GANIL)

Session Classification : Tuesday February 22nd, 2011. 9:00 - 10:20

Contribution ID : **13** Type : **not specified**

Aluminum-26 nucleosynthesis with proton-rich exotic beams

Tuesday, 22 February 2011 11:00 (40)

The goal of understanding the production of galactic Al-26 brings together progress in nuclear astrophysics from observations, theory, meteoritics, and laboratory experiments. In the case of experimental work, nuclear reactions involving unstable isotopes are being studied to elucidate the production of Al-26 in stellar explosive nucleosynthesis. This talk will discuss recent experiments carried out by our McMaster group to study such reactions with proton-rich radioactive ion beams at various laboratories worldwide (e.g., TRIUMF-ISAC, NSCL and CNS at RIKEN); in the process, it will also provide a survey of some of the different techniques currently used in laboratory experiments on the origin of the elements.

Summary

Primary author(s) : CHEN, Alan (Department of Physics and Astronomy, McMaster University)

Presenter(s) : CHEN, Alan (Department of Physics and Astronomy, McMaster University)

Session Classification : Tuesday February 22nd, 2011. 11:00 - 13:00

Contribution ID : **14** Type : **not specified**

Studies of neutron-deficient nuclei with breakup reactions

Tuesday, 22 February 2011 11:40 (40)

A short review of theoretical descriptions for breakup reactions of neutron-deficient nuclei and, in particular, the breakup of weakly bound light nuclei. They include measurements of proton-removal cross sections, longitudinal momentum distributions of core fragments, extraction of spectroscopic factors from measurements of knock-out reactions, extraction of nuclear dipole response and of radiative capture reactions of astrophysical interest.

Summary

Primary author(s) : BERTULANI, Carlos (Texas A&M University-Commerce)

Presenter(s) : BERTULANI, Carlos (Texas A&M University-Commerce)

Session Classification : Tuesday February 22nd, 2011. 11:00 - 13:00

Contribution ID : **15** Type : **not specified**

Exotic modes of excitations in neutron-deficient nuclei

Tuesday, 22 February 2011 12:20 (40)

The evolution of low-energy isoscalar and isovector dipole strength in neutron-deficient nuclei is analyzed in a fully consistent mean-field plus QRPA framework. Model calculations performed for a series of proton-rich nuclei between Z=18 and Z=28, predict the occurrence of isoscalar low-energy dipole transitions (IS-LED)
and, closer to the proton drip line, of proton pygmy dipole resonances.

Summary

Primary author(s) : VRETENAR, Dario (Physics Department, University of Zagreb)

Presenter(s) : VRETENAR, Dario (Physics Department, University of Zagreb)

Session Classification : Tuesday February 22nd, 2011. 11:00 - 13:00

Contribution ID : **16** Type : **not specified**

Spectroscopy of N~Z Nuclei: 100Sn and Neighbours

Tuesday, 22 February 2011 15:00 (40)

We have produced 100Sn and nuclei in its neighbourhood by fragmentation of 124Xe ions from the SIS at GSI, Darmstadt. The fragments of interest were separated and identified in the FRS. In addition to 259 nuclei of 100Sn we observed for the first time the N=Z-1 nuclei 93Ag, 95Cd, 97In and 99Sn. Because of the reduced yield of 103Sb we conclude that proton radioactivity with a half life below 100ns is its dominant decay channel. The fragments were stopped in a stack of DSSDs for the correlation of implantation with subsequent decays. Ten Si detectors in front and behind this implantation zone served as calorimeter for betas. The implantation detector was surrounded by the 105 Ge detectors of the RISING array. A number of isomeric states was observed. In 102Sn we find a new isomeric gamma-line which we attribute to the 6+-4+ transition. In 98Cd we also observe an unknown transition, shedding light on core excited states. For the decay of 100Sn we deduce a precise value of the half-life and of the decay energy to the lowest 1+ state in 100In. That gives us the GT strength of the decay which is the largest ever seen. For the first time we observe the gamma-cascade depopulating that 1+ state. It appears that the description of 100Sn and 100In in the truncated model space for protons (p1/2, g9/2) and neutrons (d5/2, g7/2, d3/2, s1/2, h11/2) works remarkably well.

Summary

Primary author(s) : FAESTERMANN, Thomas (Physics Dept., T U München)

Presenter(s) : FAESTERMANN, Thomas (Physics Dept., T U München)

Session Classification : Tuesday February 22nd, 2011. 15:00 - 17:00

Contribution ID : **17** Type : **not specified**

Studies in the 100Sn region with radioactive Beams

Tuesday, 22 February 2011 15:40 (40)

The higher intensities at EURISOL will make several new isotopes in the 100sn region available for studies. In particular it should be possible to study the migration of single particle orbits as 101Sn is approached. The
presentation will focus on the use of transfer reactions as probe of the single particle structure in this region and will also discuss some experiments related to the spin orbit force.

Summary

Primary author(s) : CEDERKALL, Joakim (Lund University)

Presenter(s) : CEDERKALL, Joakim (Lund University)

Session Classification : Tuesday February 22nd, 2011. 15:00 - 17:00

Contribution ID : **18** Type : **not specified**

Spectroscopic methods for the heaviest nuclei

Tuesday, 22 February 2011 16:20 (40)

A growing number of experiments is currently opening up the transfermium region of nuclei for detailed spectroscopic investigations [1,2]. In the deformed nuclei in the nobelium region this allows an identification and mapping of single particle orbitals closest to the top end of the nuclear chart.

Initial in-beam measurements in the region focussed on γ-ray spectroscopy of even-even nuclei (e.g. 252,254No, 250Fm), studying the ground-state yrast bands and allowing extraction of parameters such as the moments of inertia, and proving the deformed nature of these nuclei. More recently, attention has switched to odd-mass nuclei such as 253No, 251Md and 255Lr, the latter being the heaviest nucleus so far studied in-beam. Rotational bands have been observed in all these nuclei. Non-yrast and K-isomeric states have recently been observed in 252,254No and 250Fm through the use of both in-beam and focal plane decay spectroscopy. The studies employed a calorimetric technique, whereby the summed energy from a cascade of conversion electrons is detected in a DSSSD detector and used as a "tag" for γ-rays detected in the various germanium detectors. These experiments have yielded data which can be used to determine the excitation energies and configurations of two-quasiparticle states in the region, and compared to the predictions of various theories. These comparisons show that reasonable agreement is obtained with Woods-Saxon approaches but discrepancies are observed with the predictions of HFB calculations with SLy4 or Gogny interactions. Such observations highlight the need for such detailed spectroscopic data in order to improve the interactions used in these modern approaches.

An overview of the most recent results and the experimental techniques used will be presented and new experimental developments such as the SAGE spectrometer coming online in Jyväskylä and the new TASISpec setup at will be discussed.

- This work is supported by the UK STFC.

[1] R-D Herzberg, J. Phys. G 30, R123 (2004).
[2] R.-D. Herzberg, P.T. Greenlees, Prog. Part. Nucl. Phys. 61, 674 (2008).

Summary

Co-author(s) : HERZBERG, Rolf-Dietmar (University of Liverpool)

Presenter(s) : HERZBERG, Rolf-Dietmar (University of Liverpool)

Session Classification : Tuesday February 22nd, 2011. 15:00 - 17:00

Contribution ID : **19** Type : **not specified**

Fundamental research using the high intensity proton beams of MYRRHA at SCK•CEN

Tuesday, 22 February 2011 17:30 (25)

Since 1995, SCK•CEN has been studying the coupling of a proton accelerator, a liquid Lead-Bismuth spallation target and a Lead-Bismuth cooled, sub-critical fast reactor core. The project, since 1998 named MYRRHA, has evolved to a larger installation, able to work in subcritical mode (as an Accelerator Driven System) and in critical mode.

Apart from the experimental and irradiation possibilities in the subcritical reactor, the MYRRHA proton accelerator on its own can be used as a supply of proton beams for a number of experiments. In order to explore new research opportunities offered by the accelerator, a pre-study was carried out within the framework of the "Belgian Research Initiative on eXotic nuclei" (BriX) network of the Interuniversity Attraction Poles Programme of the Belgian State. This study was investigating unique possibilities for fundamental research using high-intensity proton beams with a fraction of the full beam during ADS operation (up to 200 μA).

An interesting approach for fundamental research using the 600-MeV proton accelerator is the installation of an Isotope Separator On-Line (ISOL@MYRRHA) facility with a ruggedized target-ion source system, which is able to provide intense low-energy Radioactive Ion Beams (RIB) for experiments requiring very long beam times (up to several months). This opens unique opportunities for RIB research in various scientific fields, which is complementary with the activities at other existing and future facilities.

MYRRHA is foreseen to be in full operation by 2024 and it will be operated in the first years as an ADS. In a second phase, when the MYRRHA reactor will run as a stand-alone critical reactor, the full proton-beam intensity might be used for ISOL@MYRRHA or other applications.

This presentation will introduce the MYRRHA and ISOL@MYRRHA facilities, the physics that can be uniquely addressed at ISOL@MYRRHA, the present status of the project and future plans.

Summary

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Presenter(s) : POPESCU, Lucia (SCK•CEN)

Session Classification : Tuesday February 22nd, 2011. 17:30 - 19:10

Contribution ID : **20** Type : **not specified**

Selective sensitivity of proton scattering to densities on the nuclear surface

Tuesday, 22 February 2011 17:55 (25)

Microscopic descriptions of nucleon scattering from nuclei depend on the matter distribution of their neutron and proton constituents. Additionally, the different behaviour of density-dependent effective
interactions in the pp and pn channels offer a selective mechanism by which proton probes couple to the proton and neutron densities of the nucleus. Recent formal studies of the optical model potential have
demonstrated the surface contributions to the optical potential depend on the gradient of the density-dependent effective interaction, and that proton probes couple strongly to the neutron than to the proton
density. These properties poses limits the sensitivity of proton scattering to the matter distribution of proton-rich nuclei. We illustrate these findings with selected applications.

Summary

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Presenter(s) : ARELLANO, Hugo (Physics Department - FCFM - U Chile)

Session Classification : Tuesday February 22nd, 2011. 17:30 - 19:10

Contribution ID : **21** Type : **not specified**

The FARCOS Project - A Femtoscope ARray for COrrelations and Spectroscopy

Tuesday, 22 February 2011 18:20 (25)

Correlations between two or more particles emitted during a nuclear reaction provide tools to study time properties of the reaction and can be used as well to explore spectroscopic properties of exotic clusters. With the aim of studying two- and multi-particle correlation functions the FARCOS project (Femtoscope ARray for COrrelations and Spectroscopy) has been conceived as an array of double sided silicon strip detectors and CsI(Tl) crystals characterized by high angular and energy resolution. The array will address topics covering both nuclear dynamics and spectroscopy with stable and radioactive beams.

The array will address the study of correlation measurements in nuclear dynamics with the use of high resolution imaging techniques providing sort of "space-time" snapshots of particle and complex fragments emitting sources. These "space-time images" will be shown to probe the N/Z degree of freedom in nuclear reactions, providing important probes of the sub-saturation density dependence of symmetry energy.

In the very same collision events, several exotic nuclear fragments are produced. Most of them are unbound and can be studied by means of two- and multi-particle coincidence measurements. These measurements reveal the existence of resonances and provide important spectroscopic information on the explored unbound states such as their spin and their branching ratios with respect to specific and new decay channels.

The high resolution that is planned to be available with the Farcos array will allow performing important studies of exotic decay channels by means of the complete reconstruction of their final momentum vectors. These studies can also provide important information about the formation and decay of special cluster states in stable and exotic nuclei. Examples of applications in the decay of unbound states in 10C, 12C and other light nuclei will be shown and the perspectives offered by Farcos will be stressed.

An important aspect of Farcos will be represented by its pulse-shaping capabilities that will allow the detection and identification of particles and fragments moving at low energies and stopped in the first layer of the silicon strip detector. These pulse-shape techniques will be of fundamental importance in order to study particle correlations even in low energy reactions. The electronics under development will play a special attention to new technologies in generic and integrated electronics.

The modularity of FARCOS will allow coupling it to other devices such as 4π detectors and magnetic spectrometers. The possibility of coupling to neutron detector arrays to perform high resolution proton-neutron correlation measurements is also under consideration.

The Farcos project aims at providing important perspectives for studies at the future European radioactive beams facilities such as Spiral2, Spes and Eurisol, both in the field of nuclear dynamics and spectroscopy.

Summary

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Presenter(s) : VERDE, Giuseppe (INFN, Sezione di Catania)

Session Classification : Tuesday February 22nd, 2011. 17:30 - 19:10

Contribution ID : **22** Type : **not specified**

Symmetries in proton-rich nuclei seen through ground-state properties

Tuesday, 22 February 2011 18:45 (25)

Light proton-rich nuclei are valuable objects to study various symmetries in nuclear systems: fundamental symmetries with superallowed decays, proton-neutron isospin symmetry, or shapes, i.e. the geometrical symmetry.
Ground-state property measurements, such as these performed at ISOLDE with laser spectroscopy and Penning-trap mass spectrometry, contribute to this topic. In this contribution I will present recent investigations using the COLLAPS and ISOLTRAP setups which cover masses, moments, and charge radii of proton-rich Ne, Mg, and K isotopes.
Symmetries are addressed in multiple ways: Magnetic moments of 21Mg and 17Ne allow studying the isospin symmetry. Charge radii of both isotopic chains reveal a wealth of geometrical phenomena, from proton halos to alpha-clustering, when adding only a few neutrons. The mass of 35K gives evidence for a breakdown of the isobaric multiplet mass equation and the precise mass of 22Mg contributes to the determination of the Vud matrix element.

Summary

Primary author(s) : KOWALSKA, Magdalena (CERN)

Presenter(s) : KOWALSKA, Magdalena (CERN)

Session Classification : Tuesday February 22nd, 2011. 17:30 - 19:10

Contribution ID : **23** Type : **not specified**

Shape coexistence in heavy nuclei

Wednesday, 23 February 2011 09:00 (40)

A remarkable feature of the atomic nucleus is its ability to take on different mean-field shapes for a small cost in energy. Since this phenomenon is a strong challenge to state-of-the-art theory, experimental data can provide a discriminating test of competing models. A strong focus for explorations of nuclear shape coexistence in recent years has been the region around the light lead nuclei. Both prolate and oblate shape minima are found to compete favourably with the spherical ground state. The prolate minimum reaches its lowest energy around the neutron mid-shell (N=104) and this trend has has been recently confirmed with the observation for the first time of excited states in the extremely exotic nucleus, 180Pb. These results will be presented.

Increasingly, the focus has shifted to measurement of matrix elements which can impose even more stringent tests of nuclear models. Very recently, the scope for extracting matrix elements has been opened up at REX-ISOLDE where accelerated ISOL beams of very heavy proton-rich nuclei are uniquely available. Coulomb excitation can be used to extract both transition and diagonal matrix elements; the latter giving information on the sign of the nuclear deformation. Recent results on Coulomb excitation of the light mercury and radon will be presented. This work has been complemented with experiments to obtain independent information on transition matrix elements using plunger lifetime measurements. Studies of excited states in the light radon and mercury nuclei have also been carried out using the novel SAGE spectrometer at the University of Jyvaskyla, where conversion electrons can be detected in coincidence with gamma rays. This approach can be used to search for E0 transitions and E0 components of J-J transitions which are an important further insight into shape coexistence in these nuclei. Preliminary data from both the plunger and SAGE measurements will be presented.

In the future, the HIE-ISOLDE facility at CERN will provide accelerated beams of heavy neutron-deficient nuclei up to 10 MeV/u. This will allow multi-step Coulomb excitation as well as the opportunity to probe the shape coexistence in still further detail by means of transfer reactions. An outline of these possibilities will be given.

The work to be presented represents the contribution of many individuals and groups from the MINIBALL/REX-ISOLDE collaboration and the SAGE/JYFL collaboration.

Summary

Co-author(s) : JENKINS, D. (York University)

Presenter(s) : JENKINS, D. (York University)

Session Classification : Wednesday February 23rd, 2011. 9:00 - 11:00

Contribution ID : **24** Type : **not specified**

Shape effects and beta decay: what can we learn from TAS measurements

Wednesday, 23 February 2011 09:40 (40)

Beta decay experiments are an important source of nuclear structure information. In this presentation we will
show examples of what can be learned from total absorption measurements in beta decay. In particular, special emphasis will be devoted to studies of shape effects and shape coexistence. Recent results obtained in the Pb region and future plans will be discussed.

Summary

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Presenter(s) : ALGORA, Alejandro (IFIC (CSIC-Univ. Valencia))

Session Classification : Wednesday February 23rd, 2011. 9:00 - 11:00

Contribution ID : **25** Type : **not specified**

np pairing in N=Z nuclei studied through 2N transfer reactions

Wednesday, 23 February 2011 10:20 (40)

Pairing in exotic nuclei is a subject of active research in nuclear physics. Of particular interest is the competition between isovector (T=1) and isoscalar (T=0) Cooper pairs, expected to occur in N=Z nuclei .

Near 40Ca and 56Ni, earlier systematic analyses of two-neutron (L=0) transfer reactions [1,2] found the data consistent with a picture involving configuration mixing induced by simple pairing degrees of freedom of the valence neutrons. While providing evidence for isovector pairing in the form of pairing vibrations [2,3], the question of whether the isoscalar component generates collective modes is still an open one.

Direct reactions involving the transfer of an np pair from even-even to the low lying 0+,1+ states in odd-odd self conjugate nuclei could be excellent probes to study np correlations. While absolute cross-section values are always desirable, we note that the ratio $\sigma(0+)/\sigma(1+)$ itself provides an almost model independent measure of the pairing collectivity in the respective channels. Thus, the (3He,p) reaction stands out as an ideal tool to study np correlations.

Following a short overview of the subject, we will discuss a series of experiments carried out at the Argonne ATLAS facility to study the (3He,p) reaction in reverse kinematics and present results obtained with a beam of 44Ti [4].

We will also speculate on the use of np knockout reactions and conclude by delineating a possible path as we move towards the next generation of rare isotopes facilities.

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Summary

Co-author(s) : MACCHIAVELLI, Augusto (Lawrence Berkeley National Laboratory)

Presenter(s) : MACCHIAVELLI, Augusto (Lawrence Berkeley National Laboratory)

Session Classification : Wednesday February 23rd, 2011. 9:00 - 11:00

Contribution ID : **26** Type : **not specified**

Aligned neutron-proton pairs in N=Z nuclei

Wednesday, 23 February 2011 11:40 (40)

It is shown that the aligned neutron-proton pair with angular momentum J=9 and isospin T=0 plays a central role in the low-energy spectroscopy of the N~Z nuclei approaching 100Sn. This observation is made in the context of the spherical shell model on the basis of several realistic two-nucleon interactions. Shell-model results are analyzed in terms of a variety of two-nucleon pairs corresponding to different choices of their coupled angular momentum J and isospin T. The analysis is performed exactly for four holes (96Cd) and carried further for six and eight holes (94Ag and 92Pd) by means of a mapping to an appropriate version of the interacting boson model.
On the basis of these results one concludes that a realistic model can be formulated in terms of s (with J=0) and b (i.e., aligned J=9) bosons. Due to its simplicity, such a model could be of use to elucidate the main structural features of N~Z nuclei in this mass region. Examples of simple predictions of such a model will be given.

Summary

Primary author(s) : VAN ISACKER, Piet (GANIL)

Presenter(s) : VAN ISACKER, Piet (GANIL)

Session Classification : Wednesday February 23rd, 2011. 11:40 - 14:00

Contribution ID : **27** Type : **not specified**

Beyond mean-field description of exotic structure and decay of proton-rich nuclei in A near 70 region

Wednesday, 23 February 2011 12:20 (40)

The interest for the investigation of the proton-rich medium mass nuclei exceeds the frontier of nuclear
structure and dynamics. Apart from displaying some rather interesting nuclear structure effects, the
superallowed $0+ \longrightarrow 0+$ Fermi β decay of these nuclei is a valuable tool in probing many properties of the
weak interaction. Nuclei at or near the N=Z line are of particular interest as micro-laboratory for high
precision tests of the Standard Model. The isospin symmetry breaking is also responsible for the mirror
energy differences induced by electromagnetic and charge-dependent strong interactions. Anomalies have
been experimentally identified in the excitation energy of the analog states in the A□70 mass region.
The properties of these nuclei are important for the rp process and the understanding of the nucleosynthesis. The simulation of many astrophysical objects requires the knowledge of properties and decay rates
of nuclei near the proton drip line. Relevant for the Gamow-Teller (GT) beta decay of the waiting point
nuclei could be the GT strength distributions for the low-lying excited states whose thermal population
may result in a significant reduction of the effective lifetime at the high temperatures of X-ray bursts.
Shape coexistence and mixing, isospin mixing, significant neutron-proton pairing correlations competing
with the like-nucleon ones, and competition between proton and neutron alignment have been identified
as the main characteristic features of nuclei near the N=Z line in the A□70 mass region. The self-consistent treatment of exotic phenomena dominated by their interplay represents a challenge for the
nuclear many-body models. Presently, the realistic description of tiny effects in this mass region aiming
to testing the fundamental interactions and symmetries as well as the required theoretical predictions
concerning the nuclear properties relevant for astrophysical scenarios are still open problems. We shall
present a self-consistent description of coexistence phenomena in the A□70 region within the beyond
mean-field complex Excited Vampir variational approach using realistic effective interactions in large

model spaces and the mentioned problems will be illustrated.

Summary

Primary author(s) : PETROVICI, Alexandra (National Institute for Physics and Nuclear Engineering)

Presenter(s) : PETROVICI, Alexandra (National Institute for Physics and Nuclear Engineering)

Session Classification : Wednesday February 23rd, 2011. 11:40 - 14:00

Contribution ID : **28** Type : **not specified**

Alpha clusters

Wednesday, 23 February 2011 13:00 (40)

The talk will examine the possible influence of clustering correlations on the structure of light proton-rich (neutron-deficient) nuclei and how the properties of such systems will be different to those on the neutron-rich side of stability. This discussion will be motivated by the presentation of previous measurements.

Summary

Primary author(s) : FREER, Martin

Presenter(s) : FREER, Martin

Session Classification : Wednesday February 23rd, 2011. 11:40 - 14:00

Contribution ID : **29** Type : **not specified**

Eurisol update

Monday, 21 February 2011 09:20 (30)

Summary

Presenter(s) : BLUMENFELD, Yorick (CERN)

Session Classification : Monday February 21st, 2011. 9:00 - 10:30

Contribution ID : **30** Type : **not specified**

Registration

Monday, 21 February 2011 08:30 (30)

Summary

Contribution ID : **31** Type : **not specified**

Concluding remarks

Wednesday, 23 February 2011 13:40 (20)

Summary

Presenter(s) : BONACCORSO, Angela (INFN, Sez. di Pisa)

Session Classification : Wednesday February 23rd, 2011. 11:40 - 14:00