

**Ecole Thématique PhyNuBE :
Première rencontre de
Physique Nucléaire de Basse
Energie 2021**

**Rapport sur les
contributions**

ID de Contribution: 1

Type: **Non spécifié**

Breaking of mirror symmetries, 2p clusters in the Ikeda conjecture and possible astrophysical implications

lundi 6 décembre 2021 09:00 (45 minutes)

Orateur: DE OLIVIERA , Francois (GANIL, France)

Classification de Session: Structure and dynamic of weakly bound systems

ID de Contribution: 2

Type: **Non spécifié**

Study of alpha clusters in KO experiments

lundi 6 décembre 2021 10:30 (45 minutes)

Orateur: BEAUMEL, Didier (IJCLab, France)

Classification de Session: Structure and dynamic of weakly bound systems

ID de Contribution: 3

Type: **Non spécifié**

Alpha clustering and quasi-molecular states at thresholds

lundi 6 décembre 2021 09:45 (45 minutes)

Orateur: EBRAN, Jean Paul (CEA-DAM, France)

Classification de Session: Structure and dynamic of weakly bound systems

ID de Contribution: 4

Type: **Non spécifié**

Communication Workshop

lundi 6 décembre 2021 15:00 (1h 30m)

The objective of this workshop goes beyond my thesis in 180 sec!

It will provide the most important skills that are imperative when presenting your work as a young scientist.

In other words, the tips that can help you succeed.

Orateur: CHEVRIER, Raphael (Arianespace, France)

Classification de Session: Workshop session

ID de Contribution: 5

Type: **Non spécifié**

Pairing in nuclei: some experimental aspects

mardi 7 décembre 2021 09:00 (45 minutes)

Orateur: DE FRANCE, Gilles (GANIL, France)

Classification de Session: Nuclear shapes at the extremes

ID de Contribution: 6

Type: **Non spécifié**

Electromagnetic transitions, lifetime measurements and the Plunger technique

mardi 7 décembre 2021 09:45 (45 minutes)

Orateur: LJUNGVALL, Joa (IJCLab, France)

Classification de Session: Nuclear shapes at the extremes

ID de Contribution: 7

Type: **Non spécifié**

Dynamical aspects of superfluid neutron stars

Orateur: ANTONELLI, Marco (LPC Caen, France)

Classification de Session: Nuclear shapes at the extremes

ID de Contribution: **8**

Type: **Non spécifié**

Introduction to theory and related challenges

mercredi 8 décembre 2021 09:00 (1 heure)

Orateur: TICHAI, Alexandre (IKP Darmstadt, Germany)

Classification de Session: What are the new frontiers in the microscopic description of nuclei

ID de Contribution: 9

Type: **Non spécifié**

Short contributions of PhD students and postdocs

Orateurs: CONTESSI, Lorenzo; SANCHEZ, Mario; LASSERI, Raphael

Classification de Session: What are the new frontiers in the microscopic description of nuclei

ID de Contribution: **10**

Type: **Non spécifié**

Nuclear and astrophysics aspects of the r-process nucleosynthesis

jeudi 9 décembre 2021 09:00 (1h 30m)

Orateur: GORIELY, Stephane (IAA-ULB, Belgium)

Classification de Session: Understanding astrophysics in the framework of nuclear physics

ID de Contribution: 11

Type: **Non spécifié**

Neutron stars observation

jeudi 9 décembre 2021 10:30 (45 minutes)

Orateur: GUILLOT, Sebastien (IRAP Toulouse, France)

Classification de Session: Understanding astrophysics in the framework of nuclear physics

ID de Contribution: 12

Type: **Non spécifié**

Parallel Computing

Orateurs: ROY, Fabrice (IAS, Meudon); LAFAGE, Vincent (IJCLab, Orsay)

Classification de Session: Workshop session

ID de Contribution: 13

Type: **Non spécifié**

Good computing practices for physicists and PhD students

vendredi 10 décembre 2021 09:00 (1h 15m)

Orateur: LAFAGE, Vincent (IJCLab, France)

Classification de Session: Instrumentation, computing and general R&D

ID de Contribution: 14

Type: **Non spécifié**

PhD student and post-doc contributions: Please submit your abstract!

Classification de Session: Instrumentation, computing and general R&D

ID de Contribution: 15

Type: **Non spécifié**

Skills workshop

mardi 7 décembre 2021 14:30 (1 heure)

Embarking on a PhD provides many opportunities for personal and professional development beyond scientific research!

This workshop aims to provide guidance and tips on harnessing these resources to build a well-rounded CV and increase your chances of getting hired after your PhD for example.

Orateur: GAURON, Philippe (IJCLab, France)

Classification de Session: Workshop session

ID de Contribution: 16

Type: **Non spécifié**

The effect of the energy functional on the pasta-phase properties of catalysed neutron stars

Nuclear pasta, that is, an inhomogeneous distribution of nuclear matter characterised by non-spherical clustered structures, is expected to occur in a narrow spatial region at the bottom of the inner crust of neutron stars, but the width of the pasta layer is strongly model-dependent. In the framework of a compressible liquid-drop model, we use Bayesian inference to analyze the constraints on the sub-saturation energy functional and surface tension imposed by both ab-initio chiral perturbation theory calculations and experimental measurements of nuclear masses. The posterior models are used to obtain general predictions for the crust-pasta and pasta-core transition with controlled uncertainties. A correlation study allows extracting the most influential parameters for the calculation of the pasta phases. The important role of high-order empirical parameters and the surface tension is underlined.

Auteur principal: DINH THI, Hoa (LPC Caen)

Co-auteurs: FANTINA, Anthea Francesca (CNRS/UPR3266); GULMINELLI, Francesca (LPC/Ensicaen)

Orateur: DINH THI, Hoa (LPC Caen)

ID de Contribution: 17

Type: Non spécifié

Understand ^{22}Na cosmic abundance by measuring lifetimes in $^{23}\text{Mg}^*$

Simulations of novae explosive nucleosynthesis predict the production of the radionuclide ^{22}Na . Its half life of 2.6 yr makes it a very interesting astronomical observable by allowing space and time correlations with the astrophysical object. This radionuclide should bring constraints on nova models. It may also help to explain abnormal ^{22}Ne abundance observed in presolar grains and in cosmic rays. Its gamma-ray line at 1.275 MeV has not been observed yet by the gamma-ray space observatories. Hence accurate yields of ^{22}Na are required. Within the novae thermal range, the main destruction reaction $^{22}\text{Na}(p,\gamma)^{23}\text{Mg}$ has been found dominated by a resonance at $E_R = 0.213$ MeV corresponding to the $E_x = 7.786$ MeV excited state in ^{23}Mg . However the measured strengths of this resonance are in disagreement [1, 2].

An experiment was performed at GANIL facility to measure the lifetime of the key state at $E_x = 7.786$ MeV. The principle of the experiment is similar to the one used in [3]. With a beam energy of 4.6 MeV/u, the reaction $^3\text{He}(^{24}\text{Mg},\alpha)^{23}\text{Mg}^*$ populated the state of interest. This reaction was tagged with particle detectors (spectrometer VAMOS++, silicon detector SPIDER) and gamma tracking spectrometer AGATA. The state of interest decays either by gamma deexcitation or proton emission. The expected time resolution with AGATA high space and energy resolutions is 1~fs. Several Doppler based methods were used to analyse the lineshape of gamma peaks.

Preliminary results will be presented. Ejectiles, protons and ^4He , were identified with SPIDER and VAMOS in order to reconstruct the excitation energies in ^{23}Mg . Doppler shifted gamma-ray spectra from ^{23}Mg states were improved by imposing coincidences with the ^4He ejectile energies measured with VAMOS. It ensured to suppress feeding from higher states. Lifetimes in ^{23}Mg were measured with a new approach. Proton emitted from unbound levels in ^{23}Mg were also identified. With an higher precision on the lifetime of the $E_x = 7.786$ MeV state and the branching ratio measured in [4], a new value of $^{22}\text{Na}(p,\gamma)^{23}\text{Mg}$ resonance strength $\omega\gamma$ was obtained. The impact of the new thermonuclear $^{22}\text{Na}(p,\gamma)^{23}\text{Mg}$ rate on the predicted ^{22}Na production will be discussed.

References

- [1] A.L. Sallaska *et al.*, Phys. Rev. Let. **105**, 152501 (2010).
- [2] F. Stegmüller *et al.*, Nuc. Phy. A **601**, 168-180 (1996).
- [3] O.S. Kirsebom *et al.*, Phys. Rev. C **93**, 025802 (2016).
- [4] M. Friedman *et al.*, Phys. Rev. C **101**, 052802(R) (2020).

Auteur principal: Mlle FOUGÈRES, Chloé (GANIL CEA/DRF - CNRS/IN2P3)

Orateur: Mlle FOUGÈRES, Chloé (GANIL CEA/DRF - CNRS/IN2P3)

ID de Contribution: 18

Type: Non spécifié

Bogoliubov coupled cluster theory for open-shell nuclei

The objective of the so-called ab initio approach to nuclear structure is to provide an accurate and universal description of nuclear systems from first principles [1]. In this context, solving the many-body Schrödinger equation requires systematically improvable many-body methods. Over the past 20 years, the development of novel expansion methods displaying a mild computational scaling with systems size have allowed access to mid-mass closed-shell nuclei. Such methods typically expand the exact ground-state wave-function around a reference/unperturbed Slater determinant and include correlations through elementary particle-hole excitations. This can be obtained from perturbative techniques [2] or from non-perturbative approaches such as coupled-cluster (CC) theory [3]. While closed-shell nuclei are well under control, the extension to open-shell nuclei remains a major challenge.

Only very recently, a novel many-body method coined as Bogoliubov coupled cluster (BCC) theory [4] has been formulated that extends the standard coupled cluster scheme to singly open-shell nuclei. This is achieved by breaking particle-number symmetry of the unperturbed state as a way to already incorporate crucial static correlations into it. In my talk I will present recent results obtained for the ground-state of oxygen isotopes based on nuclear interaction models derived from chiral effective field theory.

Once fully implemented, the non-perturbative (equation-of-motion) BCC method will allow for high-precision ab initio calculations of ground and excited states in medium-mass nuclei.

[1] H. Hergert, *Front. Phys.* 8, 379 (2020)

[2] A. Tichai, R. Roth, T. Duguet, *Front Phys.* 8, 164 (2020)

[3] G. Hagen, T. Papenbrock, M. Hjort-Jensen, D. J. Dean, *Rep. Prog. Phys.* 77, 9 (2014)

[4] A. Signoracci, T. Duguet, G. Hagen, G. Jansen, *Phys. Rev. C* 91, 064320 (2015)

Auteur principal: DEMOL, Pepijn

Orateur: DEMOL, Pepijn

ID de Contribution: 19

Type: Non spécifié

Nuclear structure studies at the FIPPS instrument at ILL

The Fission Product Prompt gamma-ray spectrometer (FIPPS) is the new nuclear physics instrument at the *Institut Laue-Langevin* (ILL). FIPPS takes advantage of an intense pencil-like neutron beam (flux 10^8 n/s/cm²) for inducing neutron capture and neutron induced fission reactions and study the nuclear structure via high resolution gamma-ray spectroscopy. The array is composed by 8 Compton suppressed HPGe clover detectors. Ancillary devices are possible, as LaBr₃ detectors for fast timing measurements or additional clover detectors (from the IFIN-HH collaboration) to increase efficiency and granularity.

After a general introduction on the main features of the instrument, recent developments to improve the energy resolution and the sensitivity of the instrument for fission studies will be reported. In particular, the procedure and effects of the correction for the cross-talk among the crystals in a same clover will be reported.

The setup and results from the first test of a diamond-base active target for neutron induced fission will be reported. These results will be shown with the ones from the well-established scintillator-based active target used at FIPPS in recent campaigns. The use of a fission tag allows for an identification of transitions from weak branches and/or isotopes produced with small fission yields.

Finally, the recently developed GEANT4 simulation code will be presented, with particular focus on the angular correlation analysis with hybrid gamma-ray arrays and on the first simulations for the development of a plunger device for lifetime measurements in fission fragments.

Auteurs principaux: COLOMBI, Giacomo; MICHELAGNOLI, Caterina (ILL); DUDOUET, Jeremie (IP2I); LJUNGVALL, Joa (IJCLab, France); LEONI, Silvia (University of Milano and INFN Milano)

Orateur: COLOMBI, Giacomo

ID de Contribution: 20

Type: Non spécifié

Description of heavy nuclei within the Shell Model

The great challenge in the Shell Model framework is the diagonalization of the effective (generally two-body) Hamiltonian in the model space. Indeed, this is a huge task for open shell nuclei as the model space dimension grows combinatorially with the number of particles. I will present our recent development which allows to expand the applicability of the Shell Model into heavy nuclei by means of a generator coordinate method (GCM) based on constrained Hartree-Fock wave-functions after angular momentum projection. In particular, we have developed an efficient minimization technique that addresses the question of selecting relevant basis states in the GCM. Several applications in $N = Z$ heavy nuclei and in the Nobelium isotopes ($Z = 102$) will be presented.

Auteur principal: Dr DAO, Duy Duc (IPHC-Strasbourg)

Co-auteur: Dr NOWACKI, Frédéric (IPHC-Strasbourg)

Orateur: Dr DAO, Duy Duc (IPHC-Strasbourg)

ID de Contribution: 21

Type: Non spécifié

Ab-initio description of the monopole resonance in light- and medium-mass nuclei

Giant monopole resonances have a long-standing theoretical importance in nuclear structure. The interest resides notably in the so-called breathing mode that has been established as a standard observable to constrain the nuclear incompressibility. The Random Phase Approximation (RPA) within the frame of phenomenological Energy Density Functionals (EDF) has become the standard tool to address (monopole) giant resonances and extensive studies, mostly in doubly-closed-shell systems, have been performed throughout the years, including via the use of so-called sum rules. A proper study of collective excitations in the ab-initio context is, however, missing.

In this perspective, the first systematic ab-initio predictions of (giant) monopole resonances will be presented. Ab-initio Quasiparticle-RPA (QRPA) and Projected Generator Coordinate Method (P-GCM) calculations of monopole resonances are compared in light- and mid-mass closed- and open-shell nuclei, which allows in particular to investigate the role of superfluidity from an ab-initio standpoint.

Sum rules are also employed within both many-body schemes to characterize the fragmentation of the monopole strength. The study further focuses on the dependence of the results on the starting nuclear Hamiltonian derived within the frame of chiral effective field theory.

Monopole resonance represents, thus, the first step towards the investigation of higher multiplicities. Eventually, the mid-term goal to establish P-GCM as a new method to study resonances in the light- and medium-mass region of the nuclide chart will be discussed: interpretation and analysis of resonance data in lighter nuclei is a very demanding task on which ab-initio P-GCM could shed new promising light.

Auteur principal: PORRO, Andrea (CEA IRFU)

Orateur: PORRO, Andrea (CEA IRFU)

ID de Contribution: 22

Type: **Non spécifié**

Nuclear Shell Model Effective Interactions from Many-Body Perturbation Theory

The interacting shell model is a modern many-body method used in nuclear structure calculations. The basic idea of the model is that the eigenproblem for a microscopic Hamiltonian is solved by diagonalization of the Hamiltonian matrix in a spherically-symmetric many-body basis (for example, a harmonic oscillator basis). The basis dimension grows very rapidly with increasing atomic number A . For nuclei with $A > 18$, only a few valence nucleons can be treated as active particles interacting with each other in a truncated Hilbert space, consisted of one or two oscillator shells outside a closed-shell core. The interaction between valence nucleons in such a model space is an effective interaction and not a bare nucleon-nucleon interaction as between free nucleons anymore. When phenomenological effective interactions are used, the shell model is known to provide excellent description of excitation spectra and transitions at low energies, while to derive accurate microscopic effective interactions from the bare nucleon-nucleon potential is still a challenge. In this work we discuss the microscopic sd shell effective interactions derived from many-body perturbation theory, as well as compare the results with empirical interactions.

Auteur principal: M. LI, Zhen (Centre d'Etudes Nucléaires de Bordeaux-Gradignan)

Orateur: M. LI, Zhen (Centre d'Etudes Nucléaires de Bordeaux-Gradignan)

ID de Contribution: 23

Type: Non spécifié

Determining neutron-induced reaction cross sections through surrogate reactions at storage rings

Investigating the interactions of neutrons with unstable nuclei is crucial to our understanding of nuclear astrophysics as it sheds light on the stellar nucleosynthesis of heavy elements. Obtaining accurate cross section data for neutron-induced reactions on these nuclei presents major experimental challenges since both beam and target are radioactive. The NECTAR (NuclEAR reaCTIONS At storage Rings) project aims to solve this problem by using the surrogate-reaction method, where one may indirectly infer the neutron-induced cross sections of short-lived nuclei, in inverse kinematics. A heavy, radioactive nucleus in the beam is to interact with a light, stable nucleus in the target to produce the compound nucleus formed in the neutron-induced reaction of interest via an alternative or surrogate reaction such as transfer or inelastic scattering. This compound nucleus may decay by fission, neutron or gamma-ray emission, and the probabilities for these modes of decay are to be measured as a function of the excitation energy of the compound nucleus. This information is used to constrain model parameters and to inform more accurate predictions of neutron-induced reaction cross sections [1].

The heavy-ion storage rings at GSI/FAIR in Germany present an ideal laboratory for the development of the surrogate reaction method, which still suffers from various target-related issues. The sustained high beam quality, along with the use of an ultra-thin gas-jet target, makes it possible to measure excitation energies and decay probabilities with an unrivalled accuracy.

A first Proof-of-Principle experiment is to be performed during the first half of 2022 at the ESR storage ring facility. The $^{208}\text{Pb}(p,p')$ reaction will be investigated in inverse kinematics with an incident beam of ^{208}Pb at 30 AMeV. Target residues will be measured with a detector telescope inside the reaction chamber, in coincidence with beam residues using DSSSD detectors downstream after a dipole magnet, thus providing decay probabilities for both neutron and gamma-ray emission.

After this first pilot experiment, NECTAR will eventually move to the CRYRING facility at GSI/FAIR, where the detection setup will be supplemented with fission fragment detectors, thus enabling for fission, neutron and gamma-ray emission probabilities to be measured simultaneously for the first time at this facility.

This presentation will focus on the concept and technical development of NECTAR, as well as the preparation for these experiments at the storage rings of GSI/FAIR.

*This work has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (ERC-Advanced grant NECTAR, grant agreement No 884715).

[1] R. Pérez Sánchez, B. Jurado et al., Phys. Rev. Lett. 125 (2020) 122502.

Auteur principal: SWARTZ, Jacobus (Centre d'Etudes Nucleaires de Bordeaux Gradignan)

Co-auteurs: JURADO, Beatriz (IN2P3/CENBG); GRIESER, Manfred (Max-Planck Institut für Kernphysik, Heidelberg); PIBERNAT, Jérôme (CENBG); SGUAZZIN, Michele (CNRS); GLORIUS, Jan (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt); LITVINOV, Yuri (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt); THOMAS, Bertrand (Centre d'Etudes Nucleaires de Bordeaux Gradignan); BLAUM, Klaus (Max-Planck Institut für Kernphysik, Heidelberg); CHIRON, Thierry (Centre d'Etudes Nucleaires de Bordeaux Gradignan); ROCHE, Mathieu (Centre d'Etudes Nucleaires de Bordeaux Gradignan); ALFAURT, Philippe (Centre d'Etudes Nucleaires de Bordeaux Gradignan); MÉOT,

Vincent (CEA-DAM, Arpajon); ROIG, Olivier (CEA-DAM, Arpajon); REIFARTH, René (Goethe University Frankfurt)

Orateur: SWARTZ, Jacobus (Centre d'Etudes Nucleaires de Bordeaux Gradignan)

ID de Contribution: 24

Type: Non spécifié

Continuum coupling correction in Gamow Shell Model

Loosely bound nuclei are currently at the center of interest in nuclear physics in problems related to the limits of stability of nuclear matter and nucleosynthesis. Since nuclear properties are profoundly affected by environment of the many-body continuum representing scattering and decay channels, a simultaneous understanding of the structural and reaction aspects is crucial for understanding of short-lived nucleonic matter.

Attempts to reconcile the nuclear shell model with the reaction theory has led to the development of the shell model for open quantum systems, the Gamow Shell Model (GSM), which change the comprehension of many nuclear phenomena and offers new perspectives for nuclear structure and reaction studies. Recently, near threshold effects have been studied in the β^-p^+ decay of ^{11}Be using Shell Model Embedded in the Continuum (SMEC). The continuum-coupling induced collectivization of shell model eigenstates is also responsible for the appearance of clustering in near-threshold states.

In my presentation, I shall concentrate on the continuum-coupling energy correction calculated in GSM and, in particular, on its near-threshold behavior as a function of the angular momentum, charge, and number of valence nucleons.

Auteur principal: LINARES FERNANDEZ, Jose Pablo (GANIL)

Co-auteur: PLOSZAJCZAK, Marek (GANIL)

Orateur: LINARES FERNANDEZ, Jose Pablo (GANIL)

ID de Contribution: 25

Type: Non spécifié

Response of solar cells to heavy ions at energies close to 10 AMeV

Solar cells have been used for several decades to detect fission fragments up to 1 AMeV. In this energy range, they provide an energy resolution of 1-2%, a time resolution of a few ns and better radiation hardness than Si detectors. All these properties, together with their low cost and low sensitivity to light particles, make solar cells an appealing alternative to silicon detectors for the detection of heavy ions.

Since 2018 we have been investigating the possibility to use solar cells for the detection of heavy ions at energies above 1 AMeV. The first exploratory measurements were performed using ^{84}Kr and ^{129}Xe beams at 7-13 AMeV, and ^{238}U at 3.8 MeV at GANIL. These measurements provided us with interesting results in relation to both energy and time resolution, and they evidenced a stable response of the cells when irradiated with beam intensities up to thousands of pps for a few minutes. These results showed the great potential of solar cells to be used in radioactive ion beam facilities for experiments and beam monitoring [1].

In March 2021 we carried out another experiment at GANIL to further study the response of solar cells of different types and dimensions to a ^{84}Kr beam at 5, 10 and 15 AMeV. In this measurement it was possible to successfully study the evolution of the cell response as a function of the beam energy and perform long radiation resistance tests. Moreover, a Si detector was also irradiated under the same conditions, thus enabling for a direct comparison with the solar cells.

In this contribution we will present the experimental procedure and the main results of the conducted measurements.

References

[1] A. Henriques et al., Nucl. Instrum. Methods A 969 (2020) 163941.

Auteur principal: SGUAZZIN, Michele (CNRS)

Co-auteurs: THOMAS, Jean-Charles (Grand Accélérateur National d'Ions Lourds); PIBERNAT, Jérôme (CENBG); JURADO, Beatriz (IN2P3/CENBG); MICHAUD, Julien; SWARTZ, Jacobus (Centre Etudes Nucleaires de Bordeaux Gradignan); JACQUOT, B. (Grand Accélérateur National d'Ions Lourds (GANIL), Caen, France); GIOVINAZZO, Jérôme (CENBG CNRS / Univ. Bordeaux); THOMAS, Bertrand (IN2P3/CENBG); ALFAURT, Philippe (CENBG, Bordeaux, France); CHIRON, Thierry (CENBG, Bordeaux, France)

Orateur: SGUAZZIN, Michele (CNRS)

ID de Contribution: 26

Type: Non spécifié

Shapes of heavy and super-heavy atomic nuclei with Skyrme Energy Density Functionals

The mean-field, or Energy Density Functional (EDF), methods allow for the study of energies and shapes of all nuclei, but the lightest ones, throughout the mass-table. These approach and their extensions such as the Random Phase Approximation (RPA) and Generator Coordinate Method (GCM)

give access to observables from ground state, excited states and large-amplitude collective motion of the

nuclei. Furthermore, the mean-field gives a natural interpretation of the nuclear configurations through

the shapes of the system in its intrinsic frame.

It is well established that a correct description of the ground states of deformed heavy nuclei, rotational

bands, isomeric states energies and fission barriers is strongly correlated with the value of the surface

energy coefficient a_{surf} and also the surface symmetry energy coefficient a_{ssym} .

A first step in the direction of a better description of shapes of heavy nuclei was recently achieved with the construction of the SLy5sX series of Skyrme-EDFs and more specifically with the SLy5s1 parameterisation. The systematically improved agreement for deformation properties of heavy nuclei

achieved with SLy5s1 compared to widely-used parameterisations such as SLy5, however, comes at the expense of a significant increase of mass residuals.

In this presentation, I will show that a slight modification of the fit protocol together with the inclusion of the often-neglected two-body contribution to the center-of-mass correction in functional

greatly improve the results for shapes, barriers heights and binding energies. I will present the details

of the fit protocol and show a set of selected results. It turns out that completely omitting the center-

of-mass correction as sometimes done for parameterisations aiming at nuclear dynamics is similarly

problematic as using the standard recipe where only the one-body part is kept. I will also discuss how

the statistical error bars on the parameters of the functional propagate on calculated quantities such as

fission barriers.

Auteurs principaux: DA COSTA, Philippe; Dr BENDER, Michael (IPN Lyon); BENNACEUR, Karim (Institut de Physique Nucléaire de Lyon); Prof. MEYER, Jacques (Institut de Physique Nucléaire de Lyon)

Orateur: DA COSTA, Philippe

ID de Contribution: 27

Type: **Non spécifié**

Can we decipher the composition of the core of a neutron star?

Recent development in multi-messenger astronomy through gravitational waves (LIGO/VIRGO) or X-ray spectra (NICER) provide new constraints to the theories of nuclear physics, where an absolute energy density functional from ab-initio modelling is still not available.

General relativity guarantees that there is a unique one-to-one correspondence between static observables of neutron stars such as mass-radius relation or tidal deformability and equation of state (EoS) of beta equilibrated matter. However, these static properties are not enough to predict the composition of the interiors of neutron stars. In a novel meta-model approach this problem is demonstrated through a simple analytical method, which is further reinforced by a Bayesian analysis. A possible remedy is also suggested which can be realized by information on symmetric matter at high densities.

Auteurs principaux: MONDAL, Chiranjib (LPC Caen); GULMINELLI, Francesca (LPC/Ensicaen)

Orateur: MONDAL, Chiranjib (LPC Caen)

ID de Contribution: 28

Type: **Non spécifié**

Universality in many-body systems

Systems that share common proprieties as critical exponents and the number and nature of quantum states are said to belong to the same universality class. However, systems in the same class may have very different typical sizes and energies. For example, some nuclear systems, cold atoms, and hadronic molecules can all be described by the same typology of theories. This allows transferring knowledge among systems belonging to the same class, with great benefit of the fields in which experimental results are scarce and more difficult to be obtained.

In this talk, I am going to describe how universality is related to effective field theories and how they can be applied from nucleons to hadrons, and atoms; what are their advantages and disadvantages; and the challenges that still remain to be solved in their future.

Auteur principal: CONTESSI, Lorenzo (CEA)

Orateur: CONTESSI, Lorenzo (CEA)

ID de Contribution: 29

Type: Non spécifié

Experimental Study of the $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ via the $^{30}\text{Si}(^3\text{He}, d)^{31}\text{P}$ transfer reaction for understanding elemental anomalies in Globular Clusters.

Globular clusters are key grounds for models of stellar evolution and early stages of the formation of galaxies. Abundance anomalies observed in the globular cluster NGC 2419, such as the enhancement of potassium and depletion of magnesium can be explained in terms of an earlier generation of stars polluting the presently observed stars. However, the nature and the properties of the polluting sites are still debated. The range of temperatures and densities of the polluting sites depends on the strength of a number of critical thermonuclear reaction rates. The $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ reaction is one of the few reactions that have been identified to have an influence for elucidating the nature of polluting sites in NGC 2419. The current uncertainty on the $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ reaction rate has strong impact on the range of possible temperatures and densities of the polluter sites.

Hence, we investigated the $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ reaction with the aim to reduce the associated uncertainties by determining the strength of resonances of astrophysical interest. In this talk I will present the study of the reaction $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ that we performed via the one proton $^{30}\text{Si}(^3\text{He}, d)^{31}\text{P}$ transfer reaction at the Maier-Leibnitz-Laboratorium Tandem. With the high resolution Q3D magnetic spectrograph, we measured the angular distributions of the light reaction products. These angular distributions are interpreted in the DWBA (Distorted Wave Born Approximation) framework to determine the proton spectroscopic factor information needed to determine the proton partial width of the states of interest. This information was used to calculate the $^{30}\text{Si}(p, \gamma)^{31}\text{P}$ reaction rate. The uncertainties on the reaction rate have been significantly reduced and key remaining uncertainties have been identified.

Auteurs principaux: HARROUZ, Djamila Sarah (IJCLab); DE SÉRÉVILLE, N; ADSELY, P; HAM-MACHE, F; LONGLAND, R

Co-auteurs: BASTIN, B; FAESTERMANN, T; HERTENBERGER, R; LA COGNATA, M; LAMIA, L; MEYER, A; PALMERINI, S; PIZZONE, R. G; ROMANO, S; TUMINO, A; WIRTH, H-F

Orateur: HARROUZ, Djamila Sarah (IJCLab)

ID de Contribution: 30

Type: Non spécifié

First trap-assisted decay spectroscopy of the ^{81}Ge ground state

The ^{78}Ni ($Z = 28$, $N = 50$) region has been one of the main focus points in nuclear structure studies during the last decades. The recently measured 2_1^+ excitation energy of ^{78}Ni $E_x(2_1^+) = 2.6$ MeV has been interpreted as the proof of its doubly magic nature. Despite this remarkable result, the nuclear structure in the region is far from fully understood. Shape coexistence phenomena observed in the $N = 40$ region seems to extend to the $N = 50$ region and result in a new island of inversion. Coexisting shapes can also lead to isomeric states which complicate the studies of these nuclei.

In this work, we re-investigate the ^{81}As level scheme populated in the decay of ^{81}Ge in a systematic attempt to improve spectroscopy knowledge in the region of suspected shape coexistence. Up to now, the β -decay studies of the $N = 49$ isotones for $Z \leq 32$ have not been performed with an unambiguous ground state and isomer separation. In this work, we have utilized the JYFLTRAP Penning trap at IGISOL, Jyväskylä and selected the $(9/2^+)$ ground state of ^{81}Ge ($Z = 32$) for detailed studies at a post-trap decay spectroscopy setup. This is a clear improvement compared to the previous spectroscopy study of the decay of ^{81}Ge \cite{Hoff81} which utilized a mass-separated $A = 81$ beam consisting mainly of ^{81}Ga .

The intrinsic half-life of the ^{81}Ge ground state has been determined as $T_{1/2} = 6.4(2)$ s, which is significantly shorter than the literature value. A new level scheme of ^{81}As has been built and is compared to shell-model calculations.

Auteur principal: Dr DELAFOSSE, Clément (IJCLab)

Orateur: Dr DELAFOSSE, Clément (IJCLab)

ID de Contribution: 31

Type: Non spécifié

Gamma Spectroscopy in a Laser-perturbed Environment

When high power lasers interact with matter, ions, electrons and their associated bremsstrahlung photons are the products. The protons can reach hundreds of MeVs and intensities of some kA within a few ns. Such high-intensity opens up new realms of nuclear physics like the study of short-lived nuclei states in a plasma by gamma spectroscopy [1].

It is common to use a LaBr₃ scintillator coupled to a Photomultiplier Tube (PMT) for gamma spectroscopy. However, high-energy depositions in the detector due to huge amount of soft X-rays from the laser interaction trigger delayed emissions in the form of afterglows within the scintillator making the PMT blind for a few ms after the laser shot. Fortunately, with a LaBr₃ and a Hybrid Photo Diode (HPD) the duration of the afterglow signal can decrease to some tens of μ s [1]. Nonetheless, the amplitudes of signals near the region of the afterglow remain altered due to variations in the gain of the photodetector.

It is imperative to implement signal treatment procedures that take into account the role of the afterglow and the amplitude variations of signals in a laser-perturbed environment. In this work, I have done offline signal processing on experimental data acquired from a HPD coupled to a LaBr₃. The experiment involved the use of laser-accelerated protons to induce nuclear excitations on a zirconium target. The outcome was the production of ^{90m}Nb nucleus, which emits several gamma rays including 122 keV and 257 keV with lifetimes of 63 μ s and 6.19 ms, respectively. I will thus present the steps taken for the signal treatments and the obtained results.

[1] Scintillators in high-power laser-driven experiments; M.Tarisien, et al. ; IEEE Transactions on Nuclear Science, Vol 65, issue 8, p.2216-2219 (2018)

Auteur principal: ATUKPOR, Emmanuel (CENBG)

Co-auteurs: Dr DOMANGE, Jocelyn (CENBG); Dr HANNACHI, Fazia (CENBG); Dr TARISIEN, Medhi (CENBG)

Orateur: ATUKPOR, Emmanuel (CENBG)

ID de Contribution: 32

Type: Non spécifié

Weak interaction studies with ^{32}Ar

Nuclear beta decay has represented for more than half a century a blooming testing ground for the Standard Model (SM), contributing particularly to the development of the theory of the electroweak interaction. The broad variety of nuclear states and beta transitions provide a highly remarkable tool to be competitive with high-energy physics experiments in searching for the possible presence of non-SM contributions to the firmly established vector - axial-vector (V-A) description of the weak interaction [1]. Particularly, the joined experimental determination of the beta-neutrino angular correlation coefficient ($a_{\beta\nu}$) and the correlated Fierz term (b_F) in pure Fermi and Gamow-Teller transitions tightly allows to set new stringent limits on the existence of scalar and tensor currents, respectively.

The most forthcoming way to retrieve $a_{\beta\nu}$ would be to measure the correlation between the leptons emitted in the decay; yet, as a direct measurement of the neutrino is almost impossible, the $a_{\beta\nu}$ coefficient can be determined from the recoil of the daughter nucleus, which can be measured either directly by means of trap measurements or via the kinematic shift it induces on the energy distribution of the β -delayed particles emitted in case of unstable daughter nuclei, as foreseen in the WISArD experiment at CERN.

The WISArD (Weak Interaction Studies with ^{32}Ar Decay) experiment [2] aims at a precise measurement of both the $a_{\beta\nu}$ and the b_F coefficients for both Fermi and Gamow-Teller transitions by using, differently from previous measurements [3], the kinematic energy shift of the β -delayed protons emitted in the same or the opposite direction to the β -particle from ^{32}Ar . A proof-of-principle experiment, though limited in statistics and performed via a still rudimental experimental set-up, has been successfully accomplished at ISOLDE in November 2018, already leading to the third best measurement of $a_{\beta\nu}$ for Fermi transitions [4]. After determining and estimating the systematic errors, a consistent upgrade of the experimental set-up has been commissioned and realized through the past two years, potentially permitting to reach the aimed precision of the permil level on the determination of both $a_{\beta\nu}$ and b_F . In this talk, the new experimental campaign conducted at ISOLDE in October 2021, along with the enhancements in the newly dedicated detection set-up, will be presented and the first preliminary results will be discussed.

Auteur principal: CRESTO, Federica

Co-auteurs: M. ALFAURT, Philippe (CENBG); Dr ASCHER, Pauline (CENBG); Dr ATANASOV, Dinko (CENBG); Dr BLANK, Bertram (CENBG); M. DAUDIN, Laurent (CENBG); Dr FLECHARD, Xavier (LPC Caen); Dr GERBAUX, Mathias (CENBG); Dr GIOVINAZZO, Jerome (CENBG); Dr GREVY, Stephane (CENBG); Dr KURTUKIAN NIETO, Teresa (CENBG); Dr LIENARD, Etienne (LPC Caen); Dr POMORSKI, Marcin (CENBG); M. ROCHE, Mathieu (CENBG); Dr SEVERIJNS, Nathal (KU Leuven); M. VANLANGENDONCK, Simon (KU Leuven); Dr VERSTEEGEN, Maud (CENBG); Dr ZAKOUCKY, Dalibor (Nuclear Physics Institute CAS)

Orateur: CRESTO, Federica

ID de Contribution: 33

Type: Non spécifié

The double Penning trap mass spectrometer PIERADE for DESIR/SPIRAL2

The DESIR (Désintégration, Excitation et Stockage d'Ions Radioactifs) hall is a part of the new extension of GANIL; the SPIRAL2 facility. This hall will be dedicated to the study of nuclear structure, astrophysics and weak interaction with low energy beams (30-60 keV). With the low-energy comes the advantage of working with good optical quality ion beams, allowing high-precision experiments. Various experimental apparatus will take place in the DESIR hall, divided into three main categories, β -decay spectroscopy, laser spectroscopy and mass spectrometry.

In the DESIR hall, ion beams coming from the upgraded SPIRAL1 facility and the Super Separator Spectrometer S3 will be available. SPIRAL1 is producing light exotic nuclei by ISOL-fragmentation and S3 a wide range of neutron deficient nuclei (including refractory elements) by in-flight fusion evaporation. SPIRAL1 and S3 will deliver unique ion beams to DESIR, but the production techniques are non-selective and, depending on the region of interest, can produce huge amounts of contaminants. To guarantee a high purity of the samples a HRS (High-Resolution Separator), composed mainly of two 90 degrees magnetic dipole and one multipole, is foreseen to be located in front of the DESIR hall. Its resolving power on the order of 10^4 will allow a purification of most isobars from the ion beam. Nevertheless, an even higher resolution is required to separate a few ions of interest from a large number of contaminants such as very close isobars or long-lived isomers.

For that purpose, at the entrance of the DESIR hall will be installed the GPIB (General Purpose Ion Buncher), a linear Paul trap for cooling and bunching continuous ion beam and the double Penning trap mass spectrometer PIPERADE (PIèges de PENning pour les ions RADionucléides à DESIR). The mass resolving power of PIPERADE is expected to be higher than 10^6 and will allow purification of close isobars and isomers. Besides purification purposes, PIPERADE will be used as a mass measurement apparatus on its own. The GPIB and PIPERADE are now fully assembled at CENBG and under commissioning before their transfer to GANIL in 2 or 3 years. Their status will be presented as well as recent achievements.

Auteur principal: DE ROUBIN, Antoine (CENBG)

Orateur: DE ROUBIN, Antoine (CENBG)

ID de Contribution: 34

Type: **Non spécifié**

Weak interaction studies with ^{32}Ar

lundi 6 décembre 2021 11:45 (25 minutes)

Orateur: CRESTO, Federica (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 35

Type: **Non spécifié**

Continuum coupling correction in Gamow Shell Model

lundi 6 décembre 2021 12:10 (25 minutes)

Orateur: LINARES FERNANDEZ, Jose Pablo (GANIL, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 36

Type: **Non spécifié**

The effect of the energy functional on the pasta-phase properties of catalysed neutron stars

jeudi 9 décembre 2021 11:45 (25 minutes)

Orateur: DINH THI, Hoa (LPC Caen, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 37

Type: **Non spécifié**

Experimental Study of the $^{30}\text{Si}(p,\gamma)^{31}\text{P}$ via the $^{30}\text{Si}(^3\text{He},d)^{31}\text{P}$ transfer reaction for understanding elemental anomalies in Globular Clusters

jeudi 9 décembre 2021 18:50 (25 minutes)

Orateur: HARROUZ, Djamila Sarah (IJCLab, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: **38**

Type: **Non spécifié**

First trap-assisted decay spectroscopy of the ^{81}Ge ground state

Orateur: DELAFOSSE, Clement (IJCLab, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 39

Type: **Non spécifié**

Gamma Spectroscopy in a Laser-perturbed Environment

jeudi 9 décembre 2021 18:00 (25 minutes)

Orateur: ATUKPOR, Emmanuel (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 40

Type: **Non spécifié**

Understand ^{22}Na cosmic abundance by measuring lifetimes in ^{23}Mg

jeudi 9 décembre 2021 18:25 (25 minutes)

Orateur: FOUGERES, Chloe (GANIL, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 41

Type: **Non spécifié**

Can we decipher the composition of the core of a neutron star?

jeudi 9 décembre 2021 12:10 (25 minutes)

Orateur: MONDAL, Chiranjib (LPC Caen, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 42

Type: **Non spécifié**

Shapes of heavy and super-heavy atomic nuclei with Skyrme Energy Density Functionals

mardi 7 décembre 2021 17:00 (25 minutes)

Orateur: DA COSTA, Philippe (IP2I, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 43

Type: **Non spécifié**

Description of heavy nuclei within the Shell Model

mardi 7 décembre 2021 17:25 (25 minutes)

Orateur: DAO, Duy Duc (IPHC, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 44

Type: **Non spécifié**

Nuclear structure studies at the FIPPS instrument at ILL

mardi 7 décembre 2021 10:30 (25 minutes)

Orateur: COLOMBI, Giacomo (ILL, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 45

Type: **Non spécifié**

Determining neutron-induced reaction cross sections through surrogate reactions at storage rings

mercredi 8 décembre 2021 18:00 (25 minutes)

Orateur: SWARTZ, Jacobus (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 46

Type: **Non spécifié**

Response of solar cells to heavy ions at energies close to 10 AMeV

mercredi 8 décembre 2021 18:25 (25 minutes)

Orateur: SGUAZZIN, Michele (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 47

Type: **Non spécifié**

First trap-assisted decay spectroscopy of the ^{81}Ge ground state

mercredi 8 décembre 2021 18:50 (25 minutes)

Orateur: DELAFOSSE, Clément (IJCLab, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 48

Type: **Non spécifié**

Bogoliubov coupled cluster theory for open-shell nuclei

mercredi 8 décembre 2021 10:00 (25 minutes)

Orateur: DEMOL, Pepijn (KU Leuven, Belgium)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 49

Type: **Non spécifié**

ab-initio description of the monopole resonance in light- and medium-mass nuclei

mercredi 8 décembre 2021 10:25 (25 minutes)

Orateur: PORRO, Andrea (CEA-IRFU, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 50

Type: **Non spécifié**

Universality in many-body systems

mardi 7 décembre 2021 12:05 (25 minutes)

Orateur: CONTESSI, Lorenzo (IJCLab/CEA, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 51

Type: **Non spécifié**

Nuclear Shell Model Effective Interaction from Many-Body Perturbation Theory

mercredi 8 décembre 2021 10:50 (25 minutes)

Orateur: LI, Zhen (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 52

Type: **Non spécifié**

Taming Nuclear complexity with neural networks

Orateur: LASSERI, Raphaël-David (IJClab, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 53

Type: **Non spécifié**

Parallel Computing

jeudi 9 décembre 2021 14:30 (1h 30m)

Orateurs: ROY, Fabrice (LUTH - CNRS - Observatoire de Paris); LAFAGE, Vincent (IJCLab, France)

Classification de Session: Workshop session

ID de Contribution: 54

Type: **Non spécifié**

Skills workshop

mardi 7 décembre 2021 16:00 (1 heure)

Orateur: GAURON, Philippe (IJCLab Orasy)

Classification de Session: Workshop session

ID de Contribution: 55

Type: **Non spécifié**

Communication Workshop

lundi 6 décembre 2021 17:00 (1h 30m)

The objective of this workshop goes beyond my thesis in 180 sec!

It will provide the most important skills that are imperative when presenting your work as a young scientist.

In other words, the tips that can help you succeed.

Orateur: CHEVRIER, Raphael

Classification de Session: Workshop session

ID de Contribution: 56

Type: **Non spécifié**

Paralell computing

jeudi 9 décembre 2021 16:30 (1h 30m)

Classification de Session: Workshop session

ID de Contribution: 57

Type: **Non spécifié**

Shape evolution in neutron-rich nuclei around mass 100 with the AGATA-VAMOS-OUPS setup

mardi 7 décembre 2021 17:50 (25 minutes)

Orateur: PASQUALATO, Giorgia (IJCLab, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 58

Type: **Non spécifié**

Shape evolution in neutron-rich nuclei around mass 100 with the AGATA-VAMOS-OUPS setup

Tuesday session

Auteurs principaux: PASQUALATO, Giorgia (IJCLab); LJUNGVALL, Joa (IJCLab)

Orateur: PASQUALATO, Giorgia (IJCLab)

ID de Contribution: 59

Type: **Non spécifié**

Universality in many-body systems

Orateur: CONTESSI , Lorenzo (IJCLab, France)

Classification de Session: Nuclear shapes at the extremes

ID de Contribution: **60**

Type: **Non spécifié**

The double Penning trap mass spectrometer PIPERADE for DESIR/SPIRAL2

mardi 7 décembre 2021 18:15 (25 minutes)

Orateur: DE ROUBIN, Antoine (CENBG, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 61

Type: **Non spécifié**

Trajectory-based approach to quantum scattering process

jeudi 9 décembre 2021 19:15 (25 minutes)

Orateur: DUPUY, Lucien (Montpellier, France)

Classification de Session: PhD student, post-doc and other short contributions

ID de Contribution: 62

Type: **Non spécifié**

Dynamical aspects of superfluid neutron stars

mardi 7 décembre 2021 11:30 (35 minutes)

Orateur: ANTONELLI, Marco (LPC Caen, France)

Classification de Session: PhD student, post-doc and other short contributions