UK Nuclear Activity

March 2015 Issue 21

In this issue,

Newsletter archive: http://npg.dl.ac.uk/OutreachNewsletter/index.html

Nuclear Physics Public Engagement Website: www.stfc.ac.uk/NuclearPhysicsForYou

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1. Nuclear Physics Publications for March

If you are publishing a paper that you think would be of media value please let Wendy Ellison wendy.ellison@stfc.ac.uk , STFC Press Officer, know. She can help with press releases and publicity. If you get in touch with her before publication she can also get material ready in advance for the day of publication.

J. Phys. G: Nucl. Part. Phys. 42 030301 (2015) http://iopscience.iop.org/0954-3899/42/3/030301/article
Enhancing the interaction between nuclear experiment and theory through information and statistics
D G Ireland[1] and W Nazarewicz[2,3,4]
Published March 2015

J. Phys. G: Nucl. Part. Phys. 42 034005 (2015) http://iopscience.iop.org/0954-3899/42/3/034005/article
Covariance analysis of finite temperature density functional theory: symmetric nuclear matter
A Rios[1] and X Roca Maza[2]
Published March 2015

J. Phys. G: Nucl. Part. Phys. 42 034010 (2015) http://iopscience.iop.org/0954-3899/42/3/034010/article
Weighing the evidence for clustering in nuclei
David Jenkins[1,2] and Sandrine Courtin[3,4]
Published March 2015

NIM A 775, 71 (2015) http://www.sciencedirect.com/science/article/pii/S0168900214014430
Digital pulse-timing technique for the neutron detector array NEDA
V. Modamio[a,*], J.J. Valiente-Dobón[a], G. Jaworski[b,c], T. Hüyük[d], A. Triossi[a], J. Egea[d,e], A. Di Nitto[f], P.-A. Söderström[g], J. Agramunt Ros[d], G. de Angelis[a], G. de France[h], M.N. Erduran[i], S. Ertürk[j], A. Gadea[d], V. González[e], J. Kownacki[c], M. Moszynski[k], J. Nyberg[l], M. Palacz[c], E. Sanchis[e], R. Wadsworth[m]
Published 1 March 2015

Phys. Rev. C 91, 034309 (2015) http://journals.aps.org/prc/abstract/10.1103/PhysRevC.91.034309
Shape-coexisting rotation in neutron-deficient Hg and Pb nuclei
C. F. Jiao (焦长峰)[1], Yue Shi (石跃)[1], H. L. Liu (刘红亮)[2], F. R. Xu (许甫荣)[1,3,*], and P. M. Walker[4]
Published 9 March 2015

Phys. Rev. C 91, 034317 (2015) http://journals.aps.org/prc/abstract/10.1103/PhysRevC.91.034317
Spectroscopy of narrow, high-lying, low-spin states in ^{20}Ne
J. A. Swartz[1,2,*], B. A. Brown[3,4], P. Papka[1,2], F. D. Smit[2], R. Neveling[2], E. Z. Buthelezi[2], S. V. Förtsch[2], M. Freer[5], Tz. Kokalova[5], J. P. Mira[1,2], F. Nemulodi[1,2], J. N. Orce[6], W. A. Richter[2,6], and G. F. Steyn[2]
Published 16 March 2015

Phys. Rev. C 91, 034319 (2015) http://journals.aps.org/prc/abstract/10.1103/PhysRevC.91.034319
Collective excitations in the transitional nuclei ^{163}Re and ^{165}Re
T. R. Davis-Merry[1], D. T. Joss[1,*], R. D. Page[1], J. Simpson[2], E. S. Paul[1], F. A. Ali[1,†], L. Bianco[1], R. J. Carroll[1,‡], B. Cederwall[3], I. G. Darby[1,§], M. C. Drummond[1], S. Eeckhaudt[4], S. Ertürk[5], M. B. Gómez-Hornillos[2], T. Grahn[4], P. T. Greenlees[4], B. Hadinia[3,‖], U. Jakobsson[4], P. M. Jones[4,¶], R. Julin[4], S. Juutinen[4], S. Ketelhut[4,#], M. Leino[4], P. Nieminen[4], M. Nyman[4], D. O'Donnell[1,**], J. Pakarinen[4], P. Peura[4], P. Rahkila[4], J. P. Revill[1], P. Ruotsalainen[4], M. Sandzelius[4], P. J. Sapple[1], J. Sarén[4], B. Sayğı[1], C. Scholey[4], J. Sorri[4], J. Thomson[1], and J. Uusitalo[4]
Published 17 March 2015

Phys. Rev. C 91, 034906 (2015) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.91.034906
Two-pion femtoscopy in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV
J. Adam et al. (ALICE Collaboration), UK Authors: D. Alexandre, L.S. Barnby, M. Borri, M. Chartier, D. Evans, M.A.S. Figueredo, L.D. Hanratty, P.G. Jones, A. Jusko, M. Krivda, G.R. Lee, R.C. Lemmon, R. Lietava, J. Norman, R. Romita, O. Villalobos Baillie
Published 24 March 2015

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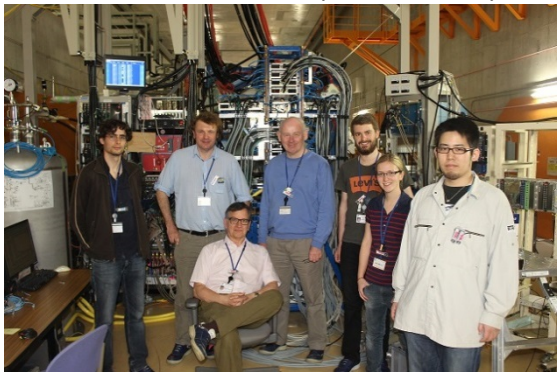
2. News to Report

a. AIDA News. The Advanced Implantation Detector Array (AIDA) is a state-of-the-art detector system for a type of nuclear physics experiment known as implantation decay correlation. The detector comprises a stack of up to 8 detectors made of Silicon wafers of 1mm thickness into which is implanted an unstable nucleus from a high energy nuclear reaction. The x-y position of the implantation is recorded along with which detector it stopped in, what energy was deposited and when it happened. Subsequent radioactive decays of the implanted nucleus to daughter, granddaughter etc. nuclei on timescales from 10's of microseconds to many hours are also detected, energies and decay times measured and x-y positions correlated with the implanted nucleus.
The electronics for this type of experiment is notoriously hard to design because the implanted nucleus typically deposits energy of up to 20GeV in the detector whereas the subsequent radioactive decays have energies between about 100keV and 10MeV. The electronics to measure the decay emission needs time to recover from the saturation caused by the high energy implantation so there is a significant period in which decays cannot be observed. AIDA has a specially designed ASIC (Application Specific Integrated Circuit) preamplifier which recovers much faster than any previous electronics and allows high resolution measurements to be made within a few microseconds of the

implantation. In addition there are no hardware triggers- all data are time-stamped using a 100MHz clock and then stored on a computer. The use of time-stamping enables AIDA to be used with a wide range of other detector systems, for example, high efficiency neutron and gamma-ray detector arrays to detect non-charged particle radioactive decay branches, isotope separator to identify the atomic number and mass of the radioactive nuclei implanted into AIDA.

AIDA was built by a collaboration between STFC national labs (DL and RAL) with the universities of Edinburgh and Liverpool as part of the NUSTAR project for FAIR. While FAIR is being constructed the array will being exploited to do science using radioactive beams from the RIKEN facility in Japan. AIDA was first installed at RIKEN in April 2014 since when various enhancements have been made to improve performance. The status in February 2015 is that all the electronics channels operate very stably, with a threshold of 160keV. Recently the synchronisation of the AIDA DAQ system was tested and found to work well with the DAQ systems of BigRIPS (RIKEN's isotope separator) and BRIKEN (a high efficiency ^{3}He neutron detector array) using timestamps from a common clock sent to all 3 DAQ systems. Consequently AIDA is now considered ready for commissioning experiments and the AIDA team are confident that their first experiment will be scheduled sometime this year.

AIDA and BRIKEN will be used to study the very neutron-rich, radioactive nuclei along the path of the r-process, the sequence of neutron capture reactions which are responsible for the nucleosynthesis of about half of the elements heavier than Iron. Major uncertainties still exist in both our understanding of this process and, indeed, the site or sites at which the r-process takes place.



Dr Tom Davinson, University of Edinburgh (AIDA project manager) about the latest tests in Feb 2015: "Overall, a very successful test with significant progress in a number of important areas. It is a pleasure to thank and acknowledge all of those at STFC Daresbury and Rutherford Appleton Laboratories, Edinburgh, Liverpool, IFC Valencia, and our hosts at RIKEN who have made this possible."

Contribution by Ian Lazarus
ian.lazarus@stfc.ac.uk (Daresbury)

b. Manchester hosts the ISOLTRAP Collaboration Meeting. ISOLTRAP is CERN ISOLDE's tandem Penning trap experiment for the study of radioactive atomic nuclei. ISOLTRAP has been a pioneer in online mass measurement studies for nearly three decades and remains at the forefront of the field. The setup consists of four consecutive ion traps for ion manipulation and high-resolution mass measurement [1]. The radioactive ion beam from ISOLDE is injected into a gas-filled, radio-frequency quadrupole where the ions are accumulated and cooled. They are then transported to the multi-reflection time-of-flight mass spectrometer (MR-ToF-MS) where the ion bunches are reflected back and forth between two electrostatic mirrors, forcing them along a 1km flight path within a 50cm apparatus; the long flight path allows to separate isobars according to their time of flight with a resolution of up to 1 in 500,000 [2]. They are subsequently injected in a gas-filled, cylindrical Penning trap where the ion bunches are centred for injection into the high-precision, hyperbolic Penning trap where the ions' cyclotron resonance can be excited. With the technique of time-of-flight ion cyclotron resonance, a resolution of 1 in a few million can be reached.

The complementarity of the MR-ToF-MS and the Penning traps at ISOLTRAP, together with the exceptional beams from ISOLDE, provides unique opportunities to study the phenomena of interest to our community. Recent nuclear structure highlights include the study of magicity at N=32,34 with beams of very neutron-rich calcium isotopes [3]. ISOLTRAP is also very well suited for the study of astrophysical processes and nucleogenesis, e.g. with the study of the neutron-star crust using neutron-rich Zn isotopes [4].

In February 2015, the School of Physics & Astronomy of The University of Manchester hosted ISOLTRAP's annual Collaboration Meeting. It was the occasion to gather its members from France, Germany, Switzerland

and beyond. Recent data from 2014 and new ideas for the years to come were discussed. The highlights included new opportunities to perform decay spectroscopy in ultra-clean conditions after the MR-ToF-MS, or the use of the phase-imaging ion cyclotron resonance technique for improved accuracy and access to more exotic isotopes [5].
For more information about ISOLTRAP, please consult the website: http://isoltrap.web.cern.ch/isoltrap/, or contact Dr Thomas Elias COCOLIOS.

[1] S. Kreim et al., NIMB 317 (2013) 492
[2] R.N. Wolf et al., IJMS 349 (2013) 123
[3] F. Wienholtz et al., Nature 498 (2013) 346
[4] R.N. Wolf et al., PRL 110 (2013) 041101
[5] S. Eliseev et al, PRL 110 (2013) 082501
Contribution by Thomas Cocolios
thomas.cocolios@manchester.ac.uk
(Manchester)

c. IoP meeting on Nuclear physics and r-process nucleosynthesis. We are pleased to announce an IoP-sponsored half-day meeting on "Nuclear Physics and R-process Nucleosynthesis", which will take place on Friday May 15th at the University of Edinburgh.
This half-day meeting aims to bring together nuclear physicists, astronomers, and astrophysicists studying nucleosynthesis during rapid neutron-capture process. It will provide a venue to learn about exciting developments in the field, such as the observation of new elemental abundances in metal poor stars, r-process models that include increasingly sophisticated treatment of the dynamical evolution of the astrophysical environment, and opportunities for experiments with r-process isotopes with a new generation of radioactive ion beam laboratories and new equipment (e.g. the AIDA detector for beta-decays developed in the UK). It will be an opportunity to discuss future lines of research and ways to coordinate the efforts of our communities across disciplinary lines.
Invited speakers include: Norbert Christlieb (University of Heidelberg), Giuseppe Lorusso (National Physical Laboratory), Tomislav Marketin* (University of Zagreb), and Nobuya Nishimura (Keele University).
All members of the UK and international community are welcome to participate, and invited to register before May 5th. Those interested in giving a presentation are encouraged to submit a brief abstract by May 1st. Please register through the meeting website:
http://indico.ph.ed.ac.uk/indico/event/iop2015
For further information contact Alfredo Estrade (aestrade@ph.ed.ac.uk).
Tom Davinson
Alfredo Estrade
Phil Woods
Contribution by Alfredo Estrade
aestrade@ph.ed.ac.uk (Edinburgh)

d. NuSTAR annual meeting. The NuSTAR annual meeting 2015 took place between 2 and 6 March 2015 at GSI. Sub-collaboration meetings were held at the beginning of the week and plenary sessions at the end. The Friday morning focussed on each sub-collaboration's plans for experiments with FAIR phase 0 which was announced as beams out of the SIS-18 accelerator from the fourth quarter of 2017 to 2020. The other main topic of discussion was the result of the recent review of the FAIR facility by the German funding agency. The NuSTAR collaboration came out of the process very well receiving the top mark of 1 out of 6. A highlight of the week was the success of ex-Manchester student Kara Marie Lynch who received the GENCO (GSI Exotic Nuclei Community) award for spectroscopy experiments with laser-assisted nuclear decay spectroscopy.
https://www.gsi.de/work/forschung/nustarenna/genco.htm
Kara gave a very nice talk on her research along the lines of a detective solving a mystery. It was very well received. Well done Kara.
Contribution by Alison Bruce
Alison.Bruce@brighton.ac.uk (Brighton)

e. T_z= -1 → 0 β decays of ^{54}Ni, ^{50}Fe, ^{46}Cr, and ^{42}Ti and comparison with mirror (^{3}He, t) measurements. Phys.Rev. C 91, 014301 (2015)**.** Studies of nuclear reactions and

radioactive decays provide our two main sources of information about atomic nuclei and their properties. Beta decays and charge exchange (CE) reactions complement each other. The former gives us absolute transition strengths but is limited in the excitation energy reached in the daughter nucleus. It is hard to obtain absolute strengths in charge exchange but there is no limit on the excitation energies of the states populated. Here a comparison was made between the beta transitions from T_z =-1 nuclei to their N = Z isobars with the complementary transitions seen in (3He,t) reactions on the mirror T_z = +1 stable target nuclei. Since the two processes are governed by the same στ operator we expect the strengths of the complementary transitions to be identical if isospin is a good quantum number. The results of the measurements reported here on the beta decays of ^{54}Ni, ^{50}Fe, ^{46}Cr, and ^{42}Ti showed that for strong transitions the corresponding strengths in the two processes agreed but for some weak transitions they do not. The results provide sufficient justification for us to normalise the strengths of the CE measurements with the results of the beta decays.

There are a number of possible reasons such as the fact that CE is a peripheral reaction, the operator is not purely στ for some transitions and we already know that isospin is a broken symmetry and there are a number of associated effects.

Future experiments are already underway to test these hypotheses at RIKEN and GANIL. They will be carried out on nuclei above the $f_{7/2}$ shell and on T_z = +/-2 nuclei.

Contribution by Bill Gelletly
w.gelletly@surrey.ac.uk *(Surrey)*

f. York group brings hope for nuclear physics.
News article in Research Fortnight, 11 March 2015 https://t.co/MAF4h59mTQ, gives the response of Jacek Dobaczewski and William Gelletly to the new nuclear theory group at York.

Contribution by Bill Gelletly
w.gelletly@surrey.ac.uk *(Surrey)*

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3. Outreach Activity

Outreach Talk.
On the 18th March 2015 Arnau Rios gave his outreach talk: 'Neutron stars: the walking dead of the stellar graveyard?' at Alleyn's school in Dulwich.

Contribution by Arnau Rios Huguet
a.rios@surrey.ac.uk (Surrey)

International Women's Day
A number of female nuclear physicists from the University of York took part in an International Women's Day event at the Yorkshire Museum on Sunday 8th March. The event was organised by Dr Gemma Wilson, who runs the York branch of ScienceGrrl, and allowed the public to individually talk to female scientists from a wide range of different disciplines.

Nuclear physics was represented by Dr Gemma Wilson, Dr Lianne Scruton and Adelle Hay. They took along some radioactive rocks, a Geiger counter and a gamma-ray detector and talked about radioactivity, detector technology and their experiences at running experiments at labs such as CERN. Other demos included the Cosmodome, an infrared camera, facial recognition experiments and a cloud in a bottle experiment. The event was successful, with more than 300 people visiting the museum that day.

For further information see this blog post or news article.

Contribution by Gemma Wilson
gemma.wilson@york.ac.uk (York)

Funding Opportnities.
The STFC Public Engagement Small Awards 2015A call is open. The call for proposals closes at 4.00pm on Thursday 30th April.

The scheme provides funds for small, local or 'pilot' projects promoting STFC science and technology. Almost anyone can apply, including grant-funded research groups, STFC research facility users, schools, museums, etc.

Awards range from £500 to £10,000 and the expenditure can go towards materials, salaries and travel & subsistence.

Projects must be relevant to publicising engagement or teaching about the STFC science and technology areas, namely:

- particle physics;
- nuclear physics;
- space, ionospheric, solar & planetary science;
- astronomy;
- astrophysics;
- cosmology
- studying materials with muon & neutron sources
- studying materials with synchrotron light sources
- research using laser facilities

Applicants should also consult the STFC Public Engagement Strategy in advance of submitting your proposal and are also encouraged (if applicable) to consider working with under-represented audiences such as girls and young women in engineering and physics, groups in areas geographically remote from STEM activity and underperforming schools.

Please see the notes for guidance for further information.

All applications must be submitted through the RCUK Joint electronic submission (Je-S) (link opens in a new window) system. E-mailed or hard copy applications will not be accepted. Please be aware that it may take up to four weeks for organisations to register for the first time on the Je-S system.

For further information and advice please contact: Andy Thompson Tel: 01793 442098.

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4. Media Interactions

UK physicists getting closer to reading the inside of stars

News of the successful commissioning of one of the first Silicon detector modules for R3B.

Press Release

Young women urged to explore sciences

Coverage of International Women's Day event at the Yorkshire Museum.

News article