UK Nuclear Activity

March 2018 Issue 57

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 contact Wendy Ellison, STFC Press Officer. 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.

Phys. Rev. C 97, 024615 (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.024615
Production of deuterons, tritons, ^{3}He nuclei, and their antinuclei in pp collisions at $\sqrt{s}$ = 0.9, 2.76, and 7 TeV
ALICE Collaboration, UK Authors: H. A. Andrews, L. S. Barnby, M. Borri, M. Chartier, D. Evans, K. L. Graham, C. Hills, P. G. Jones, A. Jusko, M. Krivda, R. C. Lemmon, R. Lietava, S. W. Lindsay, J. Norman, O. Villalobos Baillie, E. Willsher, N. Zardoshti
*Published 21 February 2018

Comput. Phys. Commun. 224, 381 (2018)
https://www.sciencedirect.com/science/article/pii/S0010465517303715
OWL: A code for the two-center shell model with spherical Woods–Saxon potentials
Alexis Diaz-Torres
Published March 2018

Eur. Phys. J. A 54, 42 (2018) https://link.springer.com/article/10.1140/epja/i2018-12474-9
The SPEDE spectrometer
P. Papadakis, D. M. Cox, G. G. O'Neill, M. J. G. Borge, P. A. Butler, L. P. Gaffney, P. T. Greenlees, R. -D. Herzberg, A. Illana, D. T. Joss, J. Konki, T. Kröll, J. Ojala, R. D. Page, P. Rahkila, K. Ranttila, J. Thornhill, J. Tuunanen, P. Van Duppen, N. Warr, J. Pakarinen
Published March 2018

*Also including missed publications from previous months.

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Elizabeth.Cunningham@stfc.ac.uk or E.Cunningham@surrey.ac.uk

Eur. Phys. J. A 54, 44 (2018) https://link.springer.com/article/10.1140/epja/i2018-12476-7
A high-efficiency gas target setup for underground experiments, and redetermination of the branching ratio of the 189.5 keV ^{22}Ne(p,γ)^{23}Na resonance
LUNA Collaboration: F. Ferraro[1,2], M. P. Takács[3,4], D. Piatti[5,6], V. Mossa[7,8], M. Aliotta[9], D. Bemmerer[3], A. Best[10], A. Boeltzig[11], C. Broggini[5], C. G. Bruno[9], A. Caciolli[5,6*], F. Cavanna[1,2], T. Chillery[9], G. F. Ciani[11,12], P. Corvisiero[1,2], L. Csedreki[12], T. Davinson[9], R. Depalo[5,6], G. D'Erasmo[7,8], A. Di Leva[10], Z. Elekes[13], E. M. Fiore[7,8], A. Formicola[12], Zs. Fülöp[13], G. Gervino[14], A. Guglielmetti[15], C. Gustavino[16], Gy. Gyürky[13], G. Imbriani[10], M. Junker[12], I. Kochanek[12], M. Lugaro[17], L. E. Marcucci[18], P. Marigo[5,6], R. Menegazzo[5], F. R. Pantaleo[7,8], V. Paticchio[8], R. Perrino[8], P. Prati[1,2], L. Schiavulli[7,8], K. Stöckel[3,4], O. Straniero[19], T. Szücs[13], D. Trezzi[15] and S. Zavatarelli[2]
Published March 2018

Eur. Phys. J. C 78, 263 (2018) https://link.springer.com/article/10.1140/epjc/s10052-018-5612-8
π^0 and η meson production in proton-proton collisions at $\sqrt{s}$ = 8 TeV
ALICE Collaboration, UK Authors: H. A. Andrews, L. S. Barnby, M. Borri, M. Chartier, D. Evans, K. L. Graham, C. Hills, P. G. Jones, A. Jusko, M. Krivda, R. C. Lemmon, R. Lietava, S. W. Lindsay, J. Norman, O. Villalobos Baillie, E. Willsher, N. Zardoshti
Published March 2018

Nucl. Phys. A, 971, 1 (2018) https://www.sciencedirect.com/science/article/pii/S0375947417304839
Production of ^{4}He and anti-^{4}He in Pb—Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV at the LHC
ALICE Collaboration, UK Authors: H. A. Andrews, L. S. Barnby, M. Borri, M. Chartier, D. Evans, K. L. Graham, C. Hills, P. G. Jones, A. Jusko, M. Krivda, R. C. Lemmon, R. Lietava, S. W. Lindsay, J. Norman, O. Villalobos Baillie, E. Willsher, N. Zardoshti
Published March 2018

Phys. Rev. Lett. 120, 102301 (2018) https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.102301
D-Meson Azimuthal Anisotropy in Midcentral Pb-Pb Collisions at $\sqrt{s_{NN}}$ = 5.02 TeV
ALICE Collaboration, UK Authors: H. A. Andrews, L. S. Barnby, M. Borri, M. Chartier, D. Evans, K. L. Graham, C. Hills, P. G. Jones, A. Jusko, M. Krivda, R. C. Lemmon, R. Lietava, S. W. Lindsay, J. Norman, O. Villalobos Baillie, E. Willsher, N. Zardoshti
Published 9 March 2018

Phys. Lett. B 778, 178 (2018) https://www.sciencedirect.com/science/article/pii/S0370269318300170
Isospin-symmetry breaking in masses of $N \simeq Z$ nuclei
P.Bączyk[a], J.Dobaczewski[abcd], M.Konieczka[a], W.Satuła[ad], T.Nakatsukasa[e], K.Sato[f]
Published 10 March 2018

NIM A 892, 84 (2018) https://www.sciencedirect.com/science/article/pii/S0168900218302948
Position resolution simulations for the inverted-coaxial germanium detector, SIGMA
J.P.Wright[a], L.J.Harkness-Brennan[a], A.J.Boston[a], D.S.Judson[a], M.Labiche[b], P.J.Nolan[a], R.D.Page[a], F.Pearce[a], D.C.Radford[c], J.Simpson[b], C.Unsworth[a]
Published 1 June 2018

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2. News to Report

a. Leslie Leonard Green (1925–2018)

Nuclear physicist and IOP Fellow Professor Leslie Green died on 25 February at the age of 92.

Born on 30 March 1925, he completed a PhD in tertiary fission in 1949 and in the same year became a lecturer at the University of Liverpool, where he worked on the 1.0 MV Cockcroft-Walton accelerator. He worked on characterising resonances in light nuclei using high efficiency NaI(Tl) gamma-ray detectors. He obtained funds for a new Van de Graff accelerator to replace the aging cyclotron that James Chadwick had financed in the 1930s with his Nobel Prize money. The accelerator arrived in 1961 and experiments started in 1962.

He was appointed to a Chair of Experimental Physics at Liverpool in 1964 and he led a rapid expansion of the Nuclear Physics Group with eight members of academic staff appointed to support him. This was the foundation of the group that still exists today. At the University

of Liverpool he carried out a number of important senior roles including being Head of Physics, Dean of the Faculty of Science and Pro-Vice Chancellor. He was appointed as member of the Nuclear Physics Board of the Science Research Council for two terms (1972-75 and 1978- 82) and was a UK member of the Nuclear Physics Committee of the International Union of Pure and Applied Physics for a four year period (1978-92).
He was part of a group of leading UK nuclear physicists who persuaded the Science Research Council to budget to build a very ambitious 30 MV tandem van de Graff. Funding was agreed in principle but the location of the Nuclear Structure Facility (NSF) was not decided at this point. He was very influential in the decision to build this accelerator at Daresbury Laboratory. He became the Director of the Daresbury Laboratory in 1981. The NSF at Daresbury raced ahead to very rapidly become one of the leading nuclear physics laboratories in the world. As Director of the Laboratory, he also had responsibility for the Synchrotron Radiation Facility (SRF). Daresbury became the originator of many ground-breaking innovations which have been adopted by many other laboratories all over the world.
He retired in 1988 and was awarded the CBE in the same year.
Professor Leslie Green was an inspirational leader who must take credit that the Nuclear Physics Research group he built in Liverpool remains a world leader in the field. He must also take a credit for Daresbury Laboratory being a world leader in its field and thereby enhancing the scientific reputation of the UK throughout the international scientific world.
Contribution by Paul Nolan P.J.Nolan@liverpool.ac.uk (Liverpool) & John Sharpey-Schafer (University of the Western Cape)

b. UK researchers take a very cool step towards a gamma-ray laser

Content taken from STFC Website

UK scientists are poised to test a new technology that could bring the gamma-ray laser out of science fiction and into reality.
The gamma-ray laser was once described as one of the thirty most important problems in physics. Much discussed, it would herald a new generation of technology for research and industry, with enhanced applications that could range from spacecraft propulsion, to cancer treatment, ultra-precise imaging techniques, and the security sector.
A key stepping stone in making the gamma-ray laser possible is the ability to produce coherent gamma-ray emissions. A long standing challenge since lasers were first invented in 1960, coherent gamma-ray emissions have been considered an almost impossible task, until now.
In a research project funded by STFC, a UK team of researchers from University College London and the University of Surrey have combined their advanced atomic and nuclear physics expertise to conceive a proposal that will experimentally demonstrate that producing coherent gamma-ray emissions is a real possibility. The proposal, arguably the first of its kind, is testable in a realistic way that has never been considered before. It will seek to overcome a number of fundamental problems which have hindered the realisation of a gamma-ray laser. Until now, other proposals either have been testable only in principle, or would require technologies not yet available. The approach of the UCL and Surrey team is instead achievable with current technology. Full details of this fascinating research have been published in Physics Letters B [1].
The proposal involves caesium and an ultra-cold gas, called a Bose-Einstein condensate (BEC). The team's idea is to make a BEC of caesium isomers (i.e. excited atomic nuclei), cooling them to 100 nano-kelvin, or one ten-millionth of a degree above absolute zero! At such extreme low temperatures, the atoms start to behave in remarkable ways - a gas of excited atoms can start to act like one single giant atom, and the nuclei inside those atoms can effectively communicate with one another. In this state, they can also decay in unison, emitting their energy simultaneously - producing a powerful burst of coherent gamma radiation. This is the first time that a BEC of a radioactive species is proposed, and in particular in their long-lived excited state, which will be produced by a particle accelerator.
Professor Phil Walker, Professor of Physics at the University of Surrey, said: "It is thanks to recent advances in our ability to make ultra-cold gases, and also in our understanding about the way that nuclei in specific gasses can behave so uniquely, that we have been able to even consider that such an exciting and potentially game-changing experiment

could be possible. We could be on our way to being one step closer to solving one of the most challenging problems in physics."
This research is no longer just theory. UCL's Professor of Physics, Professor Ferruccio Renzoni, and his team are now busy setting up an experiment at the University of Jyväskylä Accelerator Laboratory in Finland. Key components, assembled at UCL, are already in place in Finland at the experimental facility. There, a cyclotron particle accelerator will produce the unstable caesium, and the UCL's laser system will trap and cool it to 100 nano-kelvin, with a view to successfully producing the world's first coherent gamma-ray emissions.
Professor Ferruccio Renzoni said: "If the project goes as planned, our experiment in Finland will show that it is possible to produce coherent gamma radiation in this way, and will lead on to further tests that will confirm the best conditions for scaling up to make a practical device, the gamma-ray laser, over the coming years. In the meantime, several milestones in atomic physics and new insights in nuclear behaviour will be available for us to study."
Professor John Simpson, Head of STFC's Nuclear Physics Group, said: "Here in the UK we are making exciting progress in the world's quest to develop the technology that will make a gamma-ray laser possible. The social and economic benefits of such technology will be dramatic. I look forward to the results that the UK research team will achieve with their international collaborators at Jyväskylä in Finland."
[1] Coherent gamma photon generation in a Bose-Einstein condensate of ^{135m}Cs, L. Marmugi, P.M. Walker and F. Renzoni, Phys. Lett. B777 (2018) 281.
Contribution by Phil Walker p.walker@surrey.ac.uk (Surrey) & Wendy Ellison wendy.ellison@stfc.ac.uk (STFC)

c. York nuclear physics post-doc takes a prize!

On 19-25th February more than 160 nuclear physicists from around the world attended 'The IVth Topical Workshop on Modern Aspects in Nuclear Structure', in Bormio, Italy. Over 100 presentations were made throughout the week, with nine members of the UK community in attendance, four of whom gave invited talks; Carlo Barbieri (Surrey); Carl Wheldon (Birmingham); Jacek Dobaczewski (York); and Andrei Andreyev (York). In addition to this, a number of contributed talks were given by young members of the UK community, including James Cubiss (York), who won the "Best Young Speaker Award" for his presentation of results on in-source laser spectroscopy studies of the gold, mercury and bismuth isotopic chains, performed at the CERN-ISOLDE facility.
Contribution by James Cubiss james.cubiss@york.ac.uk (York)

d. Global Challenge discussions at iThemba LABS, South Africa

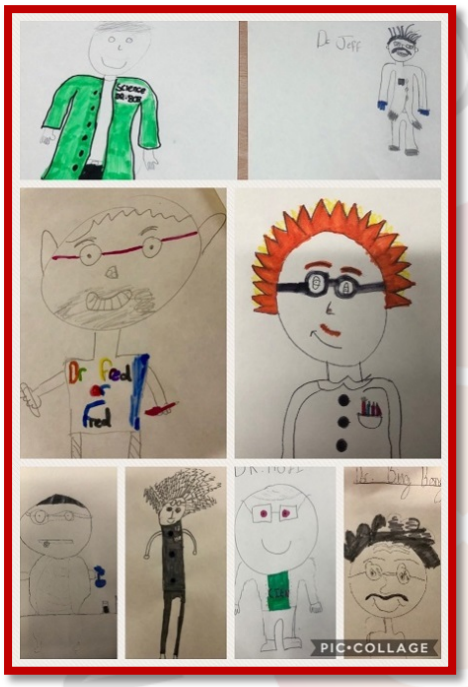
A very successful workshop was held at iThemba LABS in March where over 70 participants from countries including Botswana, Cameroon, Tanzania, Nigeria and the United Kingdom met to discuss collaboration and how to develop capacity building activities in topics and techniques in nuclear structure physics and in nuclear science. The UK delegation included representatives from the Universities of Brighton, Manchester, Liverpool, Surrey, York, UWS as well as from STFC Daresbury lab and the National Physical Laboratory. Mr Tony Medland from STFC also attended the meeting.

The workshop focussed on the application of advanced digital techniques to radiation detection including detailed discussion of techniques for measuring the lifetimes of nuclear levels and of environmental measurements and metrology. The workshop brought together those who have experience working in these subjects to explore initial ideas for sharing expertise. It concluded with a discussion on how to develop existing collaborations, build new ones and transfer knowledge between the participants.
The workshop was hosted by iThemba LABS and partially funded by the UK STFC's Global Challenge Research Fund.
Contribution by Alison Bruce Alison.Bruce@brighton.ac.uk (Brighton)

3. Outreach Activity

British Science Week

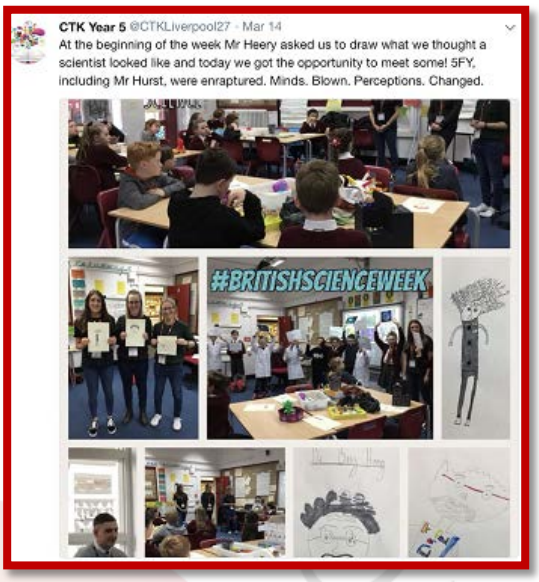
As part of British Science Week 2018, nuclear physicists from the University of Liverpool, Laura Harkness-Brennan, Lucy McAreavey and Olivia Voyce, visited Christ the King Primary School in Liverpool to share their experiences of being a scientist. In advance of the session, the pupils were each asked to draw a picture of a scientist, with the aim of challenging stereotypes. We think we achieved this! Here are some of their pictures:



Approximately one hundred pupils from years 5 and 6 participated, only one pupil drew a picture of (her future self) as a female scientist.

During the session, the students learnt about everything from atoms to the universe. We enjoyed answering their wide range of questions in our Q+A, such as “what is your favourite part of your job?”, “how can I become a scientist?”, “how could I make an atom?”, “how big is the universe?" and “can you tell me how a supernova works?”. We could have spent all day answering the fantastic questions they had. During their hands-on activity, they got to wear laboratory coats and googles, which they thoroughly enjoyed.

We were pleased at how many of them already knew the important roles scientists have and were happy to challenge their perception of who can be a scientist. Given how many excellent questions they had to ask us, we think there could be a good number of scientists among them! It was a very enjoyable experience and I can’t wait to do it again.

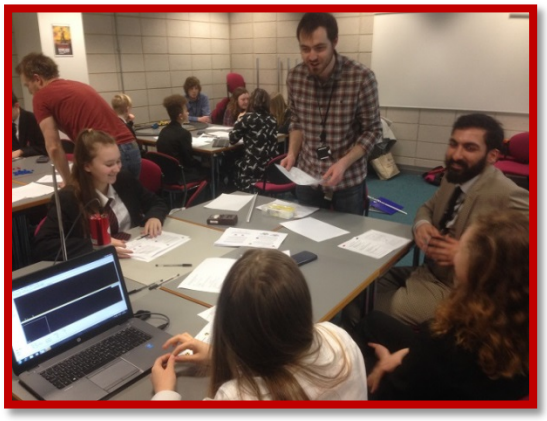


Contribution by Laura Harkness-Brennan *Laura.Harkness@liverpool.ac.uk (Liverpool)*

During British Science Week Robin Smith and Tom Ostler ran a workshop at Sheffield Hallam University called "Nuclear radiation: friend or foe?" The aim of the workshop was to educate a group of year 9 students in the many uses of nuclear radiation that benefit society and to give them a more balanced view of nuclear physics.

After a half hour lecture on applied nuclear physics the students had an hour to visit three workstations:

1) Lego nuclear fusion: students built the proton-proton chain using Lego to understand how main sequence stars release their energy.
2) Radiation detection and measurement: students measured the radiation from some common household items using a radiation monitor to measure their activities, and a LaBr detector to measure their energy spectra.
3) Particle accelerators: students investigated linear accelerators using a magnetic rail gun and learnt about the engineering challenges of building a circular accelerator by driving toy cars around a track to demonstrate the centripetal force.



The event received excellent feedback:
- Very fun and educational.
- I thought that it was informative and enjoyful and taught me new things.
- It was very informative to my unknowing Physics brain.
- A lot of knowledge I have gained, will further help me in my science lessons. I found the idea of when protons and neutrons are joined they weigh less than if they do when they aren't joined.
- Very interesting. The most effective in getting across the point was the Lego, but the mini rail gun accelerator was fun also.

Contribution by Robin Smith
Robin.Smith@shu.ac.uk (Sheffield Hallam)

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4. Media Interactions

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