UK Nuclear Activity

February 2018 Issue 56

In this issue,

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

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1. Nuclear Physics Publications for February*

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, 024605 (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.024605
Radiative neutron capture on ^{242}Pu in the resonance region at the CERN n_TOF-EAR1 facility
J. Lerendegui-Marco[1] *et al.* (n_TOF Collaboration)
Published 6 February 2018

Phys. Rev. C 97, 024309 (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.024309
Laser-spectroscopy studies of the nuclear structure of neutron-rich radium
K. M. Lynch[1,*], S. G. Wilkins[2], J. Billowes[2], C. L. Binnersley[2], M. L. Bissell[2], K. Chrysalidis[3,4], T. E. Cocolios[5], T. Day Goodacre[2,3,†], R. P. de Groote[5], G. J. Farooq-Smith[5], D. V. Fedorov[6], V. N. Fedosseev[3], K. T. Flanagan[2], S. Franchoo[7], R. F. Garcia Ruiz[2], W. Gins[5], R. Heinke[4], Á. Koszorús[5], B. A. Marsh[3], P. L. Molkanov[6], P. Naubereit[4], G. Neyens[5], C. M. Ricketts[2], S. Rothe[3], C. Seiffert[3], M. D. Seliverstov[4], H. H. Stroke[8], D. Studer[4], A. R. Vernon[2], K. D. A. Wendt[4], and X. F. Yang[5]
Published 7 February 2018

Phys. Rev. Lett. 120, 062503 (2018) https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.062503
Dawning of the N = 32 Shell Closure Seen through Precision Mass Measurements of Neutron-Rich Titanium Isotopes
E. Leistenschneider[1,2,*], M. P. Reiter[1,3], S. Ayet San Andrés[3,4], B. Kootte[1,5], J. D. Holt[1], P. Navrátil[1], C. Babcock[1], C. Barbieri[6], B. R. Barquest[1], J. Bergmann[3], J. Bollig[1,7], T. Brunner[1,8], E. Dunling[1,9], A. Finlay[1,2], H. Geissel[3,4], L. Graham[1], F. Greiner[3], H. Hergert[10], C. Hornung[3], C. Jesch[3], R. Klawitter[1,11], Y. Lan[1,2], D. Lascar[1,†], K. G. Leach[12], W. Lippert[3], J. E. McKay[1,13], S. F. Paul[1,7], A. Schwenk[11,14,15], D. Short[1,16], J. Simonis[17], V. Somà[18], R. Steinbrügge[1], S. R. Stroberg[1,19], R. Thompson[20], M. E. Wieser[20], C. Will[3], M. Yavor[21], C. Andreoiu[16], T. Dickel[3,4], I. Dillmann[1,13],

G. Gwinner[5], W. R. Plaß[3,4], C. Scheidenberger[3,4], A. A. Kwiatkowski[1,13], and J. Dilling[1,2]
Published 9 February 2018

Phys. Lett. B 777, 281 (2018) https://www.sciencedirect.com/science/article/pii/S0370269317310134
Coherent gamma photon generation in a Bose–Einstein condensate of ^{135m}Cs
Luca Marmugi[a], Philip M. Walker[b], Ferruccio Renzoni[a]
10 February 2018

Physics Letters B 777, 151 (2018) http://www.sciencedirect.com/science/article/pii/S037026931730998X
Constraining the magnitude of the Chiral Magnetic Effect with Event Shape Engineering in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 2.76 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 10 February 2018

Physics Letters B 777, 250 (2018) https://www.sciencedirect.com/science/article/pii/S0370269317309863
Reorientation-effect measurement of the first 2^+ state in ^{12}C: Confirmation of oblate deformation
M.Kumar Raju[ab1] J.N.Orce[a] P.Navrátil[c] G.C.Ball[c] T.E.Drake[d] S.Triambak[ab] G.Hackman[c] C.J.Pearson[c] K.J.Abrahams[a] E.H.Akakpo[a] H.Al Falou[c] R.Churchman[c2] D.S.Cross[e] M.K.Djongolov[c] N.Erasmus[a] P.Finlay[f] A.B.Garnsworthy[c] P.E.Garrett[f] D.G.Jenkins[g] R.Kshetri[ch] K.G.Leach[f] S.Masango[a] D.L.Mavela[a] C.V.Mehl[a] M.J.Mokgolobotho[a] C.Ngwetsheni[a] G.G.O'Neill[a] E.T.Rand[f] S.K.L.Sjue[c] C.S.Sumithrarachchi[f] C.E.Svensson[f] E.R.Tardiff[c] S.J.Williams[c] J.Wong[c]
10 February 2018

Phys. Rev. C 97, 024906 (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.024906
Systematic studies of correlations between different order flow harmonics in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 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 12 February 2018

Phys. Rev. C 97, 024611 (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.024611
Effects of unconventional breakup modes on incomplete fusion of weakly bound nuclei
Alexis Diaz-Torres and Daanish Quraishi
Published 16 February 2018

Phys. Rev. C 97, 021303(R) (2018) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.021303
Doubly magic nuclei from lattice QCD forces at MPS=469MeV/c^2
C. McIlroy[1,*], C. Barbieri[1,†], T. Inoue[2,3], T. Doi[3,4], and T. Hatsuda[3,4]
Published 20 February 2018

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2. News to Report

a. Neutron detectors with AGATA at Ganil

This photo shows the most recent AGATA set-up at GANIL with an array of neutron detectors.
The neutron detectors, which are located downstream of the target, are from the old "neutron wall" and the more recent NEDA project.
This set-up will operate throughout 2018 in a series of experiments with the DIAMANT charged particle array or the fast timing detectors FATIMA or with a plunger for lifetime measurements.

Photo courtesy of Ian Burrows and Mike Cordwell from Daresbury Laboratory who were responsible for the design and installation of this set-up at the beginning of February.
Contribution by John Simpson
John.Simpson@stfc.ac.uk (STFC Daresbury)

b. Cosmic-ray muography meeting
The innovative imaging technique of muography uses naturally-occurring background radiation in the form of cosmic-ray muons to characterise a diverse range of complex structures that cannot be imaged using conventional techniques. Research interest in muography is at an all-time high and this proposed meeting aims to unite the global community, encourage international collaboration and engage industry via dedicated user-led sessions.
More information on the schedule of talks and the speaker biographies will be available soon. Speaker abstracts will be available closer to the meeting date. Several STFC-funded speakers have been invited to present their research at this meeting as well as leading researchers from across the globe.
Attending this event:
This is a residential conference, which allows for increased discussion and networking and is free to attend.
- Advanced registration essential (more information on registration will be available soon)
- Catering and accommodation available to purchase during registration.
For further information go to the meeting website or send enquiries to the Scientific Programmes team.
This international meeting is organised by Dr David Mahon, Professor Ralf Kaiser, Professor David Ireland, Dr Craig Shearer and Professor Raffaello D'Alessandro.
Contribution by David Mahon
David.Mahon@glasgow.ac.uk (Glasgow)

c. FAIR film: Explore the Universe in the lab
In Darmstadt the world-wide unique particle accelerator facility FAIR is under construction. The Facility for Antiproton and Ion Research (FAIR) will be one of the largest and most complex accelerator facilities in the world. The centrepiece of the facility is a ring accelerator with a circumference of 1,100 meters. Around 3,000 scientists from all over the world will be able to conduct top-level research at FAIR. Their outstanding experiments will generate new fundamental insights into the structure of matter and the evolution of the universe.
The FAIR Public Relations Team have developed a video promoting the FAIR project. It is now available on YouTube with subtitles in: Finnish, French, Hindi, Polish, Romanian, Russian, Slovenian and Swedish.
If you have any questions please contact the Public Relations team of FAIR/GSI (socialmedia@gsi.de) for further information.
Contribution by Jenny Hiscock
Jenny.Hiscock@stfc.ac.uk (STFC)

d. Behaviour of exotic titanium isotopes confounds expectations
Precise weighing of very rare titanium isotopes has revealed subtle behaviours that have stymied predictions of the most successful theories of nuclear matter.
After more than one hundred years of studying the atomic nucleus, scientists are still seeking a unified theory that explains the behaviour of all nuclear matter. Most competing theoretical models explain everyday nuclei equally well, so physicists are now conducting measurements on rare and exotic nuclei to look for specific behaviors that can help differentiate amongst their modern nuclear models and elucidate more complex mechanisms at play within the nucleus.
One such behaviour is the formation of so-called "closed shells": specific combinations of the neutrons or protons in nuclei that make them bind together more tightly, which impacts the mass of the nucleus. One of these closed shells forms in some nuclei with 32 neutrons (N=32), but not in others. It is seen in potassium (with 19 protons, or Z=19), calcium (Z=20) and scandium (Z=21), but not in vanadium (Z=23) and heavier elements. The element in between scandium and vanadium, titanium (Z=22), is thus a prime candidate for studying how and why this neutron closed shell disappears.
To probe this weird neutron shell closure behaviour, a team working at Vancouver-based TRIUMF (Canada's national particle accelerator centre) produced exotic, radioactive forms of titanium and weighed them with the ultra-precise mass spectrometers at TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) facility.

The mass measurements required a high degree of resolution not normally required for studies of this nature. Moreover, since the short-lived forms of titanium could only be produced at a rate of a few per second, the process also had to be much more efficient than conventional investigations. The TITAN team collaborated with the University of Giessen on a new technology to satisfy these requirements - the exotic nuclei perform laps around a custom-built "particle racetrack" for many turns, providing a standardized travel time that can be compared to a lighter particle of known mass. With this technique, tiny mass differences can be accurately measured. As a cross-check, some measurements were repeated with the well-known Penning trap method, with the results showing that the two techniques agreed beautifully.

The results indicated that the N=32 neutron shell still exists in titanium, but that the bond energy is very weak compared to titanium's lighter cousins. These results are of great importance because these oddly-behaved shells, those that appear or disappear depending on certain properties of nuclear matter, are powerful testing grounds for our current nuclear theories. In fact, four of the most successful modern theories were challenged by these new measurements, including a prediction that the shell effects in titanium should be twice as strong as observed by the experiment. The TITAN team's work exposes critical missing pieces in our knowledge about how nuclear matter behaves and provides unique and crucial input for the construction of future nuclear models.

Contribution by Eleanor Dunling *ed897@york.ac.uk (York & TRIUMF)*

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3. Outreach Activity

Cunard Lecture Series

At the end of January, Elizabeth Cunningham gave a series of three nuclear physics related lectures on the Cunard ocean liner Queen Elizabeth sailing from New York to Aruba. Each lecture was attended by 250-300 people and covered topics related to nuclear astrophysics, radiation protection in space and dark matter.

Contribution by Elizabeth Cunningham *Elizabeth.Cunningham@stfc.ac.uk (STFC & Surrey)*

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4. Media Interactions

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