UK Nuclear Activity

April 2017 Issue 46

In this issue,

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

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

Nuclear Physics Outreach Poster – order hardcopies from STFC free of charge here

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1. Nuclear Physics Publications for April*

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 95, 014321 (2017) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.95.014321
Investigation of negative-parity states in ^{156}Dy: Search for evidence of tetrahedral symmetry
D. J. Hartley[1], L. L. Riedinger[2], R. V. F. Janssens[3], S. N. T. Majola[4], M. A. Riley[5], J. M. Allmond[6,7], C. W. Beausang[6], M. P. Carpenter[3], C. J. Chiara[3,8,9,*], N. Cooper[10], D. Curien[11,12], B. J. P. Gall[11,12], P. E. Garrett[13], F. G. Kondev[9], W. D. Kulp[14], T. Lauritsen[3], E. A. McCutchan[3,15], D. Miller[2,†], S. Miller[5], J. Piot[11,12], N. Redon[16], J. F. Sharpey-Schafer[17], J. Simpson[18], I. Stefanescu[3,8], X. Wang[5,‡], V. Werner[10,§], J. L. Wood[14], C.-H. Yu[7], S. Zhu[3], and J. Dudek[11,19]
*Published 20 January 2017

Phys. Rev. C 95, 024328 (2017) https://journals.aps.org/prc/abstract/10.1103/PhysRevC.95.024328
γ-ray spectroscopy of low-lying excited states and shape competition in ^{194}Os
T. Daniel[1,2,*], S. Kisyov[3], P. H. Regan[1,4], N. Marginean[3], Zs. Podolyák[1], R. Marginean[3], K. Nomura[5,6], M. Rudigier[1], R. Mihai[3], V. Werner[7], R. J. Carroll[1], L. A. Gurgi[1], A. Oprea[3], T. Berry[1], A. Serban[3,8], C. R. Nita[3], C. Sotty[3], R. Suvaila[3], A. Turturica[3], C. Costache[3], L. Stan[3], A. Olacel[3], M. Boromiza[3,8], and S. Toma[3]
*Published 28 February 2017

JPS Conf. Proc. 14, 021001 (2017) http://journals.jps.jp/doi/abs/10.7566/JPSCP.14.021001
Fusion Cross Sections of Astrophysics Interest Within the STELLA Project
Sandrine Courtin[1,2,3,*], Guillaume Fruet[1,2], David G. Jenkins[4], Marcel Heine[1,2], Daniele Montanari[1,2,3], Luke G. Morris[4], Gavin Lotay[5], Patrick H. Regan[5], Oliver S. Kirsebom[6], Serge Della Negra[7], Faïrouz Hammache[7], Nicolas de Sereville[7], Beyhan Bastin[8], François de Oliveira[8], Giacomo Randisi[8], Christelle Stodel[8], Christian Beck[1,2], Florent Haas[1,2]
*Published 28 February 2017

*Also including missed publications from previous months.

A. Phys. Pol. B 48 No. 3 – March 2017
Zakopane Conference on Nuclear Physics Extremes of the Nuclear Landscape
A. Phys. Pol. B 48, 351 (2017) http://www.actaphys.uj.edu.pl/fulltext?series=Reg&vol=48&page=351
Fast Timing Measurement Using an LaBr3(Ce) Scintillator Detector Array Coupled with Gammasphere
M. Rudigier,†, S. Lalkovski, E.R. Gamba, A.M. Bruce, Zs. Podolyak, P.H. Regan, M. Carpenter, S. Zhu, A.D. Ayangeakaa, J.T. Anderson, T. Berry, S. Bottoni, I. Burrows, R. Carroll, P. Copp, D. Cullen, T. Daniel, L. Fraile, M. Carmona Gallardo, A. Grant, J.P. Greene, L.A. Guegi, D. Hartley, R. Ilieva, S. Ilieva, R.V.F. Janssens, F.G. Kondev, T. Kröll, G.J. Lane, T. Lauritsend, I. Lazaruse, G. Lotaya, G. Fernandez Martinezj, V. Pucknelle, M. Reedl, J. Rohrerd, J. Sethid, D. Seweryniak, C.M. Shand, J. Simpson, M. Smolen, E. Stefanova, V. Vedia, O. Yordanov
*Published March 2017

A. Phys. Pol. B 48, 395 (2017) http://www.actaphys.uj.edu.pl/fulltext?series=Reg&vol=48&page=395
Production and Study of Neutron-rich Nuclei Using the LICORNE Directional Neutron Source
J.N. Wilson, M. Lebois, L. Qi, P. Amador-Celdran, D. Bleuel, J.A. Briz, R. Carroll, W. Catford, H. De Witte, D. Doherty, R. Eloirdi, G. Georgiev, A. Gottardo, A. Goasduff, K. Hadynska-Klek, K. Hauschild, M. Hess, V. Ingeberg, T. Konstantinopoulosh J. Ljungvallh A. Lopez-Martensh , G. Lorussok , R. Lozeval,h , R. Lutterm P. Marinin , I. Mateaa , T. Materna, L. Mathieu, A. Oberstedt, S. Oberstedt, S. Panebianco, Z. Podolyak, A. Porta, P.H. Regan, P. Reiter, K. Rezynkina, S.J. Rose, E. Sahin, M. Seidlitz, R. Shearman, B. Siebeck, S. Siem, A.G. Smith, G.M. Tveten, D. Verney, N. Warr, F. Zeiser, M. Zielinska
*Published March 2017

A. Phys. Pol. B 48, 601 (2017) http://www.actaphys.uj.edu.pl/fulltext?series=Reg&vol=48&page=601
Isomer Spectroscopy of Neutron-rich ^{165,167}Tb
L.A. Gurgi, P.H. Regan, P.-A. Söderström, H. Watanabe, P.M. Walker, Zs. Podolyák, S. Nishimura, T.A. Berry, P. Doornenbal, G. Lorussoa, T. Isobe, H. Baba, Z.Y. Xu, H. Sakurai, T. Sumikama, W.N. Catford, A.M. Bruce, F. Browne, G.J. Lane, F.G. Kondev, A. Odahara, J. Wu, H.L. Liu, F.R. Xu, Z. Korkulu, P. Lee, J.J. Liu, V.H. Phong, A. Yagi, G.X. Zhang, T. Alharbi, R.J. Carroll, K.Y. Chae, Zs. Dombradi, A. Estrade, N. Fukuda, C. Griffin, E. Ideguchi,, N. Inabe, H. Kanaoka, I. Kojouharov, T. Kubo, S. Kubono, N. Kurz, I. Kuti, S. Lalkovski, E.J. Lee, C.S. Lee, G. Lotay, C.B. Moon, I. Nishizuka, C.R. Nita , Z. Patel, O.J. Roberts, H. Schaffner, C.M. Shand, H. Suzuki, H. Takeda, S. Terashima, Zs. Vajta, S. Kanaya, J.J. Valiente-Dobón
*Published March 2017

Journal of Physics G: Nuclear and Particle Physics
Focus on Exotic Beams at ISOLDE: A Laboratory Portrait
J. Phys. G: Nucl. Part. Phys. 44 044012 (2017)
http://iopscience.iop.org/article/10.1088/1361-6471/aa5c4e
Nuclear-structure studies of exotic nuclei with MINIBALL
P A Butler[1], J Cederkall[2] and P Reiter[3]
*Published 9 March 2017

J. Phys. G: Nucl. Part. Phys. 44 054005 (2017)
http://iopscience.iop.org/article/10.1088/1361-6471/aa6411/
Physics with post accelerated beams: nuclear astrophysics
A St J Murphy
Published 3 April 2017

J. Phys. G: Nucl. Part. Phys. 44 064002 (2017)
http://iopscience.iop.org/article/10.1088/1361-6471/aa6642
Collinear laser spectroscopy at ISOLDE: new methods and highlights
R Neugart[1,2], J Billowes[3], M L Bissell[3], K Blaum[1], B Cheal[4], K T Flanagan[3], G Neyens[5], W Nörtershäuser[6] and D T Yordanov[7]
Published 19 April 2017

J. Phys. G: Nucl. Part. Phys. 44 064004 (2017)
http://iopscience.iop.org/article/10.1088/1361-6471/aa691e
Landau parameters for energy density functionals generated by local finite-range pseudopotentials
A Idini[1,2,7], K Bennaceur[1,3,4] and J Dobaczewski[1,4,5,6]
Published 24 April 2017

Phys. Lett. B, 767, 474 (2017) http://www.sciencedirect.com/science/article/pii/S037026931730103X
The role of core excitations in the structure and decay of the 16^+ spin-gap isomer in ^{96}Cd
P.J. Davies[a,*], H. Grawe[b], K. Moschner[c,g], A. Blazhev[c], R. Wadsworth[a], P. Boutachkov[d], F. Ameil[b], A. Yagi[e], H. Baba[g], T. Bäck[h], M. Dewald[c], P. Doornenbal[g], T. Faestermann[k], A. Gengelbach[i], J. Gerl[b], R. Gernhäeuser[k], S. Go[n], M. Górska[b], E. Gregor[d], T. Isobe[g], D.G. Jenkins[a], H. Hotaka[n], J. Jolie[c], I. Kojouharov[b], N. Kurz[b], M. Lewitowicz[o], G. Lorusso[g], L. Maier[k], E. Merchan[d], F. Naqvi[j], H. Nishibata[f], D. Nishimura[n], S. Nishimura[g], F. Nowacki[p], N. Pietralla[d], H. Schaffner[b], P.-A. Söderström[g], H.S. Jung[n], K. Steiger[k], T. Sumikama[l], J. Taprogge[m], P. Thöle[c], N. Warr[c], H. Watanabe[g], V. Werner[d,i], Z.Y. Xu[g], K. Yoshinaga[g], Y. Zhu[n]
Published 10 April 2017

Eur. Phys. J. A (2017) 53: 66 https://link.springer.com/article/10.1140%2Fepja%2Fi2017-12257-x
Elastic scattering phenomenology
R.S. Mackintosh
Published 11 April 2017

JINST 12 P04006 (2017) http://iopscience.iop.org/article/10.1088/1748-0221/12/04/P04006
Conceptual design of a hybrid neutron-gamma detector for study of β-delayed neutrons at the RIB facility of RIKEN
A. Tarifeño-Saldivia[a,b], J.L. Tain[b], C. Domingo-Pardo[b], F. Calviño[a], G. Cortés[a], V.H. Phong[c], A. Riego[a], J. Agramunt[b], A. Algora[b,p], N. Brewer[d,f], R. Caballero-Folch[g], P.J. Coleman-Smith[k], T. Davinson[h], I. Dillmann[g], A. Estradé[h,n,o], C.J. Griffin[h], R. Grzywacz[e], L.J. Harkness-Brennan[j], G.G. Kiss[c,p], M. Kogimtzis[k], M. Labiche[k], I.H. Lazarus[k], G. Lorusso[s,i], K. Matsui[c], K. Miernik[r], F. Montes[m,n], A.I. Morales[b], S. Nishimura[c], R.D. Page[j], Z.S. Podolyák[j], V.F.E. Pucknell[k], B.C. Rasco[d,f], P. Regan[i], B. Rubio[b], K.P. Rykaczewski[d], Y. Saito[c,g], H. Sakurai[c], J. Simpson[k], E. Sokol[t], R. Surman[q], A. Svirkhin[t], S.L. Thomas[l], A. Tolosa[b] and P. Woods[h]
Published 12 April 2017

Physica Scripta
Focus issue on Nuclear Shapes and Symmetries: From Experiment to Theory
Phys. Scr. 92 054001 (2017) http://iopscience.iop.org/article/10.1088/1402-4896/aa694d
Isomer building blocks and K-forbidden decays
P M Walker
Published 12 April 2017

Phys. Scr. 92 054004 (2017) http://iopscience.iop.org/article/10.1088/1402-4896/aa6942
Toward lifetime and *g* factor measurements of short-lived states in the vicinity of ^{208}Pb
D Ralet[1], G Georgiev[1], A E Stuchbery[2], E Clément[3], A Lemasson[3], C Michelagnoli[3], M Rejmund[3], L Atanasova[4], D L Balabanski[5], G Bocchi[6], R Carroll[7], A Dewald[8], J Dudouet[9], B Fornal[10], G de France[3], S Franchoo[11], C Fransen[8], C Müller-Gatermann[8], A Goasduff[12], A Gadea[13], B Jacquot[3], P R John[14], D Kocheva[15], T Konstantinopoulos[1], A Korichi[1], A Kusoglu[5,16], S M Lenzi[14], S Leoni[6], J Ljungvall[1], R Lozeva[17], A Maj[10], A Navin[3], R Perez[13], N Pietralla[18], C Shand[7], O Stezowski[9] and D Yordanov[11]
Published 20 April 2017

Eur. Phys. J. C (2017) 77: 245 http://link.springer.com/article/10.1140/epjc/s10052-017-4779-8
Measurement of azimuthal correlations of D mesons with charged particles in pp collisions at $\sqrt{s}$ = 7 TeV and p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV
ALICE Collaboration, UK Authors: D. Alexandre, L. S. Barnby, M. Borri, M. Chartier, D. Evans, M. A. S. Figueredo, K. L. Graham, P. G. Jones, A. Jusko, K. Krivda, R. Lemmon, R. Lietava, J. Norman, O. Villalobos Baillie, N. Zardoshti
Published 17 April 2017

Phys. Rev. Lett. 118, 162501 (2017) https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.118.162501
$^{96}_{36}Kr_{60}$–Low-Z Boundary of the Island of Deformation at N=60
J. Dudouet[1,*], A. Lemasson[2], G. Duchêne[3], M. Rejmund[2], E. Clément[2], C. Michelagnoli[2], F. Didierjean[3], A. Korichi[4,2], G. Maquart[1], O. Stezowski[1], C. Lizarazo[5,6], R. M. Pérez-Vidal[7], C. Andreoiu[8], G. de Angelis[9], A. Astier[4], C. Delafosse[10], I. Deloncle[4], Z. Dombradi[11], G. de France[2], A. Gadea[7], A. Gottardo[10], B. Jacquot[2], P. Jones[12], T. Konstantinopoulos[4], I. Kuti[11], F. Le Blanc[3], S. M. Lenzi[13,14], G. Li[6], R. Lozeva[3,4], B. Million[15], D. R. Napoli[9], A. Navin[2], C. M. Petrache[4], N. Pietralla[5], D. Ralet[5,4], M. Ramdhane[16], N. Redon[1], C. Schmitt[2], D. Sohler[11], D. Verney[10], D. Barrientos[17], B. Birkenbach[18], I. Burrows[19], L. Charles[3], J. Collado[20], D. M. Cullen[21], P. Désesquelles[4], C. Domingo Pardo[7], V. González[20], L. Harkness-Brennan[22], H. Hess[18], D. S. Judson[22], M. Karolak[23], W. Korten[23], M. Labiche[19], J. Ljungvall[4], R. Menegazzo[13], D.

Mengoni[13,14], A. Pullia[15,24], F. Recchia[13,14], P. Reiter[18], M. D. Salsac[23], E. Sanchis[20], Ch. Theisen[23], J. J. Valiente-Dobón[9], and M. Zielińska[23]
Published 17 April 2017

Phys. Rev. Lett. 118, 162302 (2017) https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.118.162302
Flow Dominance and Factorization of Transverse Momentum Correlations in Pb-Pb Collisions at the LHC
ALICE Collaboration, UK Authors: D. Alexandre, H. A. Andrews, L. S. Barnby, M. Borri, M. Chartier, D. Evans, M. A. S. Figueredo, K. L. Graham, P. G. Jones, A. Jusko, K. Krivda, R. Lemmon, R. Lietava, J. Norman, O. Villalobos Baillie, N. Zardoshti
Published 21 April 2017

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2. News to Report

a. 6th Workshop on "Nuclear Fission and Spectroscopy of Neutron-rich Nuclei"
This workshop was held at Chamrousse (France) on 20-24th March 2017 https://indico.ill.fr/indico/event/64/. The workshop was co-organized by several French laboratories and by the Nuclear Physics Group of the University of York. This workshop brought together the community studying nuclear fission and its applications, and the community performing spectroscopy of neutron-rich nuclei respectively. Close to 90 participants from across the world attended the event.
The workshop was aimed at the presentation of recent experiments, results and ideas for future work on fission and neutron-rich nuclei at existing facilities, etc. using various types of fission experiments as well as beta-decay, isomer, in-beam and laser spectroscopy, lifetime and magnetic moment measurements of neutron-rich nuclei. Fission sessions covered experiments and theory respectively. Emphasis was also put on future studies that are possible at currently existing facilities and with new instruments and facilities such as FIPPS at ILL, NFS and S3 at SPIRAL2, SPES, ARIEL, FRIB, etc. which will open new perspectives over the next few years.

Contribution by Andrei Andreyev
andrei.andreyev@york.ac.uk (York)

b. Conference on Applied Radiation Metrology (CARM2017)
We're pleased to announce that the 2017 Conference on Applied Radiation Metrology (CARM2017) will take place at NPL, Teddington, on 7-9 November 2017.
The themes of the conference will include:

- Quality Assurance for radioactivity measurement in the nuclear industry
- Novel technologies (e.g. for radiochemical separation) and measurement techniques, including sampling strategies
- Radiation Protection and the measurement of airborne radioactivity (incorporating IRMF and ARMUG)

If you are interested in giving a presentation at the conference, please contact NPL events with the provisional title of your talk by **28 April 2017**. This is important for helping us structure the agenda. Note that we welcome progress reports as well as completed projects.
There will also be an industrial exhibition throughout the conference.
Further details and how to register will be available in July.
Contribution by Paddy Regan
p.regan@surrey.ac.uk (Surrey & NPL)

c. New ALICE results show novel phenomena in proton collisions
In Nature Physics the ALICE collaboration reports that proton collisions sometimes present similar patterns to those observed in the collisions of heavy nuclei. This behaviour was spotted through observation of strange hadrons in certain proton collisions in which a large number of particles are created. The observed 'enhanced production of strange particles' is a familiar feature of quark-gluon plasma and is commonly created in collisions of heavy nuclei. But it is the first time ever that such a phenomenon is unambiguously

observed in the rare proton collisions in which many particles are created. This result is likely to challenge existing theoretical models that do not predict an increase of strange particles in these events.

The study of the quark-gluon plasma provides a way to investigate the properties of the strong interaction, while enhanced strangeness production is a manifestation of this state of matter. The quark-gluon plasma is produced at sufficiently high temperature and energy density, when ordinary matter undergoes a transition to a phase in which quarks and gluons become 'free' and are thus no longer confined within hadrons. These conditions can be obtained at the Large Hadron Collider by colliding heavy nuclei at high energy. Strange quarks are heavier than the quarks composing normal matter, and typically harder to produce. But this changes in presence of the high energy density of the quark-gluon plasma, which rebalances the creation of strange quarks relative to non-strange ones. This phenomenon may now have been observed within proton collisions as well.

In particular, the new results show that the production rate of these strange hadrons increases with the 'multiplicity' – the number of particles produced in a given collision – faster than that of other particles generated in the same collision. While the structure of the proton does not include strange quarks, data also show that the higher the number of strange quarks contained in the induced hadron, the stronger is the increase of its production rate. No dependence on the collision energy or the mass of the generated particles is observed, demonstrating that the observed phenomenon is related to the strange quark content of the particles produced. Strangeness production is in practice determined by counting the number of strange particles produced in a given collision, and calculating the ratio of strange to non-strange particles.

The Birmingham group played a leading role in the preparation of the results used in this paper.

Contribution from http://home.cern/about/updates/2017/04/new-alice-results-show-novel-phenomena-proton-collisions and edited by Lee Barnby lee.stuart.barnby@cern.ch (on behalf of UK ALICE collaborators)

d. IOP Nuclear Physics conference 2017

In the first week of April, many from the community gathered in Birmingham for the annual IOP Nuclear Physics conference. As well as interesting talks, including many from students and young post-docs, there was an STFC Town Meeting -- well attended by both the research council and nuclear community. The new CEO of STFC, Brian Bowsher, opened the town meeting, Sean Freeman and Andy Boston gave Science Board and Roadmap updates respectively and Elizabeth Cunningham presented outreach activities.

As well as the usual talk and poster sessions there was a student-focused role-model event with pizza, drinks and the York Lego binding blocks all of which elicited very positive feedback from the students attending.

Next year's IOP conference will be organised by the University of the West of Scotland.

Contribution by Tzany Kokalova Wheldon t.kokalova@bham.ac.uk (Birmingham)

e. IOP Early Career Award 2016

Dr Frank Browne, University of Brighton (now based at RIKEN, Japan), was presented with the IOP Nuclear Physics Group Early Career Award 2016 at the recent IOP conference in Birmingham. Frank then gave an invited talk about his winning research on 'The lifetimes of the first excited 2+ states in neutron-rich Zr-104, 106'.

Contribution by Tzany Kokalova Wheldon t.kokalova@bham.ac.uk (on behalf of the IOP NPG committee)

3. Outreach Activity

The Naked Scientists go Nuclear

This year we celebrate the 100th anniversary of Ernest Rutherford's landmark experiments that established our modern understanding of the atom with a positively charged, heavy and dense nucleus at the centre of the atom surrounded by the much lighter negatively charged electrons. To mark this centenary, the Naked Scientists produced a radio programme featuring a strong focus on nuclear physics. It went out live on BBC Radio Cambridgeshire, but you can listen to the podcast available at https://nakeddiscovery.com/download/audio/Naked_Scientists_Show_17.03.28_ad.mp3. Starting at the 28:30 minute mark Malcolm Longair covers historical aspects before Paddy Regan (Surrey) and Marialuisa Aliotta (Edinburgh) cover nuclear power and the creation of elements in stars. The program is brought to a close with Rodi Herzberg taking a look at the four new elements named earlier this year, which complete the 7th row of the periodic table.

Continuing this theme Rodi gave a public lecture on "Alchemy in the 21st century – A journey to the end of the periodic table" as part of the IoP Nuclear Physics Conference in Birmingham (Monday, 3rd April at 19:00, see http://nuc17.iopconfs.org/home).

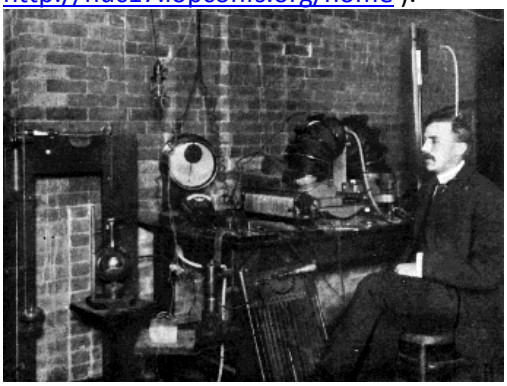

Figure 1 Ernest Rutherford in his Laboratory at McGill, ca 1905.

Contribution by Rodi Herzberg R.Herzberg@liverpool.ac.uk (Liverpool)

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4. Media Interactions

The Naked Scientists, Inside the Atom: 100 Years On

Profs. Paddy Regan (NPL& U. Surrey - nuclear power), Marialuisa Alliotta (U. Edinburgh - nucleosynthesis) and Rodi Herzberg (U. Liverpool - Superheavy Elements) were all contributors to the recent specialist Naked Scientists podcast focussing on nuclear physics.

This was first presented live on BBC Radio Cambridge on 26th March 2017 and then uploaded as a podcast for the BBC 5 live and Naked Scientists webpage.

Follow the links for the separate podcasts:

Paddy's interview on nuclear power
https://www.thenakedscientists.com/articles/interviews/how-does-nuclear-energy-work

Marialuisa's interview on nucleosynthesis
https://www.thenakedscientists.com/articles/interviews/children-starlight

Rodi's interview on superheavy elements
https://www.thenakedscientists.com/articles/interviews/building-new-heavy-elements

Contribution by Paddy Regan p.regan@surrey.ac.uk (Surrey & NPL), Marialuisa Aliotta maliotta@staffmail.ed.ac.uk (Edinburgh) & Rodi Herzberg R.Herzberg@liverpool.ac.uk (Liverpool)

ALICE in Nature Physics

The publication discussed in Section C has started to be picked up by various websites:

Symmetry Magazine
International Business Times
Phy.org
Newsweek

Contribution by Lee Barnby lee.stuart.barnby@cern.ch (on behalf of UK ALICE collaborators)