



UK Nuclear Activity

May 2020 Issue 83

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

Nuclear Physics Public Engagement Website: [NuclearPhysicsForYou](#)

[Nuclear Physics Outreach Poster](#) – order hardcopies from STFC free of charge [here](#)

1. Nuclear Physics Publications for May (also includes missed publications from previous months)

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. Lett. **124**, 132502 (Editor's pick)

<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.132502>

Charge Radius of the Short-Lived ^{68}Ni and Correlation with the Dipole Polarizability

[S. Kaufmann](#)¹, [J. Simonis](#)², [S. Bacca](#)^{2,3}, [J. Billowes](#)⁴, [M. L. Bissell](#)⁴, [K. Blaum](#)⁵, [B. Cheal](#)⁶, [R. F. Garcia Ruiz](#)^{4,7,†}, [W. Gins](#)⁸, [C. Gorges](#)¹, [G. Hagen](#)⁹, [H. Heylen](#)^{5,7}, [A. Kanellakopoulos](#)⁸, [S. Malbrunot-Ettenauer](#)⁷, [M. Miorelli](#)¹⁰, [R. Neugart](#)^{5,11}, [G. Neyens](#)^{7,8}, [W. Nörtershäuser](#)^{1,*}, [R. Sánchez](#)¹², [S. Sailer](#)¹³, [A. Schwenk](#)^{1,5,14}, [T. Ratajczyk](#)¹, [L. V. Rodríguez](#)^{15,‡}, [L. Wehner](#)¹⁶, [C. Wraith](#)⁶, [L. Xie](#)⁴, [Z. Y. Xu](#)⁸, [X. F. Yang](#)^{8,17}, and [D. T. Jordanov](#)¹⁵

Published 1 April 2020

Eur. Phys. J. WoC **232**, 03005 (2020)

<https://link.springer.com/article/10.1140/epjc/s10052-019-7389-9>

Role of the Surface Energy in Heavy-Ion Collisions

[P. D. Stevenson](#)

Published 6 April 2020

Eur. Phys. J. A (2020) 56: 75

https://epja.epj.org/articles/epja/abs/2020/03/10050_2020_Article_77/10050_2020_Article_77.html

A new approach to monitor ^{13}C -targets degradation in situ for $^{13}\text{C}(\alpha, n)^{16}\text{O}$ cross-section measurements at LUNA

G. F. Ciani^{1,2,3*}, L. Csedreki^{1,2**}, J. Balibrea-Correa^{4,5}, A. Best^{4,5}, M. Aliotta⁶, F. Barile⁷, D. Bemmerer⁸, A. Boeltzig^{1,2}, C. Brogini⁹, C. G. Bruno⁶, A. Caciolli^{9,10}, F. Cavanna¹¹, T. Chillery⁶, P. Colombetti^{12,13}, P. Corvisiero^{11,14}, T. Davinson⁶, R. Depalo⁹, A. Di Leva^{4,5}, L. Di Paolo², Z. Elekes³, F. Ferraro^{11,14}, E. M. Fiore^{7,15}, A. Formicola², Zs. Fülöp³, G. Gervino^{12,13}, A. Guglielmetti^{16,17}, C. Gustavino¹⁸, Gy. Gyürky³, G. Imbriani^{4,5}, M. Junker², I. Kochanek², M. Lugaro¹⁹, P. Marigo^{9,10}, E. Masha^{16,17}, R. Menegazzo⁹, V. Mossa⁷, F. R. Pantaleo^{7,20}, V. Paticchio⁷, R. Perrino^{7,24}, D. Piatti^{9,10}, P. Prati^{11,14}, L. Schiavulli^{7,15}, K. Stöckel^{8,21}, O. Straniero^{2,22}, T. Szücs⁸, M. P. Takács^{8,21,25}, F. Terrasi²³, D. Trezzi^{16,17} and S. Zavatarelli¹¹

Published 3 March 2020

Phys. Rev. Lett. **124**, 192701

<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.192701>

Advances in the Direct Study of Carbon Burning in Massive Stars

G. Fruet^{1,2}, S. Courtin^{1,2,3,*}, M. Heine^{1,2,†}, D. G. Jenkins⁴, P. Adsley⁵, A. Brown⁴, R. Canavan^{6,7}, W. N. Catford⁶, E. Charon⁸, D. Curien^{1,2}, S. Della Negra⁵, J. Duprat⁹, F. Hammache⁵, J. Lesrel⁵, G. Lotay⁶, A. Meyer⁵, D. Montanari^{1,2,3}, L. Morris⁴, M. Moukaddam⁶, J. Nippert^{1,2}, Zs. Podolyák⁶, P. H. Regan^{6,7}, I. Ribaud⁵, M. Richer^{1,2}, M. Rudigier⁶, R. Shearman^{6,7}, N. de Séreville⁵, and C. Stodel¹⁰

Published 12 May 2020

Phys. Rev. Lett. **124**, 212503

<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.212503>

Halo Structure of the Neutron-Dripline Nucleus ^{19}B

K. J. Cook^{1,*}, T. Nakamura¹, Y. Kondo¹, K. Hagino², K. Ogata^{3,4}, A. T. Saito¹, N. L. Achouri⁵, T. Aumann^{6,7}, H. Baba⁸, F. Delaunay⁵, Q. Deshayes⁵, P. Doornenbal⁸, N. Fukuda⁸, J. Gibelin⁵, J. W. Hwang⁹, N. Inabe⁸, T. Isobe⁸, D. Kameda⁸, D. Kanno¹, S. Kim⁹, N. Kobayashi¹, T. Kobayashi¹⁰, T. Kubo⁸, S. Leblond^{5,†}, J. Lee^{8,‡}, F. M. Marqués⁵, R. Minakata¹, T. Motobayashi⁸, K. Muto¹⁰, T. Murakami², D. Murai¹¹, T. Nakashima¹, N. Nakatsuka², A. Navin¹², S. Nishi¹, S. Ogoshi¹, N. A. Orr⁵, H. Otsu⁸, H. Sato⁸, Y. Satou⁹, Y. Shimizu⁸, H. Suzuki⁸, K. Takahashi¹⁰, H. Takeda⁸, S. Takeuchi^{8,1}, R. Tanaka¹, Y. Togano^{7,11}, J. Tsubota¹, A. G. Tuff¹³, M. Vandebrouck^{14,§}, and K. Yoneda⁸

Published 27 May 2020

Phys. Rev. C **101**, 054311

<https://journals.aps.org/prc/abstract/10.1103/PhysRevC.101.054311>

Octupole states in ^{207}Tl studied through β decay

T. A. Berry¹, Zs. Podolyák^{1,*}, R. J. Carroll¹, R. Lică^{2,3}, B. A. Brown⁴, H. Grawe⁵, Ch. Sotty^{3,6}, N. K. Timofeyuk¹, T. Alexander¹, A. N. Andreyev⁷, S. Ansari⁸, M. J. G. Borge², M. Brunet¹, J. R. Cresswell⁹, C. Fahlander¹⁰, L. M. Fraile¹¹, H. O. U. Fynbo¹², E. Gamba¹³, W. Gelletly¹, R.-B. Gerst⁸, M. Górska⁵, A. Gredley⁹, P. Greenlees^{14,15}, L. J. Harkness-Brennan⁹, M. Huyse⁶, S. M. Judge¹⁶, D. S. Judson⁹, J. Konkı^{14,15,†}, M. Kowalska², J. Kurcewicz², I. Kuti¹⁷, S. Lalkovski¹, I. Lazarus¹⁸, M. Lund¹², M. Madurga², N. Mărginean³, R. Mărginean³, I. Marroquin¹⁹, C. Mihai³, R. E. Mihai³, E. Nácher¹⁹, A. Negret³, S. Nae³, C. Niță^{3,13}, S. Pascu³, R. D. Page⁹, Z. Patel¹, A. Perea¹⁹, J. Phrompa²⁰, M. Piersa²¹, V. Pucknell¹⁸, P. Rahkila^{14,15}, E. Rapisarda², P. H. Regan^{1,16}, F. Rotaru³, M. Rudigier¹, C. M. Shand¹, R. Shearman^{1,16}, E. C. Simpson²², S. Stegemann⁸, T. Stora², O. Tengblad¹⁹, A. Turturica³, P. Van Duppen⁶, V. Vedia¹¹, P. M. Walker¹, N. Warr⁸, F. P. Wearing⁹, and H. De Witte⁶

Published 18 May 2020

Phys. Rev. C **101**, 054314

<https://journals.aps.org/prc/abstract/10.1103/PhysRevC.101.054314>

γ -ray spectroscopy of a four-quasiparticle isomer band in ^{174}Re

[R. J. Carroll¹](#), [P. M. Walker¹](#), [G. J. Lane²](#), [M. W. Reed²](#), [A. Akber²](#), [H. M. Albers³](#), [J. J. Carroll⁴](#), [D. M. Cullen⁵](#), [A. C. Dai⁶](#), [C. Fahlander⁷](#), [M. S. M. Gerathy²](#), [S. S. Hota²](#), [G. Lotay¹](#), [T. Kibédi²](#), [V. Margerin⁸](#), [A. J. Mitchell²](#), [N. Palalani²](#), [T. Palazzo²](#), [Z. Patel¹](#), [R. Shearman^{1,9}](#), [A. E. Stuchbery²](#), and [F. R. Xu⁶](#)

Published 26 May 2020

Phys. Rev. C **101**, 055801

<https://journals.aps.org/prc/abstract/10.1103/PhysRevC.101.055801>

Measurement of the $^7\text{Li}(\gamma,t)^4\text{He}$ ground-state cross section between $E_\gamma=4.4$ and 10 MeV

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Published 14 May 2020

2. News to Report

a. UK Lockdown Seminars



A number of members of the UK nuclear physics community have been giving online seminars as part of a series during the lockdown. Several more seminars are scheduled for each week of June.

These are mostly aimed at the nuclear physics community itself, rather than being outreach oriented, but all are welcome.

This is an ongoing effort hosted by the Liverpool and Manchester and more details are on our website:

<http://www.lockdownseminars.co.uk/>

*Contributed by James Smallcombe
(Univ. Liverpool)*

b. National Physics Poster Competition



Congratulations to Mark Griffiths.

On 12th May, Mark Griffiths, a PhD student at the University of Birmingham, was awarded 2nd place in the www.scientistt.net national Physics Poster competition, after being shortlisted by judges followed by a members vote. His poster, entitled “Mass measurement of Re-190”, described how the mass was measured to an accuracy of 5 keV – an improvement of over an order of magnitude – using the Munich Q3D spectrograph in Germany.

Rhenium-190 is populated in the decay of r-process-path nuclei and contains a low-lying metastable state with a half-life of 3.2 hours. The more accurate ground-state mass also means the isomeric state mass is much better constrained.

Mass measurement of Re-190

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Introduction

The purpose of this research was to measure a value for the mass of the isotope, ¹⁹⁰Re, with reduced uncertainty compared to current literature values with the aim of improving understanding of certain astrophysical processes. This was done by producing both ¹⁹⁰Re and a second isotope, ¹⁹²Ir (a well studied nucleus used to calibrate the detector), by bombarding a target isotope with a beam of high energy deuterons (a ²H nucleus, containing a proton and a neutron). Alongside the desired nuclei, α -particle (a ⁴He nucleus, containing two protons and two neutrons) ejection were produced. By measuring the energy of these α -particles the difference in energy given off by the reactions, known as the Q-value, can be calculated. A positive Q-value corresponds to an exothermic reaction where energy is given off and a negative Q-value corresponds to an endothermic reaction which requires a net input of energy to proceed. Subsequently, using known masses for the other particles involved in the reactions, a value of the mass of ¹⁹⁰Re can be calculated, with associated error.

Experimental Procedure

- This experiment was performed at the Maier-Leibnitz Laboratory (MLL) where a deuteron beam was produced using a tandem Van de Graaff particle accelerator at an energy of 18 MeV.
- This beam was directed towards the target isotopes, ¹⁹²Os and ¹⁹²Pt in order to produce ¹⁹⁰Re and ¹⁹²Ir respectively, alongside an α -particle ejection. The heavy nuclei produced in the reaction remain within the target material and are not ejected. This is shown in figure 1.
- The Q3D magnetic spectrograph, shown in figure 2, was used to measure the energy of these ejection particles by using magnets to focus particles onto a focal plane detector. The energy of the particles is proportional to the position at which they intercept the detector [2].
- The output of the Q3D gives the channel (a measure of the physical position on the focal plane) which a particle interacted with, not its energy. By finding expected energies corresponding to the known energy levels in ¹⁹²Ir [5], a calibration between position on the detector and energy can be found, as is shown in figure 3.

Motivations

- ¹⁹⁰Re is neutron rich and is produced in the series of decays from nuclei produced via a process called the astrophysical rapid neutron capture process, or the r-process.
- It is important to understand this process, as approximately half of all atomic nuclei heavier than iron are created through this mechanism [4].
- The r-process, shown in figure 4, involves a nucleus capturing several neutrons in a short time frame (fractions of a second) so that it does not have time to undergo radioactive decay.

Calibration Energy Spectrum

Figure 3: The measured energy levels of ¹⁹²Ir and ¹⁹⁰Re observed using the Q3D spectrograph. The corresponding energy for each peak is given in units of keV. The red line shows the difference in measured energy between the ground states in ¹⁹²Ir and ¹⁹⁰Re, the quantity that yields the mass measurement.

Results

- The atomic mass of ¹⁹⁰Re was measured to be 176948295 ± 5 keV.
- This compares to previous literature values of 176948280 ± 70 keV [6]. Therefore, this experiment yields an order of magnitude reduction on the uncertainty compared to previous experiments.

References

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Contributed by Tzany Kokalova Wheldon (Univ. Birmingham)

c. Radiation Detection Analyst Vacancies

Do you have practical experience in a nuclear or radiation laboratory? Do you also have experience analysing and interpreting gamma spectra with some experience of writing / reviewing technical reports? UKAEA are recruiting for a Radiation Detection Analyst to primarily perform measurements and analysis of routine waste drums and ad-hoc samples. The role has lots of scope for growth and opportunity to work independently as well as part of a large group at UKAEA.

Please see a link to the role below, if there are any questions please contact Chantal, chantal.nobs@ukaea.uk

https://ccfe.amrislive.com/wizards_v2/ccfe/vacancyView.php?requirementId=4534&

Contributed by Chantal Nobs (UKAEA)

If you have any nuclear physics vacancies that you'd like highlighting in the newsletter, please get in touch.

d. Short Review: The Physics of the Chernobyl Accident

The Physics of the Chernobyl Accident



Keith Pearce

"An accident has occurred at the Chernobyl nuclear power plant and one of the reactors was damaged. Measures are being taken to eliminate the consequences of the accident. Aid is being given to those affected. A Government commission has been set up." Soviet Union announcement 29th April 1986.

A new book has been published examining The Physics of the Chernobyl Accident. Keith Pearce draws upon his own knowledge and experience of nuclear reactor design and operation to assess and describe the Chernobyl disaster from a largely physics-based perspective.

The book is written in layman's terms where possible, but given the technical nature of the subject the reader will still require a reasonably strong background in both maths and physics. For those with such a background, the book reads well and does a good job of explaining the necessary facts.

For someone such as myself, a nuclear physicist that sometimes sits through presentations on nuclear reactor modelling, I also found the book a good resource for quickly and concisely explaining various terms often thrown about during these talks, e.g. 'void coefficients', etc.

If you are publishing a nuclear physics book that you'd like highlighting in the newsletter, please get in touch.

"The Physics of the Chernobyl Accident"
Available in [paperback](#) from Amazon priced £17.00.

3. Outreach Activity

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4. Media Interactions

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