ALLEGATO B

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Federico Ferraro
CURRICULUM VITAE

INFORMAZIONI PERSONALI (NON INSERIRE INDIRIZZO PRIVATO E TELEFONO FISSO O CELLULARE)

COGNOME	**FERRARO**
NOME	**FEDERICO**
DATA DI NASCITA	22/03/1989

Il curriculum, composto di 10 pagine, è riportato a partire dalla prossima pagina di questo documento.

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Federico Ferraro

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Date of birth: 22 March 1989

Curriculum vitae updated to May 3, 2020

Education

2014–2017 **PhD in Physics,** University of Genoa,
thesis: *Direct measurement of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction cross section at astrophysical energies*,
supervisor: Prof. Paolo Prati
date: 3 April 2017

2011–2013 **Laurea Magistrale in Fisica (Master's Degree),** University of Genoa,
thesis: *Direct measurement of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction cross section at the energy of the resonance at 417 keV*,
grade: *110/110 cum laude*
supervisor: Prof. Pietro Corvisiero
date: 24 October 2013

2008–2011 **Laurea in Fisica (Bachelor's degree),** University of Genoa,
date: 22 February 2012

Research positions

2018–now **Postdoctoral research fellow**, *University of Genoa, Department of Physics*, long-baseline neutrino oscillations

2017–2018 **Postdoctoral research fellow**, *University of Genoa, Department of Physics*, nuclear astrophysics

2014–2017 **Doctoral scholarship**, *University of Genoa, Department of Physics*

Affiliations

2013–now **INFN - Sezione di Genova**, *Via Dodecaneso 33, 16146 Genoa, Italy*

2008–now **University of Genoa, Department of Physics**, *Via Dodecaneso 33, 16146 Genoa, Italy*

Prizes

2019 **"Giuseppe P.S. Occhialini" Diploma**, International School of Subnuclear Physics, 57$^{\text{th}}$ Course: in search for the unexpected, Ettore Majorana Foundation and Centre for Scientific Culture, Erice, IT

2018 **"Claudio Villi" National Prize**, Istituto Nazionale di Fisica Nucleare (INFN), national prize for the best PhD thesis in nuclear physics in 2017

2015 **Prize for the highly commended student poster**, European Physical Society, Nuclear Physics in Astrophysics VII conference, York, UK

PhD thesis

title *Direct measurement of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction cross section at astrophysical energies*

supervisor Prof. Paolo Prati

description During my PhD I performed the direct measurement of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction cross section at astrophysical energies. In particular I measured the strength of the resonances at 156.2, 189.5 and 259.7 keV and I put new upper limits on the possible resonances at 71 and 105 keV. Moreover, thanks to the ultra low background, I measured the non-resonant cross section at unprecedentedly low energies. In this very low energy range, below 400 keV, the cross section is so small that any measurements in a surface lab would be hampered by the cosmic-ray induced background, therefore this experiment was carried out at the Laboratory for Underground Nuclear Astrophysics (LUNA) situated in the Gran Sasso National Laboratory (LNGS) in Italy. I used the 400 keV underground electrostatic accelerator and a windowless, differential-pumping, extended gas target in combination with a high-efficiency, large solid angle coverage, segmented bismuth germanate (BGO) detector. I personally designed parts of the setup, including the interaction chamber and I characterized the gas target and the detector. I took part in the 2 years long data taking period and I performed the data analysis, calculating the cross section and evaluating the associated uncertainties. Moreover, I used my results to estimate the thermonuclear reaction rate of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction as a function of the temperature and I discussed the astrophysical implications of the new rate.

Master's thesis

title *Direct measurement of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction cross section at the energy of the resonance at 417 keV*

supervisor Prof. Pietro Corvisiero

description I carried out my Master's thesis work as part of an experimental campaign on the resonances between 400 keV and 1300 keV in the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction. I participated in the measurements at the 3 MV tandem accelerator of the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany. A proton beam was accelerated and shot on a $^{22}\mathrm{Ne}$ target implanted in a tantalum backing. Two high-purity germanium (HPGe) detectors were used in combination with active anti-Compton shielding realized by means of BGO detectors around the HPGe crystals. I characterized the detectors and the implanted target and I participated in the data-taking shifts. I focused on the resonance at 417 keV, obtaining a strength which is consistent with the previous literature, with an overall uncertainty reduced by a factor of two.

Training courses

2016 **Safety in the use of compressed gases**, *AIR LIQUIDE*, LNGS, Assergi

2016 **Cryogenic liquids**, *Linde*, LNGS, Assergi

2014 **LabVIEW Core 2**, *National Instruments*, Rome

2014 **LabVIEW Core 1**, *National Instruments*, Padua

Research activity

DUNE
2018–now

DUNE (*Deep Underground Neutrino Experiment*) is a future long-baseline neutrino oscillation experiment. It will include a near detector close to the source of the beam at Fermilab and a far detector 1300 km away, at the Sanford Underground Research Facility (SURF) in the United States. The two detectors will be placed in a neutrino (or antineutrino) beam with an energy spectrum peaked at 2-3 GeV. The science goals of DUNE include a comprehensive investigation of neutrino oscillations to test leptonic CP violation and determine mass hierarchy. Moreover, DUNE will search for proton decay and will be able to study galactic supernovae explosions and the consequent formation of neutron stars or black holes.

Personal contribution

I am studying the performances of SAND (System for Accurate Neutrino Detection), a part of the DUNE near detector based on the KLOE magnet and calorimeter in combination with straw tube trackers and higly segmented scintillator trackers inside the magnetized volume. I am working both on the software for the simulation of the detector, including electronics, and the R&D for the refurbishment and improvement of its components. This work is now part of the Conceptual Design Report of the Near Detector and is soon to be part of its Technical Design Report. I am also investigating the chance to include a 1 ton liquid argon target inside SAND, instrumented with SiPMs arrays in combination with MURA (Modified Uniform Redundant Array) coded masks or $\mathrm{MgF_2}$ lenses to reconstruct the interaction vertex. Furthermore, I am studying light collection in one of the far detector modules (containing 17000 tons of liquid argon), to evaluate its performances for solar neutrino physics.

SBN
2018–now

The SBN (*Short-Baseline Neutrino*) Program at Fermilab will measure properties of neutrinos, specifically how the flavor of a neutrino changes as it moves through space and matter. It includes three different detectors (ICARUS, MicroBooNE and SBND) to perform sensitive searches for electron neutrino appearance and muon neutrino disappearance in the Booster Neutrino Beam. All of the detectors are types of liquid-argon time projection chambers and contribute to the development of the detection technology that will be used in the long-baseline Deep Underground Neutrino Experiment (DUNE). The detectors will be equipped with a Cosmic Ray Tagger (CRT) system that will identify crossing particles using scintillation modules, to mitigate their effect in event reconstruction.

Personal contribution

I am involved in the realization of the top CRT for the ICARUS detector, including the construction of its 125 modules, each one composed by 2 layers of scintillating slabs arranged in orthogonal directions and read out by SiPMs. I assembled a part of the modules and I put in place the test electronics. I tested the readout electronics and measured the detection efficiency of the modules I assembled.

LUNA
2013–now

LUNA (*Laboratory for Underground Nuclear Astrophysics*) consists of a high current, 400 keV electrostatic accelerator installed underground at LNGS, Italy. The accelerator is provided with one beamline for solid targets and one beamline for windowless, differential-pumping, extended gas targets. The aim of LUNA is to directly measure the cross section of the most important fusion reactions responsible for stellar hydrogen burning and nucleosynthesis as well as Big Bang nucleosynthesis. Thanks to the 1400 m thick rock shielding provided by the Gran Sasso mountain, the cosmic-ray induced background at LUNA is suppressed by several orders of magnitude with respect to a surface laboratory. This makes LUNA able to investigate the very small cross section of key astrophysical reactions in the very energy range which is relevant for astrophysics, in the Gamow window.

Personal contribution

My contribution mainly concerns the gas target and its instrumentation, with particular focus on the differential-pumping system and the measurement of the gas target properties. I designed and realized the new calorimetric system which measures the beam current in experiments involving gas targets, and I developed more accurate procedures to calibrate the calorimetric measurement against the electrical measurement. I designed and realized the interaction chamber for the study of the $^{22}\mathrm{Ne}(\mathrm{p},\gamma)^{23}\mathrm{Na}$ reaction, which was subsequently used also for the $^{2}\mathrm{H}(\mathrm{p},\gamma)^{3}\mathrm{He}$ and $^{22}\mathrm{Ne}(\alpha,\gamma)^{26}\mathrm{Mg}$ reactions. I actively participate in data taking shifts and data analysis for present measurements.

Conferences

contributed talks at international conferences

1. **Topics in Astroparticle and Underground Physics 2019**, 9-13 September 2019, Toyama, Japan
2. **2018 European Nuclear Physics Conference**, 2-7 September 2018, Bologna, Italy
3. **XXXV Mazurian Lakes Conference on Physics**, 3-9 September 2017, Piaski, Poland
4. **International Nuclear Physics Conference 2016**, 11-16 September 2016, Adelaide, Australia

poster presentations at international conferences

1. **Nuclei in the Cosmos XV**, 24-29 June 2018, Assergi, Italy
2. **Nuclear Physics in Astrophysics VII**, 18-22 May 2015, York, United Kingdom
3. **Nuclei in the Cosmos XIII**, 7-11 July 2014, Debrecen, Hungary

invited talks at national conferences

1. **IX Incontro dei Gruppi Italiani di Astrofisica Nucleare Teorica e Sperimentale**, 5-6 October 2017, Bologna, Italy

contributed talks at national conferences

1. **105° Congresso Nazionale della Società Italiana di Fisica**, 23-27 September 2019, L'Aquila, Italy
2. **Incontri di Fisica delle Alte Energie 2016**, 30 March - 1 April 2016, Genova, Italy

participation in other national conferences

1. **VIII Incontro dei Gruppi Italiani di Astrofisica Nucleare Teorica e Sperimentale**, 28-30 April 2015, Padova, Italy

organization of national conferences

1. **X Incontro dei Gruppi Italiani di Astrofisica Nucleare Teorica e Sperimentale**, 23-25 October 2019, Genova, Italy

Schools

1. **International School of Subnuclear Physics, 57th Course: in search for the unexpected** (EMFCSC school), 21-30 June 2019, Erice, Italy
2. **Neutrinos in Physics, Astrophysics and Cosmology** (ISAPP School), 13-24 June 2017, Arenzano, Italy
3. **8th European Summer School on Experimental Nuclear Astrophysics**, 13-20 September 2015, Santa Tecla, Italy
4. **Gran Sasso Summer Institute, Hands-On Experimental Underground Physics at LNGS**, 22 September - 3 October 2014, Assergi, Italy

Teaching

A.A. 19/20 **University of Genoa, Department of Physics**
course of Neutrinos and Nuclear Astrophysics for PhD students (20 hours)
teaching and participation in the exam commission

A.A. 14/15 **University of Genoa, Department of Civil, Chemical and Environmental Engineering**
course of General Physics for undergraduates (40 hours)
teaching, exercises and participation in the exam commission

Outreach

2019 **"AggiornaMenti"**, refresher courses and educational workshops for secondary school teachers, INFN-Sezione di Genova

2019 **"Art & Science"**, guided tour of the laboratories in the Physics Department with hands-on activities, University of Genoa and INFN-Sezione di Genova

2018 **University of the third age**, lesson on Nuclear Physics and its applications for cultural heritage, University of Genoa

2018 **Seminar for high school students**, Liceo Scientifico "O. Grassi", Savona, Italy

2017 **University of the third age**, lesson on stellar and Big Bang Nucleosynthesis, University of Genoa

2017 **Seminar for high school students**, Liceo Scientifico "O. Grassi", Savona, Italy

Language skills

native language: Italian

other languages: English (full working proficiency), French (basic)

IT skills

Operating systems: Unix, Linux, Mac OS, Windows

languages: C, C++, Verilog, Visual Basic

Development environments: LabVIEW, Visual Studio

editing: LaTeX, MS Office, HTML

simulation and analysis frameworks: ROOT, Geant4, Fluka, Mathematica, MatLab, Microcap

Publications

Scopus author details

Documents by author	31
Total citations	287
h-index	11

Summary of publications reported below (including reports and proceedings)

accepted for publication	1
reviewed journal papers	23
design reports	7
proceedings	10
LNGS annual reports	6
total	47

accepted for publication

[1] V. Mossa et al. "Setup commissioning for an improved measurement of the $\mathrm{D(p,\gamma)^3He}$ cross section at Big Bang Nucleosynthesis energies". In: *Eur. Phys. J. A* (2020).

reviewed journal papers

[2] G. F. Ciani et al. "A new approach to monitor ^{13}C-targets degradation in situ for $^{13}\mathrm{C}(\alpha,\mathrm{n})^{16}\mathrm{O}$ cross-section measurements at LUNA". In: *Eur. Phys. J. A* 56 (3 2020), p. 75. ISSN: 1434-

601X. DOI: 10.1140/epja/s10050-020-00077-0. URL: https://doi.org/10.1140/epja/s10050-020-00077-0.

[3] A. Best et al. "Cross section of the reaction $^{18}\mathrm{O}(\mathrm{p},\gamma)^{19}\mathrm{F}$ at astrophysical energies: The 90 keV resonance and the direct capture component". In: *Physics Letters B* 797 (2019), p. 134900. ISSN: 0370-2693. DOI: https://doi.org/10.1016/j.physletb.2019.134900. URL: http://www.sciencedirect.com/science/article/pii/S0370269319306227.

[4] A. Boeltzig et al. "Direct measurements of low-energy resonance strengths of the $^{23}\mathrm{Na}(\mathrm{p},\gamma)^{24}\mathrm{Mg}$ reaction for astrophysics". In: *Physics Letters B* 795 (2019), pp. 122–128. ISSN: 0370-2693. DOI: https://doi.org/10.1016/j.physletb.2019.05.044. URL: http://www.sciencedirect.com/science/article/pii/S037026931930365X.

[5] C.G. Bruno et al. "Improved astrophysical rate for the $^{18}\mathrm{O}(\mathrm{p},\alpha)^{15}\mathrm{N}$ reaction by underground measurements". In: *Physics Letters B* 790 (2019), pp. 237–242. ISSN: 0370-2693. DOI: https://doi.org/10.1016/j.physletb.2019.01.017. URL: http://www.sciencedirect.com/science/article/pii/S0370269319300334.

[6] F. Ferraro et al. "Direct Capture Cross Section and the $E_p = 71$ and 105 keV Resonances in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ Reaction". In: *Phys. Rev. Lett.* 121 (17 Oct. 2018), p. 172701. DOI: 10.1103/PhysRevLett.121.172701. URL: https://link.aps.org/doi/10.1103/PhysRevLett.121.172701.

[7] J. Balibrea-Correa et al. "Improved pulse shape discrimination for high pressure ^{3}He counters". In: *Nuclear Instruments and Methods in Physics Research A* 906 (Oct. 2018), pp. 103–109. DOI: 10.1016/j.nima.2018.07.086.

[8] D. Bemmerer et al. "Effect of beam energy straggling on resonant yield in thin gas targets: The cases $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ and $^{14}\mathrm{N}(p,\gamma)^{15}\mathrm{O}$". In: *EPL (Europhysics Letters)* 122.5 (2018), p. 52001. DOI: 10.1209/0295-5075/122/52. URL: http://stacks.iop.org/0295-5075/122/i=5/a=52001.

[9] D. Massabò et al. "ChAMBRe: a new atmospheric simulation Chamber for Aerosol Modelling and Bio-aerosol Research". In: *Atmospheric Measurement Techniques Discussions* 2018 (2018), pp. 1–23. DOI: 10.5194/amt-2018-147. URL: https://www.atmos-meas-tech-discuss.net/amt-2018-147/.

[10] F. Cavanna et al. "Erratum: Three New Low-Energy Resonances in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ Reaction [Phys. Rev. Lett. 115, 252501 (2015)]". In: *Phys. Rev. Lett.* 120 (23 June 2018), p. 239901. DOI: 10.1103/PhysRevLett.120.239901. URL: https://link.aps.org/doi/10.1103/PhysRevLett.120.239901.

[11] F. Ferraro et al. "A high-efficiency gas target setup for underground experiments, and redetermination of the branching ratio of the 189.5 keV $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ resonance". In: *Eur. Phys. J. A* 54.3 (2018), p. 44. DOI: 10.1140/epja/i2018-12476-7. URL: https://doi.org/10.1140/epja/i2018-12476-7.

[12] F. Ferraro. "Underground Nuclear Astrophysics at LUNA". In: *Acta Physica Polonica B* 49 (2018), p. 429. DOI: 10.5506/APhysPolB.49.429.

[13] A. Boeltzig et al. "Improved background suppression for radiative capture reactions at LUNA with HPGe and BGO detectors". In: *Journal of Physics G: Nuclear and Particle Physics* 45.2 (2018), p. 025203. DOI: 10.1088/1361-6471/aaa163. URL: http://stacks.iop.org/0954-3899/45/i=2/a=025203.

[14] O. Straniero et al. "The impact of the revised $^{17}\mathrm{O}(p,\alpha)^{14}\mathrm{N}$ reaction rate on $^{17}\mathrm{O}$ stellar abundances and yields". In: *Astronomy and Astrophysics* 598 (2017), A128. DOI: 10.1051/0004-6361/201629624. URL: https://doi.org/10.1051/0004-6361/201629624.

[15] M. Lugaro et al. "Origin of meteoritic stardust unveiled by a revised proton-capture rate of ^{17}O". In: *Nature Astronomy* 1, 0027 (Jan. 2017), p. 0027. DOI: 10.1038/s41550-016-0027. arXiv: 1703.00276 [astro-ph.SR].

[16] D. Trezzi et al. "Big Bang ^{6}Li nucleosynthesis studied deep underground". In: *Astroparticle Physics* 89 (Mar. 2017), pp. 57–65. DOI: 10.1016/j.astropartphys.2017.01.007.

[17] A. Slemer et al. "^{22}Ne and ^{23}Na ejecta from intermediate-mass stars: the impact of the new LUNA rate for $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$". In: *Monthly Notices of the Royal Astronomical Society* 465.4 (2017), pp. 4817–4837. DOI: 10.1093/mnras/stw3029. URL: http://dx.doi.org/10.1093/mnras/stw3029.

[18] G. Gervino et al. "Ultra-sensitive γ-ray spectroscopy set-up for investigating primordial lithium problem". English. In: *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* (2015). ISSN: 0168-9002. DOI: 10.1016/j.nima.2015.11.019.

[19] R. Depalo et al. "Direct measurement of low-energy $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ resonances". In: *Phys. Rev. C* 94 (5 Nov. 2016), p. 055804. DOI: 10.1103/PhysRevC.94.055804. URL: https://link.aps.org/doi/10.1103/PhysRevC.94.055804.

[20] C. G. Bruno et al. "Improved Direct Measurement of the 64.5 keV Resonance Strength in the $^{17}\mathrm{O}(p,\alpha)^{14}\mathrm{N}$ Reaction at LUNA". In: *Phys. Rev. Lett.* 117 (14 Sept. 2016), p. 142502. DOI: 10.1103/PhysRevLett.117.142502. URL: https://link.aps.org/doi/10.1103/PhysRevLett.117.142502.

[21] A. Boeltzig et al. "Shell and explosive hydrogen burning". In: *The European Physical Journal A* 52.4 (Apr. 2016), p. 75. ISSN: 1434-601X. DOI: 10.1140/epja/i2016-16075-4. URL: https://doi.org/10.1140/epja/i2016-16075-4.

[22] F. Cavanna et al. "Three New Low-Energy Resonances in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ Reaction". In: *Phys. Rev. Lett.* 115 (25 Dec. 2015), p. 252501. DOI: 10.1103/PhysRevLett.115.252501. URL: https://link.aps.org/doi/10.1103/PhysRevLett.115.252501.

[23] R. Depalo et al. "Strengths of the resonances at 436, 479, 639, 661, and 1279 keV in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ reaction". In: *Phys. Rev. C* 92 (4 Oct. 2015), p. 045807. DOI: 10.1103/PhysRevC.92.045807. URL: https://link.aps.org/doi/10.1103/PhysRevC.92.045807.

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design reports

[25] B. Abi et al. *Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume 4 Far Detector Single-phase Technology*. 2020. arXiv: 2002.03010 [physics.ins-det].

[26] B. Abi et al. *Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume 3 DUNE Far Detector Technical Coordination*. 2020. arXiv: 2002.03008 [physics.ins-det].

[27] B. Abi et al. *Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume 2 DUNE Physics*. 2020. arXiv: 2002.03005 [hep-ex].

[28] B. Abi et al. *Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume 1 Introduction to DUNE*. 2020. arXiv: 2002.02967 [physics.ins-det].

[29] B. Abi et al. *The DUNE Far Detector Interim Design Report Volume 1: Physics, Technology and Strategies*. 2018. arXiv: 1807.10334 [physics.ins-det].

[30] B. Abi et al. *The DUNE Far Detector Interim Design Report, Volume 2: Single-Phase Module*. 2018. arXiv: 1807.10327 [physics.ins-det].

[31] B. Abi et al. *The DUNE Far Detector Interim Design Report, Volume 3: Dual-Phase Module*. 2018. arXiv: 1807.10340 [physics.ins-det].

proceedings

[32] Federico Ferraro. "^{22}Ne(p,γ)^{23}Na cross section measurement at astrophysical energies." In: vol. 1468. IOP Publishing, Feb. 2020, p. 012239. DOI: 10.1088/1742-6596/1468/1/012239. URL: https://doi.org/10.1088%2F1742-6596%2F1468%2F1%2F012239.

[33] S. Hammer et al. "Study of the $^{2}\mathrm{H}(\mathrm{p},\gamma)^{3}\mathrm{He}$ cross section at Ep = 400-800 keV". In: *Proceedings, 5th International Solar Neutrino Conference: Dresden, Germany, June 11-14, 2018*. 2019, pp. 473–476. DOI: 10.1142/9789811204296_0030.

[34] Federico Ferraro. "Low-Energy Resonances and Direct Capture Cross Section in the ^{22}Ne(p,γ)^{23}Na Reaction". In: *Nuclei in the Cosmos XV*. Vol. 219. Springer International Publishing, Aug. 2019, pp. 351–354. ISBN: 978-3-030-13876-9. DOI: 10.1007/978-3-030-13876-9_63.

[35] Federico Ferraro. "Measurement of the strengths of the resonances at 417, 458, 611, 632 and 1222 keV in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ reaction". In: vol. 940. IOP Publishing, Jan. 2018, p. 012041. DOI: 10.1088/1742-6596/940/1/012041.

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[37] F. Ferraro. "Low-Background, High-Efficiency Setup for the Study of $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ Reaction at Low Energy". In: *Proceedings of the 14th International Symposium on Nuclei in the Cosmos (NIC2016)*. JPS Conf. Proc. 14 020412. 2017. DOI: 10.7566/JPSCP.14.020412. eprint: https://journals.jps.jp/doi/pdf/10.7566/JPSCP.14.020412. URL: https://journals.jps.jp/doi/abs/10.7566/JPSCP.14.020412.

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[41] F. Ferraro et al. "Study of the resonances at 417, 611, and 632 keV in the $^{22}\mathrm{Ne}(p,\gamma)^{23}\mathrm{Na}$ reaction". In: *Proceedings of the 13th International Symposium on Nuclei in the Cosmos (NIC2014)*. Ed. by PoS. NIC XII 093. 2014.

LNGS annual reports

[42] M. Aliotta et al. "Annual Report 2018". In: ISBN-978-88-940122-4-8. Laboratori Nazionali del Gran Sasso, 2018. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

[43] M. Aliotta et al. "Annual Report 2017". In: ISBN-978-88-940122-3-1. Laboratori Nazionali del Gran Sasso, 2017. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

[44] M. Aliotta et al. "Annual Report 2016". In: ISBN-978-88-940122-2-4. Laboratori Nazionali del Gran Sasso, 2016. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

[45] M. Aliotta et al. "Annual Report 2015". In: ISBN-978-88-940122-1-7. Laboratori Nazionali del Gran Sasso, 2015. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

[46] M. Aliotta et al. "Annual Report 2014". In: ISBN-978-88-940122-8-6. Laboratori Nazionali del Gran Sasso, 2014. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

[47] M. Aliotta et al. "Annual Report 2013". In: ISBN-978-88-940122-0-0. Laboratori Nazionali del Gran Sasso, 2013. Chap. "LUNA: Laboratory for Underground Nuclear Astrophysics".

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