LUNA NEWSLETTER

LABORATORY FOR UNDERGROUND NUCLEAR ASTROPHYSICS

Updates from Underground

BY PAOLO PRATI

Collaboration Dinner at the General Meeting held in Bari (Italy) on 23-24 November 2017

Welcome to the second issue of the LUNA newsletter! The last 12 months have been quite difficult at Gran Sasso because of a series of environmental events, including extraordinary snows and swarms of earthquakes. Nevertheless, the Gran Sasso Laboratory has been fully operational and so has LUNA. The 400 kV accelerator delivered beam on target for about 35 weeks to run experiments on reactions important for Big Bang Nucleosynthesis and to test experimental solutions for a renewed study of the $^{13}C(\alpha,n)^{16}O$. Stay tuned as new results are going to be published shortly.

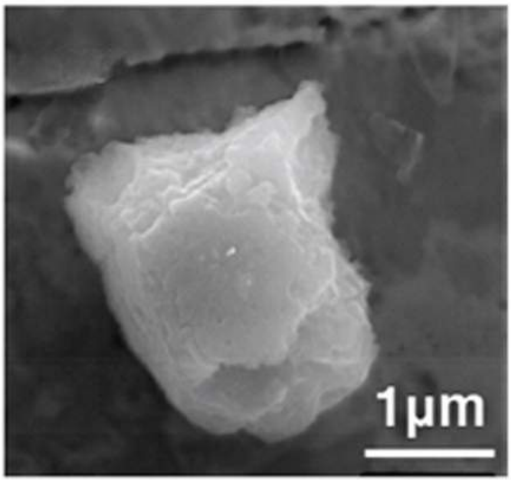
Exciting news come also from the LUNA-MV side. While the new accelerator is under construction at HVE, work to build the new LUNA laboratory inside Hall B at LNGS is about to start. An intense activity is scheduled for the next year to prepare the new laboratory: the countdown to launch the new MV-era has begun. We will provide further updates with the next issue of this newsletter. Until then, I hope you'll enjoy this newsletter with the most relevant news from our collaboration.

In the foreground: (from left to right) Antonio Caciolli, Gyorgy Gyurky, Marialuisa Aliotta, Gianluca Imbriani, Maria Lugaro, Carlo Broggini, Alessandra Guglielmetti.

NEWS FROM THE LABORATORY

Our New $^{17}O(p,\alpha)^{14}N$ Rate and the Puzzle of Missing Stardust Gems

BY MARIA LUGARO



The isotopic make-up of microscopic ruby, sapphire, and silicate grains, formed in ancient stars and recovered from meteorites, can be analysed in the laboratory with very high precision. Their composition is found to be completely different from isotopic abundances observed in the Solar System and can thus provide a direct signature of the nuclear reactions occurring in the parent stars where the grains originated. Asymptotic giant branch stars of initial mass roughly 6 times that of the Sun are predicted to produce stardust in relatively large abundance. However, no grains had been found so far in meteorites with an isotopic make-up that could be attributed to nuclear reactions in these stars. A population of roughly 15% of the analysed stardust grains show very low abundances of ^{18}O, together with enhancements of ^{17}O, and sometimes ^{26}Al and ^{25}Mg. These could be the signature of asymptotic giant branch stars of initial mass roughly 6 times that of the Sun, except that the models predicted too much ^{17}O. A possible solution to this puzzle has emerged thanks to the LUNA $^{17}O(p,\alpha)^{14}N$ experiment. The new reaction rate [1] is roughly 2 to 2.5 times higher than previously estimated, which results in the models now being able to destroy ^{17}O more efficiently and to replicate the observations [2]. The grains have now found their parent stars!

Photo of a micro-corundum/sapphire grain (credit: A. Takigawa)

PUBLICATIONS

[1] CG Bruno *et al.*, Physical Review Letters 117 (2016) 142502
[2] M Lugaro *et al.*, Nature Astronomy 1 (2017) 0027

The $^{22}Ne(p,\gamma)^{23}Na$ Reaction

BY ANTONIO CACIOLLI

The $^{22}Ne(p,\gamma)^{23}Na$ reaction (Q = 8.79 MeV) occurs during hydrogen burning in the neon-sodium (NeNa) cycle and affects the nucleosynthesis of neon and sodium isotopes. In particular, the reaction influences the surface composition of Red Giant Branch stars (Gamow peak 30-100 keV), the composition of the ejecta from Asymptotic Giant Branch Stars and classical novae (Gamow peak 100-600 keV) [1] and possibly the simmering phase prior to the explosion of a type Ia supernova [2].

Before LUNA measurements, the ^{22}Ne(p,γ)^{23}Na reaction rate was poorly known because of the contribution from a large number of resonances, many of which had never been observed directly [3,4]. Three resonances were directly observed for the first time [5], thanks to the low counting setup installed at LUNA and a new reaction rate was presented [6,7]. The astrophysical impact on AGB stars was also discussed [8]. In the meantime, a new experiment has been published in 2017 [9] confirming the reaction rate reported by LUNA.
However, the contribution from two low energy resonances at 70 and 105 keV remains still unclear, since their existence is disregarded by the most recent database [10] although they are included in the NACRE [3] compilation. A high efficiency setup [11], has now been used at LUNA to precisely study these two resonances and to measure the direct capture contribution with an improved precision. The new setup has a 50% efficiency for the γ rays produced by the reaction. Data taking has now been concluded. Results will be reported in a forthcoming publication.

REFERENCES

[1] C. Iliadis *et al.*, Astrophys J. Suppl. Ser. 142 (2002) 105
[2] D.A. Chamulak *et al.*, Astrophys. J. 677 (2008) 160
[3] C. Angulo *et al.*, Nucl. Phys. A 656 (1999) 3
[4] C. Iliadis *et al.*, Nucl. Phys. A 841 (2010) 251
[5] F. Cavanna *et al.*, Eur. Phys. J. A 50 (2014) 179
[6] F. Cavanna *et al.*, Phys Rev. Lett. 115 (2015) 252501
[7] R. Depalo *et al*l., Phys. Rev. C 94 (2016) 055804
[8] A. Slemer *et al.*, MNRAS 465 (2017) 4817
[9] K.J. Kelly *et al.*, Phys. Rev. C 95 (2017) 015806
[10] A.L. Sallaska *et al.*, Astrophys. J. Supp. 207 (2013) 18
[11] F. Ferraro *et al.*, submitted to Eur. Phys. J. A (2017)

Hydrogen Burning and the ^{18}O(p,γ)^{19}F and ^{23}Na(p,γ)^{24}Mg reactions

BY ANDREAS BEST

The nucleosynthesis of elements from helium up to silicon mainly occurs in Red Giant and Asymptotic Giant Branch stars and Novae. The relative abundances of the synthesised nuclides critically depend on the rates of the nuclear processes involved, often through non-trivial reaction chains, combined with complex mixing mechanisms.
When a star reaches high enough temperatures in its interior, leakage through the CNO cycles can occur and reactions in the NeNa and MgAl cycles are initiated. The ^{18}O(p,γ)^{19}F and ^{23}Na(p,γ)^{24}Mg reactions play a key role in this context, while the ^{18}O(p,γ)^{19}F reaction may also directly affect the observed depletion of ^{18}O in a certain type of pre-solar grains. In both cases, low-energy resonances can directly influence the rate at astrophysical relevant energies.

Both the ^{18}O(p,γ)^{19}F and ^{23}Na(p,γ)^{24}Mg reactions have been measured at LUNA and data analyses are in their final phase.
Measurements of ^{18}O(p,γ)^{19}F were done from the maximum proton energy at LUNA of 400 keV down to 140 keV, using a HPGe detector, and down to 90 keV, using a BGO detector. The HPGe data allowed to obtain greatly improved branchings and a more precise strength determination of minor resonances in the ^{18}O(p,γ)^{19}F reaction. The main focus of the BGO measurements was to determine both the strength of a 90 keV resonance and the low-energy direct capture cross section. Reaction signals were observed down to the lowest energy and DC and resonant cross sections were extracted from the data [1]. Results will soon be published in a forthcoming paper.

For $^{23}Na(p,\gamma)^{24}Mg$, the HPGe phase focused on the two stronger resonances of astrophysical interest at proton energies of 251 keV and 309 keV. The branchings of the 251 keV resonance were determined for the first time thanks to the high quality HPGe data acquired. Additional information (branching ratios, strengths) on a few minor resonances was obtained as well. Both astrophysical resonances were studied during the BGO phase to provide checks on systematic differences. The BGO detector was also used to investigate the energy region around a weak, but potentially important, 138 keV resonance. Data analysis is ongoing to extract either the value or an improved upper limit of its resonance strength.

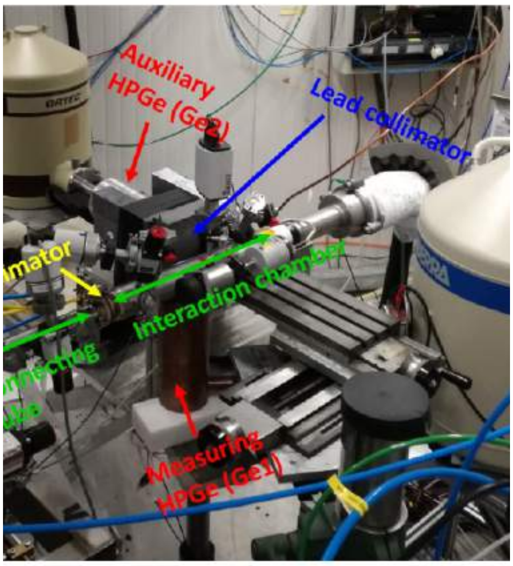
To reduce the uncertainty in the absolute values of resonance strengths, studies of the sodium targets stoichiometry were also performed at the Helmholtz-Center Dresden-Rossendorf by elastic recoil detection analysis. In addition, a study of the BGO intrinsic background and a characterisation of the improved shielding developed for these measurements has recently been accepted for publication [2].

PUBLICATIONS

[1] F Pantaleo, PhD Thesis, University of Bari, Italy (2017)
[2] A Boeltzig *et al.*, Journal Physics G (2017) accepted

The $^{2}H(p,\gamma)^{3}He$ Reaction and the Primordial Deuterium Abundance

BY FRANCESCA CAVANNA



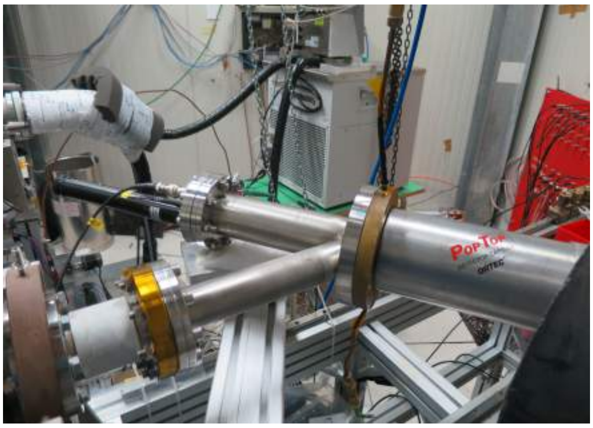
The existence of a Cosmic Microwave Background (CMB), the expansion of the universe, and the overall agreement between observed and calculated abundances of light elements, created during the Big Bang Nucleosynthesis (BBN), represent fundamental pillars of modern cosmology. Concerning BBN, however, the comparison between observed and calculated deuterium abundance is presently limited by the poor knowledge of the deuterium-burning process at BBN energies (30 keV < E_{cm} < 300 keV). An improved measurement of the $^{2}H(p,\gamma)^{3}He$ reaction cross section would also allow to substantially improve the determination of the universal baryon density and to further constrain the existence of the so-called "dark radiation", *i.e.* the existence of relic relativistic particles not foreseen in the standard model (in which only photons and three neutrino species are considered) [1].
Aim of the LUNA experimental campaign, started in 2016, was to measure the $^{2}H(p,\gamma)^{3}He$ cross section in the BBN energy range with the highest accuracy to date. The $^{2}H(p,\gamma)^{3}He$ experiment at LUNA took place in two phases with different setups. The first comprised a windowless deuterium gas target surrounded by a BGO detector, as described in the first issue of this Newsletter. The second involved a new target chamber and a 137% HPGe detector in close geometry. The detection efficiency was determined with radioactive sources (^{60}Co and ^{137}Cs) and with a well-known resonance in the $^{14}N(p,\gamma)^{15}O$ reaction. Data taking with the second setup has now been completed. The $^{2}H(p,\gamma)^{3}He$ excitation function was measured in the energy range 33 keV < E_{cm} < 260 keV. As the physics case requires a precise cross section measurement, great care was devoted to the investigation of possible sources of systematic errors, including the beam heating effect, the response of the calorimeter used for beam current measurement, and the angular distribution of the photons emitted by the $^{2}H(p,\gamma)^{3}He$ reaction [2]. Data analysis for the HPGe phase is currently on going.

PUBLICATIONS

[1] E. Di Valentino *et al.*, Physical Review D 90 (2014) 023543
[2] V. Mossa, PhD Thesis, University of Bari, Italy (2017)

The Big Bang and the ^{6}Li Abundance

BY ROSANNA DEPALO



The detection of lithium in stars provides unique constraints on the early stellar structure and evolution, as well as on Big Bang Nucleosynthesis. The ^{6}Li(p,γ)^{7}Be cross section is poorly constrained at the energies of astrophysical interest. In a recent direct measurement of the ^{6}Li(p,γ)^{7}Be cross section by He *et al*. a new resonance-like structure was discovered [1], corresponding to a positive-parity excited state of ^{7}Be with E_x~5800 keV. Such excited state has never been observed in previous experiments and it is not reproduced by theoretical models.

In order to place new constraints on the existence of such resonance, a new precision measurement of the ^{6}Li(p,γ)^{7}Be cross section was performed at LUNA. An intense proton beam was delivered onto a solid target containing ^{6}Li. The detection system included both a silicon detector and an HPGe detector in close geometry. With this setup it was possible to detect at the same time the charged particles from the ^{6}Li(p,α)^{3}He reaction and the gamma rays from the ^{6}Li(p,γ)^{7}Be reaction.

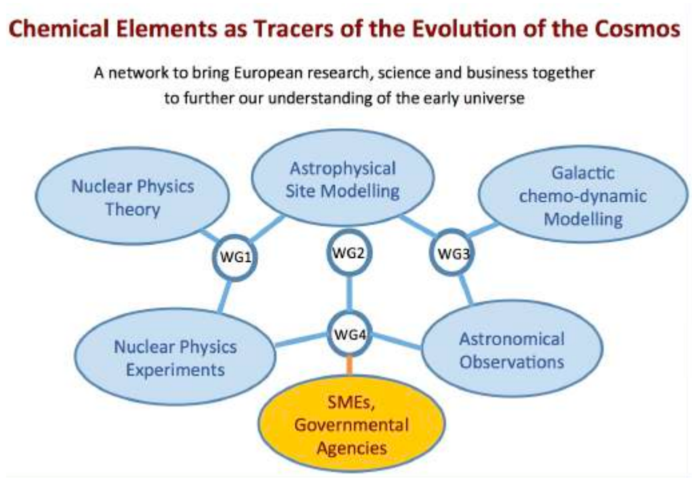
Target characterisation was performed at the Helmholtz-Zentrum Dresden-Rossendorf using both Nuclear Reaction Analysis and Elastic Recoil Detection Analysis. The data taking was completed in September 2017; data analysis is presently ongoing.

REFERENCES

[1] JJ He *et al.* Physics Letters B 725 (2013) 287–291

ChETEC: Chemical Elements as Tracers of the Evolution of the Cosmos

BY ALESSANDRA GUGLIELMETTI



Starting in 1971, COST [1] has been the longest-running European framework supporting trans-national cooperation among researchers, engineers and scholars across Europe.

COST does not fund research itself, but provides support for networking activities carried out within COST Actions. Among the 25 actions approved on 24 October 2016 out of 478 eligible proposals collected, was the Action "**ChETEC-Chemical Elements as Tracer of the Evolution of the Cosmos**" [2]. ChETEC will focus on studying the evolution of the cosmos via the chemical fingerprints left by the nuclear reactions that take place in stars. Goals of the Action will be to coordinate research efforts in astronomy, astrophysics, and nuclear physics; to build pan-European inter-disciplinary bridges between these disciplines; and to link this blue skies research with SMEs who can provide the technological tools required for the exploitation of data, software and techniques and in return join the innovation cycle. The Action will also train a new generation of European scientists providing inter-disciplinary expertise and knowledge-transfer skills with the aim of strengthening the Innovation Union.

The network comprises 29 European countries, represented by a Management Committee composed of up to two members for each country. The LUNA collaboration is heavily involved: five LUNA members are in the Management Committee, four of whom with leading roles in the Action. During the main meeting event that took place in Keele (UK) last October, the network identified several “open questions” and established associated working teams. The opportunity of joining one or more of these teams is still open to anyone interested.

REFERENCES

[1] COST, **European Cooperation in Science and Technology**
[2] ChETEC, **Chemical Elements as Tracer of the Evolution of the Cosmos**

MEMBER SPOTLIGHT

Federico Ferraro

Hometown: Albissola Marina (Italy)

Education: PhD in Physics at the University of Genoa (Italy)

Current Position: Post-Doctoral Research Fellow, Department of physics, University of Genoa (Italy)

What is the focus of your research? To make a long story short, I am mainly interested in the measurement of low-energy nuclear reactions with a gas target system. Since the electrical measurement of the beam current impinging on such a target is not possible, I devised a calorimetric system to measure the beam power and ultimately its current, from the knowledge of the beam energy and energy loss.

What do you like most about LUNA? Although LUNA is an important player in nuclear astrophysics, our experiment is on a human scale. This allowed me to take care of every single aspect of the experiments we carried out, from vacuum and electronics to data taking and analysis. This is a great opportunity that is not so common in experimental nuclear (or particle) physics. I can either get my hands dirty with vacuum grease or clean them up and use my laptop to calculate the thermonuclear reaction rate.

How do you spend your free time? My biggest passion is skiing. During winter I spend most of my weekends on the snow, having fun on steep slopes and free-ride routes with my friends. Waiting for the winter I also like to ski on screes. This may sound a little weird, but is real fun! I am not only mad about skiing, but I also like hiking and boating during summer.

What are your goals for the future? I would like to deal with new exciting challenges in nuclear astrophysics and take part in the forthcoming LUNA-MV project. Nevertheless, I believe that my knowledge and competences would strongly benefit from a new research activity. I am especially interested in experimental R&D activities concerning the detection of rare events exploiting cutting edge technologies and techniques I am not yet familiar with.

SCIENTIFIC OUTPUT

Publications

JANUARY 2017 - DECEMBER 2017

- **M Lugaro** *et al. Origin of meteoritic stardust unveiled by a new proton-capture rate of oxygen-17* **Nature Astronomy 1 (2017) 0027**

- **A Slemer** *et al. Neon and Sodium ejecta from intermediate mass stars: The impact of the new LUNA rate for the* $^{22}Ne(p,\gamma)^{23}Na$ **Monthly Notices of the Royal Astronomical Society 465 (2017) 4817-4837**

- **O Straniero** *et al. The impact of the revised* $^{17}O(p,\alpha)^{14}N$ *reaction rate on the* ^{17}O *stellar abundances and yields* **Astronomy & Astrophysics 598 (2017) A128**

- **D Trezzi** *et al*. *Big Bang* ^{6}Li *nucleosynthesis studied deed underground* **Astroparticle Physics 89 (2017) 17**

- **A Boeltzig** *et al*. *Improved background suppression for radiative capture reactions at LUNA with HPGe and BGO detectors* **Journal of Physics G: Nucl. and Part. Phys. (2017) accepted**

Invited Talks

JANUARY 2017 - DECEMBER 2017

- M Aliotta, 55th International Winter Meeting on Nuclear Astrophysics, 23-27 January 2017, Bormio (Italy)
- M Aliotta, Workshop on Nuclear Astrophysics at Dresden Felsenkeller, 26-28 June 2017, Dresden (Germany)
- M Aliotta, BRIDGE Workshop, 4-5 September 2017, Edinburgh, UK
- M Aliotta, 9th European Summer School on Experimental Nuclear Astrophysics, 17-24 September 2017, St Tecla (Italy)
- A Best, 9th European Summer School on Experimental Nuclear Astrophysics, 17-24 September 2017, St Tecla (Italy)
- A Best, GIANTS IX, 5-6 October 2017, Bologna (Italy)
- C Broggini, 9th European Summer School on Experimental Nuclear Astrophysics, 17-24 September 2017, St Tecla (Italy)
- C Broggini, International School of Nuclear Physics, Erice, 16-24 September 2017 (Italy)
- CG Bruno, GIANTS IX, 5-6 October 2017, Bologna (Italy)
- A Caciolli, FUSION17, 20-24 February 2017, Hobart (Australia)
- F Cavanna, 16th International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics (CGS16), 18-22 September 2017 , Shanghai (China)
- GF Ciani, GIANTS IX, 5-6 October 2017, Bologna (Italy)
- R Depalo, GIANTS IX, 5-6 October 2017, Bologna (Italy)
- R Depalo, Particles And Nuclei International Conference 2017 (PANIC2017) 1-5 September 2017, Beijing (China)
- F Ferraro, GIANTS IX, 5-6 October 2017, Bologna (Italy)
- A Formicola, PISA Summer School, 24-28 July 2017, Pisa (Italy)
- A Formicola, VIII International Nuclear Physics in Astrophysics Conference, 18-23 June 2107, Catania (Italy)
- A Formicola, NuPhys2017: Prospects in Neutrino Physics, 20-22 December 2017, London (UK)
- A Guglielmetti, XVII International Workshop on Neutrino Telescopes, 13-17 March 2017, Venezia (Italy)
- A Guglielmetti, Otranto School for PhD students, 26-31 May 2017, Otranto (Italy)
- A Guglielmetti, Società Italiana di Fisica, 11-15 September 2017, Trento (Italy)
- A Guglielmetti, Ages^2: taking stellar ages to the next power, 18-22 September 2017, Elba (Italy)
- G Imbriani, Gordon Research Conference at Colby-Sawyer College, 19-23 June 2017, New London, NH, (USA)

- G Imbriani, Towards the ANDES laboratory flag-ship and further experiments, 29-30 June 2017, Buenos Aires, (Argentina)
- M Lugaro, Meeting of the MTA CSFK, 15 February 2017, Budapest (Hungary)
- M Lugaro, Meeting of the MTA Department of Physics, 11 May 2017, Budapest (Hungary)
- M Lugaro, The AGB-Supernovae Mass Transition Conference, 27-31 March 2017, Roma (Italy)
- P Prati, XVI Conference on Theoretical Nuclear Physics in Italy**,** October 3-5 2017, Cortona (Italy)
- P Prati, Topics in Astro-particle and Underground Physics, 24-28 July 2017, Sudbury, Ontario (Canada)
- P Prati, Workshop on Nuclear Astrophysics at Dresden Felsenkeller, 26-28 June 2017, Dresden (Germany)
- P Prati, ISTRO 3rd International 15-19 May 2017, Častá-Papiernička (Slovacchia)
- O Straniero, 14th Russbach School on Nuclear Astrophysics, 12-18 March 2017, Russbach (Austria)
- O Straniero, 9th European Summer School on Experimental Nuclear Astrophysics, 17-24 September 2017, St Tecla (Italy)

CONGRATULATIONS TO…

Andreas Best (University of Napoli, Italia) for winning a *Junior Principal Investigator Grant* (€100k) for R&D of a neutron detector. The grant is funded by Compagnia di San Paolo - Banco di Napoli.

Carlo G. Bruno (University of Edinburgh, UK) for successfully defending his PhD thesis on *Underground measurements of hydrogen-burning reactions on* $^{17,18}O$ *at energies of astrophysical interest* in June 2017.

Antonio Caciolli (University of Padua, Italy) for his appointment to a fixed-time Researcher Position at the University of Padua.

Giovanni F. Ciani (Gran Sasso Sciente Institute, Italy) for submitting the best poster prize by a PhD student at the VIII International Nuclear Physics in Astrophysics Conference, held in Catania (Italy) on 18-23 June 2017.

Rosanna Depalo (University of Padua, Italy) for winning one of six *Young Researcher Research Grants* (€150k) for the study of hydrogen desorption from graphite targets.

Federico Ferraro (University of Genoa, Italy) for defending his PhD thesis on *Direct measurement of the* $^{22}Ne(p,\gamma)^{23}Na$ *reaction cross section at astrophysical energies* in April 2017.

Viviana Mossa (University of Bari, Italy) for submitting her PhD thesis on *Study of the* $^{2}H(p,\gamma)^{3}He$ *reaction in the Big Bang nucleosynthesis energy* to be defended in March 2018.

Francesca Pantaleo (University of Bari, Italy) for submitting her PhD thesis on *Direct cross section measurement of the* $^{18}O(p,\gamma)^{19}F$ *reaction at LUNA* to be defended in March 2018.

Denise Piatti (University of Padua, Italy) for winning the Prize “Laura Bassi” for young postgraduate students in Physics. The Prize was conferred during the Annual Meeting of the Società Italiana di Fisica.

Marcell P. Takács (Technische Universitaet Dresden) for defending his PhD thesis on *Hydrogen burning: Study of the* $^{22}Ne(p,\gamma)^{23}Na$, $^{3}He(\alpha,\gamma)^{7}Be$ *and* $^{7}Be(p,\gamma)^{8}B$ *reactions at ultra-low energies* in September 2017.

JOB OPPORTUNITIES

Interested in working with us at LUNA? Please consider the following opportunities for PhD studentships and Post-Doctoral Fellowships. These are typically highly selective international competitions and normally require strong academic records and, in the case of post-doctoral jobs, proven research experience and leadership potential. If you think you meet these requirements, please get in touch to discuss things further.

PhD Studentships

- **GRAN SASSO SCIENCE INSTITUTE (GSSI, Italy)**. Calls for applications are issued once a year, typically in **April**. Studentships are for **3 years,** which include a one-year compulsory attendance to training courses. Successful applicants will receive a gross stipend of €16,200/year. Accommodation and meals in L'Aquila are provided free of charge. For further details, please visit: **http://gssi.infn.it**

  If interested in applying, please contact: Dr Alba Formicola (**alba.formicola@lngs.infn.it**)

- **SCOTTISH UNIVERSITY PHYSICS ALLIANCE (SUPA, UK)**. Calls for applications are issued once a year, with deadline at the end of **January**. Studentships are typically for **3.5 years** with a stipend of about £12,000/year with additional funds for fieldwork. For further details, please visit: **http://apply.supa.ac.uk/apply**

  If interested in applying, please contact: Prof Marialuisa Aliotta (**m.aliotta@ed.ac.uk**)

In addition, please note that PhD scholarships are awarded once a year at most Italian universities. Calls are normally published in the summer. If you are interested in applying for a studentships to work at LUNA please refer to PhD positions available at the following universities: Bari, Genova, Milano, Napoli, Padova, Torino. Alternatively, get in touch with a member of the LUNA Collaboration based at any of those institutions (see **luna.lngs.infn.it** for the full list of LUNA members).

Post-Doctoral Positions and Fellowships

- **INFN POST-DOCTORAL FELLOWSHIPS FOR EXPERIMENTAL PHYSICS (ITALY).** These fellowships are for non-Italian citizens only. Eligible applicants must hold a PhD title (or equivalent) obtained by no more than 8 years prior to the call deadline (typically in **November**). Time-limit extensions apply. The fellowship is initially for one year with the possibility for a second-year extension. Annual gross salary is €36,000. For further details, please visit: **https://reclutamento.infn.it/ReclutamentoOnline/#!bandi/FELLOWSHIP**

  If interested in applying, please contact any of the INFN members of the LUNA Collaboration

- **ROYAL SOCIETY NEWTON INTERNATIONAL FELLOWSHIPS (UK).** The scheme provides the opportunity for the best **early stage post-doctoral researchers** from all over the world to work at UK research institutions for a period of two years. Eligible candidates should have completed their PhD by the time funding starts. They should have no more than **7 years of active full time postdoctoral experience** at the time of application. Applicants are normally agreed with the host institution (in this case, the School of Physics and Astronomy - University of Edinburgh) well in advance of the intended deadline. Newton Fellowships last for **2 years**. Funding consists of £24,000 per annum for subsistence costs, and up to £8,000 per annum research expenses, as well as a one-off payment of up to £2,000 for relocation expenses. Application rounds are typically in **March** and **September**. For further details, please visit: **https://royalsociety.org/grants-schemes-awards/grants/newton-international/**

  If interested in applying, please contact: Prof Marialuisa Aliotta (**m.aliotta@ed.ac.uk**)

- **ROYAL SOCIETY UNIVERSITY RESEARCH FELLOWS (UK).** The scheme provides the opportunity to build an independent research career. Those appointed are expected to be strong candidates for permanent posts in universities at the end of their fellowships. The Fellowships are for **5 years** with a possible 3 year extension. The basic salary, commensurate with the applicant's skills, responsibilities, expertise and experience, can be up to a maximum of £39,708.70 per annum. Eligible candidates must posses a PhD title and between **3-8 years of post-doctoral research experience** by the application deadline. Applications are normally agreed with the host institute (in this case, the School of Physics and Astronomy - University of Edinburgh). Shortlisted applicants will be invited for interview at the Royal Society in **early-mid April**. For further details, please visit: **https://royalsociety.org/grants-schemes-awards/grants/university-research/**

  If interested in applying, please contact: Prof Marialuisa Aliotta (**m.aliotta@ed.ac.uk**)

- **STFC ERNEST RUTHERFORD FELLOWSHIPS (UK).** These are highly prestigious and highly competitive fellowships that may lead to permanent academic posts. The Fellowships are for **5 years** with a typical salary of £33,000-35,000/year (depending on level of experience). Eligible candidates must have 5 years of postgraduate research experience, with normally a minimum of 2 years of post-doctoral experience. Applications MUST be agreed with the host institute (in this case, the School of Physics and Astronomy - University of Edinburgh), where a pre-selection based on CV and a draft research plan takes place by the **end of August each year.** Selected applicants will have to submit a full research proposal to STFC for further consideration. Candidates who pass the STFC pre-selection process in January will be invited for interviews in Swindon (UK) in February. Posts normally start in September. For further details, please visit: **http://www.stfc.ac.uk/funding/fellowships/ernest-rutherford-fellowship/**

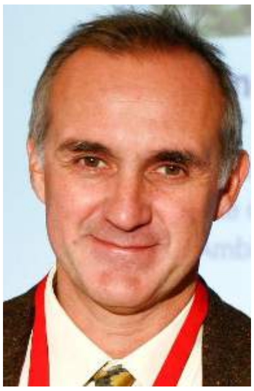
  If interested to apply, please contact: Prof Marialuisa Aliotta (**m.aliotta@ed.ac.uk**)

Please note that additional opportunities may arise from time to time within individual groups of the Collaboration. For updates, please consult the Job Opportunities page at the Collaboration website at **http://luna.lngs.infn.it**

THE COLLABORATION - CONTACT US

The LUNA Collaboration comprises about 40 researchers from the following Institutions:

- **INFN**, Assergi LNGS, Lecce, Roma (Italy)
- **GSSI**, L'Aquila (Italy)
- **Universities** and **INFN** of **Bari, Genova, Milano, Napoli, Padova, Torino** (Italy)
- **Konkoly Observatory,** Budapest (Hungary)
- **MTA ATOMKI**, Debrecen (Hungary)
- **HZDR**, Dresden (Germany)
- **University of Edinburgh**, Edinburgh (UK)
- **Osservatorio Astronomico di Collurania**, Teramo (Italy)



For any question about LUNA, or if you are interested in joining the Collaboration, please contact the LUNA Spokesperson: Prof Paolo Prati (**paolo.prati@ge.infn.it**)

For any question about this Newsletter, please contact the Chair of the Editorial Board: Prof Marialuisa Aliotta (**m.aliotta@ed.ac.uk**)