Astrophysics with Radioactive Isotopes

Report of Contributions

Contribution ID: **29** Type: **not specified**

Welcome

Presenters: SZABÓ, Róbert; PIGNATARI, Marco (Hull University)

Session Classification: Morning session 1

Contribution ID: **32** Type: **Oral Presentation**

On the discrepancy between the observed and predicted abundances of the radioactive isotope ^{7}Be produced in nova explosions

Recent measurements of the ^{7}Be abundance in nova ejecta show that it may exceed theoretically predicted values by an order of magnitude. I will demonstrate that this discrepancy can be significantly reduced if a nova explosion model takes into account that, according to observations, nova envelopes are enriched in ^{4}He. I will also explain why the assumption that nova accreted envelopes are pre-enriched in ^{3}He made in previous models to explain the anomalously high abundances of ^{7}Be in nova ejecta does not help to solve the problem.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - theory

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Stellar evolution

Primary author: DENISENKOV, Pavel (University of Victoria)

Presenter: DENISENKOV, Pavel (University of Victoria)

Contribution ID: **34** Type: **Oral Presentation**

Chemical Evolution of 26Al and 60Fe in the Milky Way

We present the results of theoretical mass estimates of ^{26}Al and ^{60}Fe throughout the Galaxy, performed with a numerical chemical evolution model including detailed nucleosynthesis prescriptions for both stable and radioactive nuclides. We have tested several sets of stellar yields taken from the literature, either for massive, low and intermediate mass stars, nova systems (only for ^{26}Al) and supernovae Type Ia, and then computed the total masses of ^{26}Al and ^{60}Fe in the Galaxy. In particular, we have studied the bulge and the disc of the Galaxy in a galactocentric radius range between 0 and 22 kpc. We have assumed that the bulge region (between 0 and 2 kpc) evolved very quickly suffering a strong burst of star formation, while the disc formed more slowly and inside-out, in agreement with previous works.
We have compared our results with the ^{26}Al mass observed by the γ-ray surveys COMPTEL and INTEGRAL, in order to select the best model. Concerning ^{60}Fe, for which we do not have any observed value, we have just predicted its mass so as to provide a theoretical constraint for future surveys.
We have found that low and intermediate mass stars as well as Type Ia supernovae contribute negligibly to the two isotopes, while massive stars are the dominant source. The contribution from novae is, however, necessary to reproduce the observations. Our best model predicts a mass of 2.12 $M_\odot$ of ^{26}Al, in agreement with observations, while for ^{60}Fe our best mass estimate is around ~ 1.05 $M_\odot$.
We have also predicted the present rate of injection of ^{26}Al and ^{60}Fe in the Galaxy and compared it with previous results by Timmes et al. (1995). We have predicted a larger present time rate of injection along the disc and a lower one in the bulge, relative to the previous work.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Chemical Evolution: the Milky Way

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Primary author: VASINI, Arianna

Co-authors: Prof. MATTEUCCI, Francesca (Università degli Studi di Trieste); Dr SPITONI, Emanuele (Universitè Cote d'Azur)

Presenter: VASINI, Arianna

Contribution ID: **35** Type: **Oral Presentation**

Understanding 22Na cosmic abundance

Simulations of explosive nucleosynthesis in novae predict the production of the radioisotope ^{22}Na. Its half-life of 2.6 yr makes it a very interesting astronomical observable by allowing space and time correlations with the astrophysical object. This radioisotope should bring constraints on nova models. It may also help to explain abnormal ^{22}Ne abundance observed in presolar grains and in cosmic rays. Its gamma-ray line at 1.275 MeV has not been observed yet by the gamma-ray space observatories. Accurate yields of ^{22}Na are required. At peak nova temperatures, the main destruction reaction ^{22}Na(p, γ)^{23}Mg has been found dominated by a resonance at E_R=0.204 MeV corresponding to the Ex=7.785 MeV excited state in ^{23}Mg. However, the measured strengths of this resonance disagree by more than a factor 3, see Ref. [1, 2].

An experiment was performed at GANIL facility to measure both the lifetime and the proton branching ratio of the key state at Ex=7.785 MeV. The principle of the experiment is based on the one used in [3]. With a beam energy of 4.6 MeV/u, the reaction ^{3}He(^{24}Mg, α)^{23}Mg* populated the state of interest. This reaction was measured with particle detectors (spectrometer VAMOS++, silicon detector SPIDER) and gamma tracking spectrometer AGATA. The expected time resolution with AGATA high space and energy resolutions is 1 fs. Several Doppler based methods were used to analyse the lineshape of γ-ray peaks.

Our new results will be presented. Doppler shifted γ-ray spectra from ^{23}Mg states were improved by imposing coincidences with the excitation energies reconstructed with VAMOS. This ensured to suppress the feeding from higher states. Lifetimes in ^{23}Mg were measured with a new approach. Proton emitted from unbound states in ^{23}Mg were also identified. With an higher precision on the measured lifetime and proton branching ratio of the key state, a new value of the resonance strength $\omega\gamma$ was obtained, it is below the sensitivity limit of the direct measurement experiments. The ^{22}Na(p, γ)^{23}Mg thermonuclear rate has been so reevaluated with the statistical Monte Carlo approach. The amount of ^{22}Na ejected during novae will be discussed as a tool for better understanding the underlying novae properties. The detectability limit of ^{22}Na from novae and the observation frequency of such events will also be discussed with respect to the next generation of gamma-ray space telescopes.

References
[1] A.L. Sallaska *et al.*, Phys. Rev. L **105**, 152501 (2010).
[2] F. Stegmuller *et al.*, Nuc. Phys. A **601**, 168-180 (1996).
[3] O.S. Kirsebom *et al.*, Phys. Rev. C **93**, 1025802 (2016).

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Primary author: FOUGÈRES, Chloé (GANIL (FRANCE))

Co-authors: DE OLIVEIRA SANTOS, Francois; E710 COLLABORATION

Presenter: FOUGÈRES, Chloé (GANIL (FRANCE))

Contribution ID: **36** Type: **Oral Presentation**

The tunable Laue lens –a new telescope for MeV gamma rays

Observations of the gamma rays from radioactive decays in astrophysical sources are severely hampered by limited instrument sensitivities and the dominant background caused by interactions of high energy cosmic rays inside the spacecraft and the instrument. Background suppression is essential and can be most effectively implemented by exploiting the geometric constraints in the Compton process. This was demonstrated 30 years ago with the successful COMPTEL experiment. A new NASA mission, 'COSI', with much improved sensitivity is now in preparation for a 2025 launch. COSI will certainly be an important milestone in the development of MeV gamma astronomy. Still, the angular resolution of COSI will in the 5-degree range at MeV energies and the effective area in the few hundred cm2 range. To go much beyond this a COSI-like detector must be supplemented by a focusing telescope. The Laue telescopes have since long been proposed for such a next step. But due to the peculiarities of crystal diffraction optics Laue telescopes have appeared as applicable only in selected, narrow energy bands. It will be shown that a tunable Laue lens can overcome many of the limitations of the classical fixed-energy telescopes and moreover, that tunability can be implemented in simpler ways and with much smaller weight penalty than indicated in the first experiments with this idea.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Instrumentation

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Stellar explosions and mergers - observations

Primary author: LUND, Niels

Presenter: LUND, Niels

Contribution ID: **37** Type: **Oral Presentation**

The Emerging Theory of Three-Dimensional Core-Collapse Supernova Explosions

Using our code Fornax we have simulated the collapse and explosion of the cores of many massive-star models in three spatial dimensions. This is the most comprehensive set of realistic 3D core-collapse supernova (CCSN) simulations yet performed and has provided very important insights into the mechanism and character of this 50-year-old astrophysical puzzle. I will present detailed results from this suite of runs and the novel conclusions derived from our new capacity to simulate many 3D, as opposed to 2D and 1D, full physics models every year. Emerging are insights into the criteria for explosion, the systematics of explosion energy and residual neutron-star mass with progenitor, the characteristics of proto-neutron star convection, neutrino and gravitational-wave emissions and signatures, the morphology of CCSN explosions, and supernova nucleosynthesis. This new capability, enabled by this new algorithm and modern HPC assets, is poised to transform our understanding of this central astrophysical phenomenon.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Astronomy

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Nuclear physics - theory

Primary author: Prof. BURROWS , Adam (Princeton)

Presenter: Prof. BURROWS , Adam (Princeton)

Contribution ID: **38** Type: **Oral Presentation**

Very massive stars winds as sources of the short-lived ^{26}Al radioactive isotope

The ^{26}Al short-lived radioactive nucleus is the source of the observed galactic diffuse emission at 1.8 MeV. While different sources of ^{26}Al have been explored, such as AGB stars, massive stars winds, and supernovae, the contribution of very massive stars have never been studied.

We present new results on the stellar wind contribution of very massive stars, *i.e.* stars with initial masses between 150 and 300 $M_\odot$ to the enrichment in ^{26}Al of the galactic interstellar medium.
We discuss the production of ^{26}Al by studying rotating and non-rotating very massive stellar models with initial masses between 150 and 300 $M_\odot$ for metallicities Z=0.006, 0.014, and 0.020. We confront this result to a simple Milky Way model taking into account both the metallicity and the star formation rate gradients.
We obtain that very massive stars in the metallicity range considered in this work might be very significant contributors to the ^{26}Al enrichment of the interstellar medium. Typically, the contribution of massive star winds to the total quantity of ^{26}Al in the Galaxy increases by 150\% when very massive stars are considered.

Very massive stars, despite their rarity, might be important contributors to ^{26}Al and overall very important actors for nucleosynthesis in the Galaxy.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Primary author: MARTINET, Sébastien (Université de Genève)

Co-authors: MEYNET, Georges; Mr NANDAL, Devesh (Université de Genève); EKSTRÖM, Sylvia; YUSOF, Norhasliza (University of Malaya); HIRSCHI, Raphael (Keele University); Dr GEORGY, Cyril (Université de Genève); DWARKADAS, Vikram (Univ of Chicago); Prof. GOUNELLE, Mathieu (Muséum national d'Histoire naturelle); HAEMMERLÉ, Lionel (Université de Genève)

Presenter: MARTINET, Sébastien (Université de Genève)

Contribution ID: **39** Type: **Oral Presentation**

Investigation of cross section and reaction rate for 155Gd (n,g)156Gd reaction in the range of 0-0.5 MeV

In this study, the cross-sections of 155Gd(n,g)156Gd reaction in the 0-0.5 MeV incident energy range were evaluated by using TALYS 1.95 nuclear reaction code. Available experimental cross-section values of this reaction were obtained from EXFOR, Experimental Nuclear Reaction Library of IAEA. Both, experimental and theoretical cross section values were interpreted by using graphical demonstration. In addition, we think that this work will shed light on the studies to be done with the Gadolinium (Gd) element, which has very valuable magnetic properties.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - theory

2nd keyword (optional)

3rd keyword (optional)

Primary authors: SARPÜN, Ismail Hakki; Dr YILDIZ, ErcaN (Kahramanmaras Sutcu Imam University); Dr YILDIRIR, Unal (Göynük Science High School); Prof. AYDIN, Abdullah (Kırıkkale University)

Presenter: Dr YILDIRIR, Unal (Göynük Science High School)

Contribution ID: **40** Type: **Oral Presentation**

Astrophysical properties for the 197Au(a,n)200Tl reaction in the energy range of 10-40 MeV

In this study, the Talys 1.95 nuclear reaction code was used in the evaluation of 197Au(a,n)200Tl reaction cross-sections in 10-40 MeV incident energy range. EXFOR, Experimental Nuclear Reaction Library of IAEA, was used to get available experimental cross-section values of this reaction. The astrophysical S-factors that explain the probability of reaction in low energy were evaluated using both theoretical and experimental cross-section values. All results were compared with each other using graphical demonstration.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - theory

2nd keyword (optional)

3rd keyword (optional)

Primary authors: SARPÜN, Ismail Hakki; YILDIZ, ERCAN (Kahramanmaras Sutcu Imam University); Dr OZSOY, Cengiz (Goynuk High School); Prof. TURK CAKIR, Ilkay (Ankara University)

Presenter: SARPÜN, Ismail Hakki

Contribution ID: **41** Type: **Oral Presentation**

Uncertainty Analysis of 23Mg(p,γ)24Al reaction rate occurring in Classical Novae

Aim: To study the effect of uncertainty in 23Mg(p,γ)24Al reaction rate occurring in O-Ne and C-O novae at Classical Nova temperatures by performing a comparative study of one-zone nova nucleosynthesis for different rates of this reaction from the JINA-Reaclib database references.
Background: Stellar burning sites are the primary sources of vast majority of elements heavier than helium. One particular nucleosynthesis site is the classical novae, which are explosions resulting from the accretion of hydrogen-rich material onto a White Dwarf star.
Sensitivity studies, which model the effect of nuclear reaction rate variations on nucleosynthesis predictions, have determined a substantial number of proton capture reactions that have the potential for an observable effect on classical nova nucleosynthesis. One of these reactions is the proton capture on radioactive 23Mg, resulting in 24Al plus a γ ray. The 23Mg(p,γ)24Al reaction rate has been investigated through a variety of experimental and theoretical means over the last two decades.
Method: Joint Institute for Nuclear Astrophysics (JINA) reaction library is an online database for thermonuclear reactions of astrophysical importance. The current version of the Reaclib stores reaction rates as a function of temperature in the seven-parameter rate parameterization of Thielemann et al. (1987) and F.-K. Thielemann (1995) interpolation. For the 23Mg(p,γ)24Al reaction rate, Reaclib provides 6 different sources of reference. Each of these references evaluates the rate with an analytical expression. The evaluated rates have been compared to the NuGrid default rate used in one-zone nova nucleosynthesis simulations on the UVic astrohub web server TINA (Training In Nuclear Astrophysics) at characteristic nova temperatures. The differences between analytical and NuGrid default reaction rates have been estimated and their effect on the abundances of intermediate-mass elements predicted by one-zone nova nucleosynthesis simulations have been studied. The rate of the 23Mg(p,γ)24Al reaction was evaluated with available analytical approximations for NuGrid O-Ne and C-O nova models with masses of white dwarf ranging from 1.15 M⊙ to 1.3 M⊙ for mass accretion rate dM/dt = 2×10−10 M⊙/yr. The three different white dwarf central temperatures, TWD = 7, 10, and 12 MK. The accreted material has the 50% pre-mixed Weiss and Barcelona initial compositions. The peak H-burning temperatures in these models reach the values of 257, 436, and 355 MK.
Result: The reaction rate uncertainty study has found that the large variations of the 23Mg(p,γ)24Al rate between its different available sources result in significant variations of the predicted abundances of H, He, Li, C, O, N, F, Ne, Na, Mg, Al, Si, S, P, Cl, Ar, K and Ca isotopes. Also, the 23Mg(p,γ)24Al reaction rate will be directly measured and studied experimentally in the near future using the DRAGON (Detector of Recoils And Gammas Of Nuclear reactions) facility at TRIUMF, Vancouver, BC, Canada.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Nuclear physics - theory

3rd keyword (optional)

Interstellar Medium

Primary authors: AMANDA CRYSTAL, Edwin (Saint Mary's University, Halifax); Dr CHRISTIAN, Greg (Saint Mary's University); Dr DENISSENKOV, Pavel (University of Victoria)

Presenter: AMANDA CRYSTAL, Edwin (Saint Mary's University, Halifax)

Contribution ID: **42** Type: **Oral Presentation**

Measurement of (d, p) and (d, ^{3}He) reactions with ^{7}Be in the context of lithium abundance anomaly

The disagreement between abundances of observed ^{7}Li in metal-poor halo stars and primordial ^{7}Li as predicted by Big Bang Nucleosynthesis (BBN) theory is unsolved for decades. Before considering new physics beyond standard model, recent works tried to search for a nuclear physics solution. This includes studying the cross sections of relevant nuclear reactions, particularly those leading to the destruction of ^{7}Be. The d + ^{7}Be rate used in BBN calculations over the past thirty years was based on an estimate of a constant S-factor of 100 MeV-b. Thus the ^{7}Be(d,p)^{8}Be reaction was considered as a potential candidate to solve the lithium abundance anomaly. The ^{7}Be(d,^{3}He)^{6}Li reaction also needs to be studied in the context of the anomaly and there is only one measurement of this reaction.
We carried out an experiment at the HIE-ISOLDE radioactive ion beam facility at CERN to measure the ^{7}Be(d,p)^{8}Be and ^{7}Be(d,^{3}He)^{6}Li reactions in inverse kinematics using a 5 MeV/A ^{7}Be beam on a CD_2 target. An array of double-sided silicon strip detectors covering $8° - 165°$ in lab was utilised to detect the charged particles emitted from these reactions. The total cross sections of the (d,p) and (d,^{3}He) channels are obtained at a higher centre-of-mass energy than the required Gamow energies. We measured the higher excited states of ^{8}Be up to 22 MeV for the first time in the ^{7}Be(d,p)^{8}Be channel. The excitation functions of the reactions are calculated using TALYS by normalization to the present data and the S-factors are extrapolated to the Gamow energies. The experimental results in the context of the lithium anomaly will be presented.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Nuclear physics - experimental

3rd keyword (optional)

Primary author: Mr ALI, Sk Mustak (Bose Institute)

Co-authors: GUPTA, Dhruba (Bose Institute (IN)); KUNDALIA, Kabita (BOSE INSTITUTE, KOLKATA); SAHA, Swapan K. (Bose Institute); TENGBLAD, Olof (Consejo Superior de Investigaciones Cientificas (CSIC) (ES)); DIAZ OVEJAS, Javier (Consejo Superior de Investigaciones Cientificas (CSIC) (ES)); PEREA MARTINEZ, Angel (Consejo Superior de Investigaciones Cientificas (CSIC) (ES)); CEDERKALL, Joakim

(Lund University (SE)); PARK, Jason (University of British Columbia/TRIUMF); Dr SZWEC, Stuart (University of Jyvaskyla)

Presenter: Mr ALI, Sk Mustak (Bose Institute)

Contribution ID: **43** Type: **Oral Presentation**

Pathways of metal flows in the Milky Way as traced by 26Al

We studied the distribution and kinematics of metal flows
in the Milky Way with INTEGRAL observations of the 1.8 MeV
radioactive decay line of 26Al and hydrodynamic simulations.
The gamma rays pinpoint the flows of freshly produced metals
from massive stars about 1 Myr (decay time) after ejection.
We find in concordance from simulations
and observations that 26Al is mostly ejected into big bubbles
and superbubbles that connect to the Galactic halo.
A significant fraction of 26Al is in the hot gas phase.
Mixing between hot and cold gas can be observed in the
nearby ScoCen superbubble, which has a clear 26Al detection.
Overall, a picture emerges where the complex Galactic
ecosystem channels fresh metals along various pathways
from the nearest star-forming cloud out to the
Galaxy halo.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Interstellar Medium

2nd keyword (optional)

3rd keyword (optional)

Primary author: KRAUSE, Martin (University of Hertfordshire)

Presenter: KRAUSE, Martin (University of Hertfordshire)

Contribution ID: **44** Type: **Oral Presentation**

Galactic Chemical Evolution with radioactive isotopes

In addition to the insights gained by studying the galactic evolution of chemical elements, short lived radioisotopes contain additional information on astrophysical nucleosynthesis sites.
Meteorites can carry information about the nucleosynthetic conditions in the early Solar System using short lived radioisotopes [1][2], while detections of live isotopes of cosmic origin in the deep sea crust help us understand recent nucleosynthetic processes in the Solar neighborhood [3]. We use a three dimensional, high resolution chemical evolution code to model the conditions at the time of the formation of the Solar System, as well as to explain why different classes of radioisotopes should often arrive conjointly on Earth, even if they were produced in different sites. Further, we included radioisotope production into a cosmological zoom-in chemodynamical simulation of a Milky Way-type galaxy, which provides a map of gamma-rays from the decay of radioactive Al-26 consistent with the observations by the INTEGRAL instrument [4].

[1] Lugaro, Ott, Kereszturi, 2018 PrPNP 102, 1L

[2] Côté et al., 2021 Science 371, 945

[3] Wallner et al., 2021 Science 372, 742W

[4] Kretschmer et al., 2013 A&A 559, A99

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Chemical Evolution: the Milky Way

2nd keyword (optional)

Origin of the Solar System

3rd keyword (optional)

Interstellar Medium

Primary author: Dr WEHMEYER, Benjamin (Konkoly Obs & Univ Hertfordshire)

Co-authors: Dr YAGÜE LÓPEZ, Andrés (LANL); Dr CÔTÉ, Benoit; Dr PETŐ, Mária (Konkoly Observatory); Prof. KOBAYASHI, Chiaki (Univ of Hertfordshire); Dr LUGARO, Maria

Presenter: Dr WEHMEYER, Benjamin (Konkoly Obs & Univ Hertfordshire)

Contribution ID: **45** Type: **Oral Presentation**

Technetium in and Mass-Loss from Mira Stars

Not predicted by stellar evolution theory, observations find that Miras without the 3DUP indicator technetium (Tc) in their atmospheres have a *higher* near-to-mid IR colours than their Tc-rich siblings (Uttenthaler 2013, A&A 556, A38). Since a near-to-mid IR colour such as K-WISE4 is an indicator of the mass-loss rate of AGB stars, this suggests that the mass-loss rate from post-3DUP Miras is lower than from pre-3DUP Miras. This is unexpected also because stars with 3DUP activity are thought to be more evolved than Tc-poor Miras, and mass loss is thought to increase along the evolution on the AGB. Different explanations for this result are discussed. One of them is that the radioactive decay of unstable isotopes, foremost ^{26}Al, could impact the formation of dust in the stellar atmosphere and thereby the acceleration of the stellar wind (Uttenthaler et al. 2019, A&A 622, A120). We present new observational results in support of this hypothesis. In particular, we show new results involving measurements of the gas mass-loss rate (Uttenthaler et al., in preparation). More work, in particular on the role of radioactive isotopes in stellar atmospheres, is required to better understand this intriguing phenomenon.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Primary authors: Dr GOBRECHT, David; Dr MCDONALD, Iain; UTTENTHALER, Stefan; Mr BERNHARD, Klaus; Dr CRISTALLO, Sergio

Presenter: UTTENTHALER, Stefan

Contribution ID: **46** Type: **Oral Presentation**

The intermediate neutron capture process in AGB stars

Despite considerable progresses over the past decades, the origin of trans-iron elements is not yet fully understood. In addition to the slow (s) and rapid (r) neutron capture processes, an intermediate neutron capture process (i-process) is thought to exist at neutron densities intermediate between the s- and r-processes. The isotopic signature of some pre-solar grains and the chemical composition of the so-called r/s-stars support the existence of this process but the astrophysical site(s) hosting the i-process is (are) actively debated. The early AGB phase of low-mass stars is a promising site. In this presentation, I will focus on the development of the i-process in state-of-the-art AGB stellar models computed with the STAREVOL code. I will pay special attention to the chemical fingerprint of these stars, and show that they can produce some short-lived radionuclides.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Primary author: CHOPLIN, Arthur (Université Libre de Bruxelles)

Co-authors: SIESS, Lionel (Free University of Brussels); GORIELY, Stephane (Free University of Brussels)

Presenter: CHOPLIN, Arthur (Université Libre de Bruxelles)

Contribution ID: **47** Type: **Oral Presentation**

Deep underground laboratory measurement of 13C(α,n)16O in the Gamow windows of the s- and i-processes

The 13C(α,n)16O reaction is the main neutron source for the slow neutron capture process (s-process) in the Asymptotic Giant Branch (AGB) stars [1] and for the intermediate process (i-process) [2]. It is activated at the temperature around T = 0.1 GK [3,4] and 0.2 GK [2], which correspond to the Gamow windows of Ecm = 0.15 −0.3 MeV and 0.2 −0.54 MeV, for the s- and i-processes, respectively. Due to the vast cosmic background, direct measurements at the ground laboratories stopped at energies above Ecm = 0.27 MeV [5], unable to effectively constrain the crucial threshold state and provide a reliable extrapolation down to stellar energies. Besides that, the extrapolation accuracy is further limited by large discrepancies among those measurements [6,7]. We performed the first consistent direct measurement in the range of Ecm = 0.24 −1.9 MeV using the accelerators at the China Jinping Underground Laboratory (CJPL) and Sichuan University. Our measurement covers almost the entire i-process Gamow window in which the large uncertainty of the previous experiments has been reduced from 60% down to 15%, eliminates the large systematic uncertainty in the extrapolation arising from the inconsistency of existing data sets, and provides a more reliable reaction rate for the studies of the s- and i-processes along with the first direct evidence for the near-threshold state.

References:
[1] C. Kobayashi, A. I. Karakas, and M. Lugaro, The Astrophysical Journal 900, 179 (2020).
[2] F. Herwig, M. Pignatari, P. R. Woodward, D. H. Porter, G. Rockefeller, C. L. Fryer, M. Bennett, and R. Hirschi, The Astrophysical Journal 727, 89 (2011).
[3] R. Gallino, C. Arlandini, M. Busso, M. Lugaro, C. Travaglio, O. Straniero, A. Chieffi, and M. Limongi, The Astrophysical Journal 497, 388 (1998).
[4] S. Bisterzo, C. Travaglio, M. Wiescher, F. Käppeler, and R. Gallino, The Astrophysical Journal 835, 97 (2017).
[5] H. W. Drotleff, A. Denker, H. Knee, M. Soine, G. Wolf, J. W. Hammer, U. Greife, C. Rolfs, and H. P. Trautvetter, The Astrophysical Journal 414, 735 (1993).
[6] R. J. deBoer, C. R. Brune, M. Febrarro, J. Görres, I. J. Thompson, and M. Wiescher, Phys. Rev. C 101, 045802 (2020).
[7] D. Brown, M. Chadwick, R. Capote et al., Nuclear Data Sheets 148, 1 (2018), special Issue on Nuclear Reaction Data.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary author: LIN, Weiping (Institute of Nuclear Science and Technology, Sichuan University)

Presenter: LIN, Weiping (Institute of Nuclear Science and Technology, Sichuan University)

Contribution ID: **48** Type: **Oral Presentation**

Dating supernova grain formation using radioactive isotopes

The abundance of decay products of radioactive, now extinct, isotopes in stardust grains can provide constraints on the formation time of these grains, which means the time between nucleosynthesis of a given radioactive isotope and grain formation. As common in dating schemes, the application requires a separation between the elements of the parent and the daughter isotope. An obvious way is difference in volatility so that one of the elements condenses into the grain, while the other does (almost) not.
The elements Cs and Ba, with the decay of 137Cs (half-life 30 a) into 137Ba, constitute such a pair. Barium has been found in supernova SiC grains (X grains), but Cs is too volatile and is not incorporated. From a subset of the few SiC-X1 grains analyzed so far we have previously derived a nominal formation time of ⍰20 years after supernova explosion [1]. This is based on the relative abundance of 137Ba, in comparison with nucleosynthesis calculations that reproduce the Mo isotopic pattern of such grains [2, 3]. The so obtained age is surprisingly long compared to expectation.
In the REE mass region there are two pairs that might offer additional information. In mainstream SiC grains from AGB stars Eu and Sm are deficient relative to neighboring elements due to their higher volatility [4]. If this also applies to supernova SiC grains, dating might be possible using 155Eu (half-life 4.76 a) and 147Pm (half-life 2.62 a). Decay of 155Eu before grain formation would lead to 155Gd, ending up in the grain, while 155Eu still alive at grain formation would be excluded, leading to a deficit in 155Gd compared to the expected abundance after decay of precursors. Incorporation of Sm would be ineffective, while 147Pm still present would be incorporated and its subsequent decay within the grain could lead to (in the extreme) Sm that is almost mono-isotopic 147Sm.
Realizing the potential of the approach is challenging. It will require more isotopic analyses of heavy elements in supernova grains and improved understanding of supernova nucleosynthesis in the Ba / REE mass region.
References: [1] Ott U. et al. (2018), ApJ 885, 128. [2] Meyer B.S. et al. (2000), ApJL 540, L49. [3] Rauscher T. et al. (2002), ApJ 576, 323. [4] Yin Q.-Z. et al. (2006) ApJ 647, 676.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Meteoritic Materials and Stardust

2nd keyword (optional)

3rd keyword (optional)

Primary author: OTT, Ulrich

Presenter: OTT, Ulrich

Contribution ID: **49** Type: **Oral Presentation**

Chemical abundance study on a large set of P-rich stars

Chemically peculiar stars, such as the recently discovered metal-poor ([Fe/H]∼-1) phosphorus-rich stars, query the current theories on stellar nucleosynthesis and galactic chemical evolution. Consequently, the origin of these stars, their progenitors and hence the source of phosphorus in the Galaxy remains unclear.
In this study, we achieved a remarkable enlargement of the P-rich stars sample, from originally 15 to approximately 85 stars. Based on the high resolution near-IR (H-band) spectra from the SDSS-IV/APOGEE-2 survey (DR17), a detailed abundance analysis of 13 elements, C, N, O, Na, Mg, Al, S, Si, Fe, Ce, Nd, P, Ca has been successfully performed on the new enlarged sample using the Brussels Automatic Code for Characterizing High accUracy Spectra (BACCHUS). As a result, we report overabundances of several elements, such as O, Mg, Al, Si and Ce, confirming strong correlations between phosphorus and other elements. These correlations put important constraints on the search for the P-rich stars progenitors and the nucleosynthetic mechanism behind the unusual abundance patterns of the P-rich stars.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Stellar evolution

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Chemical Evolution: the Milky Way

Primary author: BRAUNER, Maren (Instituto de Astrofísica de Canarias (IAC))

Co-authors: Dr MASSERON, Thomas (Instituto de Astrofísica de Canarias (IAC)); GARCÍA-HERNÁNDEZ, Aníbal (Instituto de Astrofísica de Canarias (IAC))

Presenter: BRAUNER, Maren (Instituto de Astrofísica de Canarias (IAC))

Contribution ID: **50** Type: **Oral Presentation**

New 59Fe Stellar Decay Rate and its Implications for the 60Fe Radioactivity in Massive Stars

The discrepancy between observations from γ-ray astronomy of the 60Fe/26Al γ-ray flux ratio and recent calculations is an unresolved puzzle in nuclear astrophysics. The stellar β-decay rate of 59Fe is one of the major nuclear uncertainties impeding us from a precise prediction. Due to contributions from thermally populated low-lying states in 59Fe, the total β-decay rate in a typical 60Fe-synthesis environment is about two orders of magnitude larger than the terrestrial one. Since direct measurement of the β-decay rates from excited states of 59Fe is not possible, we used the 59Co(t,3He)59Fe charge-exchange reaction to measure its inverse transition and the β-decay rate of 59Fe is then obtained by applying the detailed balance theory. The new stellar decay rate of 59Fe is a factor of 3.5 +/- 1.1 larger than the currently adopted rate at T = 1.2 GK. Stellar evolution calculations show that the 60Fe production yield of an 18 solar mass star is decreased significantly by 40% when using the new rate. Our result eliminates one of the major nuclear uncertainties in the predicted yield of 60Fe and alleviates the existing discrepancy of the 60Fe/26Al ratio.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary author: GAO, Bingshui

Presenter: GAO, Bingshui

Contribution ID: **51** Type: **Oral Presentation**

Cosmic radioactivity probing the epoch of SN or merger nucleosynthesis and neutrino interactions

There is a growing consensus in recent multi-messenger astronomy that the neutron-star merger (NSM) could be a possible site for the production of heavy elements including long-lived radioactive nuclei. We will first discuss that the collapsar, which is very massive single star collapsing to a black hole, and core-collapse supernovae (CCSNe) such as magneto-hydrodynamically driven-jets and neutrino-driven winds dominate the nucleosynthesis of heavy r-elements [1] and p-isotopes like 92,94Mo and 96,98Ru [2] over the entire history of cosmic evolution. We also find that the NSM contribution delays in cosmological timescale until recent epoch due to very slow GW radiation in our Galactic chemical evolution model [1]. Since collapsars and CCSNe eject extremely large flux of energetic neutrinos, the neutrino-process nucleosynthesis (including neutrino-proton process) is strongly affected by both collective and MSW flavor oscillation effects at high density environment. Long-lived radioactive isotopes such as 92Nb (halflife 34.7My), 98Tc (4.20My), 53Mn (3.74My), etc. are produced there abundantly and serve as ideal chronometers to estimate the epoch of SN explosions. Comparing our theoretical calculations and observed isotopic anomalies of these neutrino-isotopes found in meteorites, we will estimate the epoch of SN event which affected strongly the solar-system formation. These nucleosynthetic products could be the most sensitive probe of neutrino interactions in high-density matter and constrain the still unknown mass hierarchy. We will propose how to constrain the mass hierarchy in our nucleosynthetic method in terms of the neutrino-isotopes 180Ta, 138La, 98Tc, 92Nb, 11B, 7Li, etc. [3]. We will also discuss the critical roles of the both primary neutrino-nucleus reactions and secondary radioactive nuclear reactions to respectively produce and destroy these neutrino-isotopes [4] whose experiments are being planned.

[1] Y. Yamazaki, Z. He, T. Kajino, et al., submitted to ApJ (2022), arXiv:2102.05891.
[2] H. Sasaki, Y. Yamazaki, T. Kajino, et al., ApJ 924 (2022), Issue 1, id.29, 7pp.
[3] H. Ko, M.-K. Cheoun, E. Ha, et al., ApJ 891 (2020), Issue 1, id.L24, 6 pp.
[4] X. Yao, M. Kusakabe, T. Kajino, S. Cherubini, S. Hayakawa, H. Yamaguchi,
in preparation (2022); Web of Conf. (EDP Sci.) Proc. NIC-XVI, in press (2022).

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Cosmic Radioactive Deposits in Solar-System Samples

3rd keyword (optional)

Nuclear physics - theory

Primary author: KAJINO, Toshitaka

Presenter: KAJINO, Toshitaka

Contribution ID: **52** Type: **Oral Presentation**

Radioactive isotopes as tracers for the origin of micrometeorites

Solar system objects are constantly bombarded by solar and galactic cosmic-rays generating cosmogenic radioactive isotopes. The measurement of such isotopes in interplanetary dust particles (IDPs) provides an important step towards reconstructing the time they spent in space and hence, towards identifying the nature and origin of their parent bodies.
Generally, IDPs are produced from collisions or surface sublimation of Solar System objects (e.g., asteroids and comets). The solar radiation pressure causes the IDPs to slowly spiral towards our Sun. A fraction intercepts with Earth and lands on its surface as micrometeorites (MMs) –mostly submillimetre-sized spherical particles that were briefly melted during atmospheric entry.
We measured the ^{26}Al and ^{10}Be content of 12 MMs with sizes of 90-500 μm collected from urban areas, particularly from the rooftops of buildings, and from Antarctic sediments. These experimental results were compared to results from theoretical models providing cosmic-ray exposure ages and orbital evolutions. Applying these models, we tested different input parameters including 1) IDP diameters, compositions, and densities, 2) initial orbital parameters, 3) cosmic-ray flux profiles and 4) degrees of ablation during passage through the Earth's atmosphere. Each of these parameters yielded different final ^{26}Al and ^{10}Be concentrations, which were compared to our experimental data for deducing the spatial origins of the MMs in our Solar System.
This initial study shows that our MMs potentially derive from within the Asteroid Belt up to the Kuiper Belt. However, for individual MMs multiple origins are possible. Hence, better statistics of radioactive isotopes within MMs may help to further constrain the sources of dust in our Solar System.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Meteoritic Materials and Stardust

2nd keyword (optional)

Cosmic Rays

3rd keyword (optional)

Cosmic Radioactive Deposits in Solar-System Samples

Primary author: FEIGE, Jenny

Presenter: FEIGE, Jenny

Contribution ID: **53** Type: **Oral Presentation**

The γ-process nucleosynthesis in core-collapse supernovae

The nucleosynthesis of elements heavier than iron in stars is one of the most relevant topics in nuclear astrophysics. The neutron-capture processes made most of the abundances of heavy elements in the solar system, but they are not able to make a number of rare proton-rich stable isotopes (p-nuclei) lying on the left side of the valley of stability. The γ-process, i.e. a chain of photodisintegrations on heavy nuclei, is the most established process for the synthesis of p-nuclei in core collapse supernovae. In this talk, I will present the main features of the γ-process nucleosynthesis in massive stars, considering a range of different progenitor stars and supernova explosions. I will discuss present uncertainties affecting the γ-process, and the discrepancies between theory and observations affecting the production of the stable p-nuclei and of the radioactive isotopes ^{92}Nb and ^{146}Sm, which signature has been measured in Early Solar System material.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Stellar explosions and mergers - theory

Primary author: ROBERTI, Lorenzo (Konkoly Observatory, CSFK)

Co-authors: PIGNATARI, Marco (Hull University); LUGARO, Maria

Presenter: ROBERTI, Lorenzo (Konkoly Observatory, CSFK)

Contribution ID: **54** Type: **Oral Presentation**

Looking for dust in core-collapse supernovae with a Bayesian approach

Dust plays a key role in fundamental astrophysical processes, while, supernova (SN) explosions provide an exceptional opportunity to examine both the final explosions of massive stars and their impact on their circumstellar environment. Furthermore, theoretical expectations and observations advocate that a significant amount of dust can be produced during or before SN explosions. Nevertheless, while several thousand days post explosion, SNe powered by the decay of radioactive isotopes, late-time mid-infrared excess can be attributed to newly-formed and/or pre-existing dust grains.

We aim to investigate in the multidimensional parameter space of different types of dusty SNe and interpret our models using a Bayesian inference framework. This approach enables us to characterize the posterior probability distribution of models, hence determine the most probable regions of the parameter space and reveal the possible degeneracies between parameters. We fit smooth and clumpy numerical models to the IR spectral energy distributions with the MOCASSIN (MOnte CArlo SimulationS of Ionized Nebulae) radiative transfer code and examine the physical parameters of the dust (e.g. mass, location, grain sizes and species). For sampling, we apply a Markov Chain Monte Carlo (MCMC) algorithm using the "emcee" package in Python.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - observations

2nd keyword (optional)

3rd keyword (optional)

Primary author: ZSÍROS, Szanna

Presenter: ZSÍROS, Szanna

Contribution ID: **55** Type: **Oral Presentation**

PIC simulations of relativistic jets with toroidal magnetic field

The properties of relativistic jets, their interaction with the ambient environment, and particle acceleration due to kinetic instabilities are studied self-consistently with Particle-in-Cell simulations. An important key issue is how a toroidal magnetic field affects the evolution of an electron-positron and electron-proton jets, how kinetic instabilities such as the Weibel instability (WI), the mushroom instability (MI) and the kinetic Kelvin-Helmholtz instability (kKHI) are excited with and without the toroidal magnetic field, and how such instabilities contribute to particle acceleration. We show that WI, MI and kKHI excited at the linear stage, generate a quasi-steady ⊠-component of electric field which accelerates and decelerates electrons. In this report, we use a new jet injection scheme where an electric current is self-consistently generated at the jet orifice by the jet particles. We inject both electron-positron and electron-proton jets with a toroidal magnetic field (with a top-hat and Lorentzian jet density profiles) and for a sufficiently long time in order to examine the non-linear effects of the jet evolution. We find that different jet compositions present different strongly excited instability modes. The magnetic field in the non-linear stage generated by different instabilities becomes dissipated and reorganized into a new topology at the nonlinear stage. The 3-dimensional magnetic field topology indicates possible reconnection locations and the accelerated particles are significantly accelerated in the non-linear stage by the dissipation of the magnetic field and/or reconnection. This study will shed further light on the nature of astrophysical relativistic magnetized jet phenomena.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Cosmic Rays

2nd keyword (optional)

3rd keyword (optional)

Primary authors: MELI, Athina (North Carolina A&T State University / ULiege); NISHIKAWA, Kenichi (Alabama A&M University)

Presenter: NISHIKAWA, Kenichi (Alabama A&M University)

Contribution ID: **56** Type: **Oral Presentation**

Neutron induced reactions and unstable nuclei: recent THM investigations at astrophysical energies

Neutron induced reactions on unstable nuclei play a significant role in the nucleosynthesis of the elements in the cosmos. Their interest range from the primordial processes occurred during the Big Bang Nucleosynthesis up to the "stellar cauldrons"where neutron capture reactions build up heavy elements. In the last years, several efforts have been made to investigate the possibility of applying the Trojan Horse Method (THM) to neutron induced reactions mostly by using deuteron as "TH-nucleus". Here, the main advantages of using THM will be given together with a more focused discussion on the recent 7Be(n,a)4He and the 14N(n,p)14C reactions. The former reaction was studied via the THM application to the quasi-free 2H(7Be,aa)p reaction and it represents the extension of the method to neutron-induced reactions in which an unstable beam is present. The 14N(n,p)14C reaction was studied via the 2H(14N,p14C)p experiment performed at INFN-LNS via a 50 MeV 14N beam provided by the TANDEM accelerator. These applications open new frontiers in the application of the method (i.e. the study of 7Be+d or 11C+alpha reactions) extending its range of applicability for contributing to astrophysically relevant problems.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Primary author: Dr SERGI, Maria Letizia (UniCT & INFN-LNS)

Presenter: Dr SERGI, Maria Letizia (UniCT & INFN-LNS)

Contribution ID: **58** Type: **Oral Presentation**

Accounting for Short-Lived Radionuclides in the Early Solar System in the Context of a Triggered Star Formation Origin of the Solar System

A critical constraint on solar system formation is the high ^{26}Al/^{27}Al abundance ratio of 5 $\times 10^{-5}$ at the time of formation, which was about 17 times higher than the average Galactic ratio, while the ^{60}Fe/^{56}Fe value was lower than the Galactic value of 3 $\times 10^{-7}$. This challenges the assumption that a nearby supernova was responsible for the injection of these short-lived radionuclides into the early solar system. We show that this conundrum can be resolved if the Solar System was formed by triggered star formation at the edge of a Wolf-Rayet (W-R) bubble. Aluminium-26 is produced during the evolution of the massive star, released in the wind during the W-R phase, and condenses into dust grains (that have been observed around W-R stars in IR observations). The dust grains survive passage through the reverse shock and the low density shocked wind, reach the dense shell swept-up by the bubble, detach from the decelerated wind and are injected into the shell. The dust grains will be destroyed by grain evaporation or non-thermal sputtering, releasing the ^{26}Al into the shell. Some portions of this shell subsequently collapses to form the dense cores that give rise to solar-type systems. The star will either collapse directly to a black hole, as in some models, or give rise to a supernova explosion. Even if the latter, the aspherical supernova does not inject appreciable amounts of ^{60}Fe into the proto-solar-system, thus accounting for the observed low abundance of ^{60}Fe. We discuss the details of various processes within the model, and conclude that it is a viable model that can explain the initial abundances of ^{26}Al and ^{60}Fe. Besides ^{26}Al and ^{60}Fe, many other short-lived radionuclides (SLRs) were present in the ESS, including ^{10}Be, ^{36}Cl, ^{41}Ca, ^{53}Mn, ^{107}Pd, ^{129}I, and ^{182}Hf. We further investigate whether the triggered star formation model can account for the abundance of these other SLRs, and show that it can adequately explain the abundances of most short-lived radionuclides in the early solar system.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Origin of the Solar System

2nd keyword (optional)

Meteoritic Materials and Stardust

3rd keyword (optional)

Stellar evolution

Primary author: DWARKADAS, Vikram

Co-authors: Prof. DAUPHAS, Nicolas (University of Chicago); Prof. MEYER, Bradley (Clemson University); Mr DILMOHAMED, Shamaul (University of Chicago); Mr BOYAJIAN, Peter (University of Chicago); Dr BOJAZI, Michael (Clemson University)

Presenter: DWARKADAS, Vikram

Contribution ID: **60** Type: **Oral Presentation**

First preliminary results on the s-process branchings 79Se(n,g) and 94Nb(n,g) and future prospects

The recent upgrade of the CERN n_TOF neutron-spallation target has resulted in improved experimental conditions regarding neutron-energy resolution and background level. A concomitant effort has been also made in terms of detection systems, thereby remarkably improving some limitations of previous set-ups. These upgrades, together with a major effort on sample production at PSI and ILL, have enabled the first direct neutron-capture cross section measurements on the radioactive isotopes 79Se and 94Nb. On one hand, the beta-decay of 79Se shows a prominent thermal dependency, which can be exploited to probe the thermal conditions during core He-burning and shell C-burning in massive stars. On the other hand, the interplay between beta-decay and neutron-capture at 94Nb in AGB stars may influence the production of 94Mo, whose isotopic abundance in presolar SiC grains is yet an important topic of debate. A short summary will be presented on the innovative experimental approaches used to perform these two challenging experiments and first preliminary results will be presented to highlight the quality of the results and to discuss their potential impact on s-process nucleosynthesis.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Instrumentation

Primary authors: DOMINGO PARDO, Cesar (Univ. of Valencia and CSIC (ES)); LADARESCU PALIVAN, Ion (Univ. of Valencia and CSIC (ES)); BALIBREA CORREA, Javier (Univ. of Valencia and CSIC (ES)); LERENDEGUI MARCO, Jorge (Univ. of Valencia and CSIC (ES)); BABIANO SUAREZ, Victor (Univ. of Valencia and CSIC (ES))

Presenter: DOMINGO PARDO, Cesar (Univ. of Valencia and CSIC (ES))

Contribution ID: **61** Type: **Oral Presentation**

r-Process sites and their role in producing the heaviest elements and their radioactive isotopes

Various nucleosynthesis studies have predicted the ejection of rapid neutron capture r-process elements. They include (i) core-collapse supernovae with a very weak r-process, possibly producing trans-Fe elements Sr, Y, Zr (and continuing to slightly higher mass numbers), (ii) quark-deconfinement supernovae with a weak r-process contribution (including Eu in small amounts), (iii) magneto-rotational supernovae with weak to moderate r-process contributions (including Eu in moderate to slightly larger but varying amounts), (iv) neutron star mergers with a strong r-process (probably also producing radioactive actinide isotopes), and finally (v) collapsars or massive neutron star mergers with a very strong r-process from black hole accretion tori.
Only one of these sites (neutron star mergers) has shown proven evidence for a (strong) r-process. Is it possible to verify the imprint of the other possible sources to galactic evolution by analyzing the abundances of very metal-poor (VMP) halo stars? We utilize statistical methods to analyze the observational abundance patterns from trans-Fe elements up to the actinides and come to the conclusion that one can identify at least four categories of astrophysical events which must have contributed with different abundance patterns, ejecta amounts, and occurrence frequencies, probably related to the above mentioned sites. Especially the relations of r-I and r-II stars to an actinide boost seem to point to specific sites.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Chemical Evolution

Primary author: Prof. THIELEMANN, Friedrich-Karl (University of Basel and GSI Darmstadt)

Co-authors: Dr FAROUQI, Khalil (University of Heidelberg); Prof. ROSSWOG, Stephan (Stockholm University); Prof. KRATZ, Karl-Ludwig (University of Mainz and Max Planck Institute for Chemistry)

Presenter: Prof. THIELEMANN, Friedrich-Karl (University of Basel and GSI Darmstadt)

Contribution ID: **62** Type: **Oral Presentation**

r-Process Radioisotopes from Near-Earth Supernovae and Kilonovae

The astrophysical sites where r-process elements are synthesized remain mysterious: it is clear that neutron-star-mergers (kilonovae, KNe) contribute, and some classes of core-collapse supernovae (SNe) are also possible sources of at least the lighter r-process species. The discovery of ^{60}Fe on the Earth and Moon implies that one or more astrophysical explosions have occurred near the Earth within the last few Million years (Myr), probably SNe. Intriguingly, ^{244}Pu has now been detected, mostly overlapping with ^{60}Fe pulses. However, the ^{244}Pu flux may extend to before 12Myr ago, pointing to a different origin. Motivated by these observations and difficulties for r-process nucleosynthesis in SN models, we propose that ejecta from a KN enriched the giant molecular cloud that gave rise to the Local Bubble where the Sun resides. Accelerator Mass Spectrometry (AMS) measurements of ^{244}Pu and searches for other live isotopes could probe the origins of the r-process and the history of the solar neighborhood, including triggers for mass extinctions, e.g., at the end of the Devonian epoch, motivating the calculations of the abundances of live r-process radioisotopes produced in SNe and KNe that we present here. Given the presence of ^{244}Pu, other r-process species such as ^{93}Zr, ^{107}Pd, ^{129}I, ^{135}Cs, ^{182}Hf, ^{236}U, ^{237}Np and ^{247}Cm should be present. Their abundances and well-resolved time histories could distinguish between SN and KN scenarios, and we discuss prospects for their detection in deep-ocean deposits and lunar regolith. We show that AMS ^{129}I measurements in Fe-Mn crusts already constrain a possible nearby KN scenario. Thus, we urge searches for r-process radioisotopes in deep-ocean Fe-Mn crusts, and in the lunar regolith samples brought to Earth recently by the Chang'e-5 lunar mission and upcoming missions including Artemis.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Nuclear physics - experimental

Primary authors: WANG, Xilu (Institute of High Energy Physics, Chinese Academy of Sciences); CLARK, Adam; ELLIS, John (CERN); ERTEL, Adrienne; FIELDS, Brian (University of Illinois); FRY, Brian; LIU, Zhenghai; MILLER, Jesse; SURMAN, Rebecca (University of Notre Dame)

Presenter: WANG, Xilu (Institute of High Energy Physics, Chinese Academy of Sciences)

Contribution ID: **63** Type: **Oral Presentation**

Prospects for Nucleosynthesis Observations with NASA's new Gamma-Ray Mission COSI

For 20 years, the spectrometer SPI on INTEGRAL was and still is the only gamma-ray telescope to observe active nucleosynthesis in the Milky Way. The nuclear line emissions of the 26Al decay from massive stars, 22Na and 7Be decay from novae, 44Ti and 56Co decay from supernovae — all have been studied with SPI. Because of this long exposure time and steady improvements for handling the instrumental background, details in the 1.809 MeV map from 26Al along the Galactic plane towards higher latitudes emerged that could only be spectrally analysed with SPI thanks to its unprecedented spectral resolution. However, the distribution of positrons, which are the indirect proof of more beta-plus unstable isotopes in the Galaxy, follows an opposite trend: most of the annihilation radiation at 511 keV is found in the Milky Way bulge. This long-standing conundrum is difficult to solve with SPI as its sensitivity after 20 mission years will not improve significantly.
In 2025, the new gamma-ray mission COSI (Compton Spectrometer and Imager) will launch, mounting 16 high-purity Germanium strip detectors in a compact design. Compton imaging can improve the sensitivity at those energies by at least one order of magnitude, potentially revealing never-seen sources in the MeV sky, such as novae, 511 keV point sources, or individual Wolf-Rayet stars in 26Al.
In this talk, I will give an overview of the latest SPI measurements in these topics, introduce the new COSI mission using examples from its prototype's balloon campaign, and show the possibilities with the future COSI satellite mission.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Instrumentation

3rd keyword (optional)

Astronomy

Primary author: SIEGERT, Thomas (JMU Würzburg)

Presenter: SIEGERT, Thomas (JMU Würzburg)

Contribution ID: **64** Type: **Discussion (Introduction and Facilitation)**

Distributing nucleosynthesis ejecta

Sources of nucleosynthesis may occur in different interstellar environments, from empty fields through clusters of sources, such as in massive-star groups. Such differences are important for the recycling times and efficiencies towards next-generation star formation. With radioactivity from 26Al we have a tool to trace ejecta flows over millions of years. With 60Fe (and 244Pu) in terrestrial sediments we have proof of flows towards Earth. We will discuss lessons from 26Al spectroscopy and its theoretical foundations to the issue of the fate of ejecta from sources of nucleosynthesis

Length of presentation requested

Discussion: Introduction 5 min + Facilitation 25 min

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - observations

2nd keyword (optional)

Chemical Evolution: the Milky Way

3rd keyword (optional)

Interstellar Medium

Primary author: DIEHL, Roland

Presenter: DIEHL, Roland

Contribution ID: **65** Type: **Oral Presentation**

An astrochemical perspective on Radioactive Molecules

Astrophysical observations of radioactive isotopes, like 26Al, 44Ti, or 60Fe, provide insight into the nucleosynthesis of stellar cores [1]. Recently, the radioactive molecule 26AlF was unambiguously astronomically identified towards the object CK Vul [2] by rotational transitions in the microwave spectral region, using the radio telescope observatory ALMA and other telescope facilities. In addition, the vibrational modes of radioactive molecules can be used to identify them in hot stellar environments with infrared instruments such as EXES/SOFIA or the James Webb telescope.

While accurate rotational and vibrational spectra of diatomic molecules can be derived from laboratory measurements of their stable isotopologues, this isotopic scaling method fails for triatomic species such as 26AlOH and forall larger species and thus, requiring in situ spectroscopic measurements on radioactive molecules. Facilities such as ISOLDE/CERN [3] and TRIUMF in Canada are perfectly suited for producing radioactive molecules in supersonic beams. Spectroscopic studies of radioactive species at ISOLDE or TRIUMF will enable future astronomical observations that will provide more detailed information about the processes in the interiors of massive stars. In this talk, astrophysically relevant molecules for studies using rotational and vibrational spectroscopy will be discussed.

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[1] Tur *et al.*, ApJ **718**, 357 (2010)
[2] Kaminski *et al.*, Nat. Ast. **2**, 778 (2018)
[3] Garcia Ruiz *et al.*, Nature **581**, 396 (2020)

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Meteoritic Materials and Stardust

2nd keyword (optional)

Chemical Evolution

3rd keyword (optional)

Interstellar Medium

Primary author: BREIER, Alexander A. (University of Kassel (DE))

Co-author: GIESEN, Thomas F. (University of Kassel (DE))

Presenter: BREIER, Alexander A. (University of Kassel (DE))

Contribution ID: **66** Type: **Oral Presentation**

Alpha-induced cross section measurements for explosive nucleosynthesis scenarios by the activation method

About 50% of the stable isotopes heavier than iron are synthesized via explosive nucleosynthesis processes [Thi17, Arc14, Rau13]. The path of the weak r-process (which synthesizes light neutron-rich isotopes) and the γ-process (which is mainly responsible for the synthesis of the 32-35 proton-rich nuclei) is located close to the valley of stability. Accordingly, several relevant reactions can be studied using stable targets and the activation technique [Gyü19]. The modeling of these astrophysical scenarios requires the use of reaction network calculation. The necessary cross sections are taken from the Hauser-Feshbach (H-F) model calculations. For reactions involving α-particles the key input of the H-F model is the α-nucleus optical model potential (α-OMP). By carrying out (α,n) cross section measurements, the available α-OMP parameter sets can be studied.
For this purpose a series of activation cross section measurements were carried out and further studies are in progress at Atomki. In this presentation an overview on the recent measurement of the 96Zr(α,n) [Kis21] and 100Mo(α,n) [Sze21] reactions, relevant for the weak r-process nucleosynthesis will be given. Furthermore, the cross sections of the 92,94Mo(α,n) and 92Mo(α,p) reactions were also measured to constrain the α-OMP's used in γ-process simulations. Details on the cross section measurements and their impact on the theoretical calculations will be presented.

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Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary author: SZEGEDI, Tibor Norbert

Co-authors: KISS, Gabor (Institute for Nuclear Research (Atomki)); GYÜRKY, György; SZÜCS, Tamás (Institute for Nuclear Research (Atomki)); TOTH, Akos (Institute for Nuclear Research (Atomki))

Presenter: SZEGEDI, Tibor Norbert

Contribution ID: **67** Type: **Oral Presentation**

Upgrading the dppn45 post-processing nucleosynthesis code

Decay rates have a significant effect on the abundance of branching point elements and short-lived nuclei. Thus, a correct description of the decay rates is essential for the accurate study of the s-process in AGB stars. The dppns45 post-processing nucleosynthesis code calculates the changes in the abundances of isotopes due to mixing and nuclear burning after the detailed stellar structure was calculated by a stellar structure evolution code. The nuclear reaction network of dppns45 is originally based on the reaclib formula (Thielemann et al., 1987). The JINA reaclib libraries have several advantages, however, they do not include temperature and density dependence of decay rates. To remedy this shortcoming, a new version of the code includes a routine that allows using tabulated values of decay rates instead of the reaclib fit. During this work, I expand the reaction network to account for the temperature and density dependence of the radioactive decay and electron captures. The tables were created based on the NEXTGEN (Xu et al., 2013) database, and new rates are currently being tested on a model with M = 3 solar masses and z = 0.014 metallicity. The purpose of the testing process is to determine whether the use of tabulated rates instead of reaclib fit causes a significant difference in the final surface abundances. According to the results so far, it can be assumed that the new version of the dppns45 code works, there are significant differences between the tabulated and the reaclib rates, especially for the 152Gd, whose surface abundance is greatly influenced by three (151Sm-›151Eu, 152Eu-›152Sm and 152Eu-›152Gd) new rates.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

3rd keyword (optional)

Primary author: SZÁNYI, Balázs (Konkoly Observatory, University of Szeged)

Co-authors: YAGÜE LÓPEZ, Andrés (LANL); KARAKAS, Amanda (Monash University); LUGARO, Maria (Konkoly Observatory)

Presenter: SZÁNYI, Balázs (Konkoly Observatory, University of Szeged)

Contribution ID: **68** Type: **Oral Presentation**

First direct measurement of the 13N(alpha,p)16O reaction relevant for core-collapse supernovae

The first direct measurement of the total ^{13}N(α,p)^{16}O reaction cross sections was performed using a 34.6 MeV beam of radioactive ^{13}N and the active-target detector MUSIC at Argonne National Laboratory. The ^{13}N(α,p)^{16}O reaction affects the nucleosynthesis in core-collapse supernovae (CCSNe) for a range of relevant temperatures according to several recent sensitivity studies. The ^{13}N(α,p)^{16}O reaction cross sections at astrophysical energies have only been deduced via various indirect methods, and have never been measured directly. Recently published results for the ^{13}N(α,p)^{16}O reaction rate from this measurement will be presented, including new experimental data, a theoretical analysis, and an improved astrophysical reaction rate. This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357. This research used resources of ANL's ATLAS facility, which is a DOE Office of Science User Facility.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Instrumentation

3rd keyword (optional)

Primary author: JAYATISSA, Heshani

Co-authors: Dr AVILA, Melina; Dr REHM, Karl Ernst; Dr TALWAR, Rashi; MOHR, Peter; Dr AURANEN, Kalle (Argonne national laboratory); Dr CHEN, Jie; GORELOV, Dmitry; Dr HOFFMAN, Calem R. (Argonne National Laboratory (US)); Dr JIANG, Cheng-Lie; Dr KAY, Benjamin Peter (Argonne National Laboratory (US)); Dr KUVIN, Sean; Dr SANTIAGO-GONZALEZ, Daniel

Presenter: JAYATISSA, Heshani

Contribution ID: **69** Type: **Oral Presentation**

Using ^{31}Cl β-Delayed Proton Decay to Constrain ^{30}P$(p,\gamma)^{31}$S in ONe novae

Sensitivity studies have identified $^{30}\mathrm{P}(p,\gamma)^{31}\mathrm{S}$ as crucial for understanding nucleosynthesis of $A \geq 30$ nuclides in oxygen-neon (ONe) novae, affecting the calibration of nuclear thermometers and the identification of the origins of ^{30}Si-enriched presolar grains. A radioactive beam experiment was performed at the National Superconducting Cyclotron Laboratory to measure the weak, low-energy, β-delayed proton decay of ^{31}Cl to constrain the large uncertainties in the thermonuclear rate of this reaction. This was the first dedicated science experiment using the Gaseous Detector with Germanium Tagging (GADGET) system, during which the proton branching ratio of the key $J^{\pi} = 3/2^{+}$, 260-keV resonance in ^{31}S was measured. Here, we present the final results of this measurement. We report the weakest β-delayed, charged-particle emission ever measured below 400 keV. Using a 1D, fully hydrodynamic simulation, we predict nuclear abundances in classical nova ejecta and compare to astronomical observation.

This work was supported by the National Science Foundation under Grants No. PHY-1913554, No. PHY-1102511, No. PHY-1565546, PHY-2110365, No. PHY-2011890; the Department of Energy Office of Science under Award No. DE-SC0016052; the Natural Sciences and Engineering Research Council of Canada (NSERC); the Spanish MINECO Grant No. AYA2017-86274-P, the E. U. FEDER funds, the AGAUR/Generalitat de Catalunya Grant No. SGR-661/2017, the EU Horizon 2020 Grant No. 101008324 ChETEC-INFRA, the ChETEC COST Action (CA16117); and Korean NRF Grants No. 2020R1A2C1005981 and No. 2016R1A5A1013277.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Stellar explosions and mergers - observations

Primary author: BUDNER, Tamas (Michigan State University)

Co-authors: FRIEDMAN, Moshe (Hebrew University of Jerusalem); WREDE, Christopher (Michigan State University); BROWN, Alex (Michigan State University); JOSE, Jordi (UPC BarcelonaTECH); PEREZ-LOUREIRO, David (National Superconducting Cyclotron Laboratory); SUN, Lijie (National Superconducting Cyclotron Laboratory); SURBROOK, Jason (Michigan State University); AYYAD, Yassid (Facility for Rare

Isotope Beams); BARDAYAN, Dan (University of Notre Dame); CHAE, Kyungyuk (Sungkyunkwan University); CHEN, Alan (McMaster University); CHIPPS, Kelly (Oak Ridge National Laboratory); CORTESI, Marco (Facility for Rare Isotope Beams); GLASSMAN, Brent (Michigan State University); HALL, Matthew (University of Notre Dame); JANASIK, Molly (Michigan State University); LIANG, Johnson (McMaster University); O'MALLEY, Patrick (University of Notre Dame); POLLACCO, Emanuel (University of Paris-Saclay); PSALTIS, Athanasios (McMaster University); STOMPS, Jordan (Michigan State University); WHEELER, Tyler (Michigan State University)

Presenter: BUDNER, Tamas (Michigan State University)

Contribution ID: **70** Type: **Oral Presentation**

A statistical exploration of CEMP star classification with s-process models

Increasingly larger databases of observed stellar abundances of heavy elements beyond iron present an opportunity to apply a statistical machine learning approach to the traditional comparison between models and observations. In this work we will present our results on CEMP stars. Our aim is to provide an automatic and unbiased process to group these stars in relation to their s-process abundances, which allows us to identify trends in the observations as well as those elements that have a higher impact on the classification. This analysis is done by systematically comparing a database of 650 low-metallicity stars with low-metallicity Asymptotic Giant Branch stellar models from FRUITY (Cristallo et al. 2016) and Monash (Amanda Karakas, private communication). From the comparison we calculate a set of Goodness of Fit (GoF) metrics, and we classify the observational samples based on the same metrics. The impact of single elements or of a group of elements on the classification is measured and taken into account. The obtained classifications are discussed, in comparison with previous results.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

3rd keyword (optional)

Primary author: YAGÜE LÓPEZ, Andrés

Co-authors: Dr PLACCO, Vinicius (NOIRLab); PIGNATARI, Marco (Hull University); DEN HARTOGH, Jacqueline (Keele University)

Presenter: YAGÜE LÓPEZ, Andrés

Contribution ID: **71** Type: **Oral Presentation**

Cosmogenic isotopes activity measured in Cavezzo, an anomalous L5 chondrite recovered in Italy

On January 1st 2020, eight cameras of the PRISMA fireball network detected a very bright bolide over the skies of northern-central Italy. Thanks to these observations, we were able to locate a strewn-field of few square kilometers and recover two specimens, weighing 3.1 g (F1) and 52.2 g (F2), just three days after the fall.
Laboratory analysis on the Cavezzo meteorite showed substantial differences in the lithology, geochemistry, and oxygen isotopic composition of the two specimens. These results led to the classification of Cavezzo as a L5-anomalous chondrite, making it unique and representing a new meteorite type.
Measurements of gamma activity were performed on the main mass F2 at the Monte dei Cappuccini underground Research Station (Torino, Italy) with a large-volume and highly selective HPGe-NaI(Tl) spectrometer, revealing the presence of fifteen cosmogenic isotopes. The detection of short-lived radionuclides, with half-lives down to few days (e.g., V-48), confirmed the recent fall of the sample. Long-lived cosmogenic isotopes concentration (e.g., Al-26) allowed us to estimate the pre-atmospheric size of the meteoroid and the shielding depth of the meteorite. Furthermore, the activity of cosmogenic isotopes with a decadal and centennial half-life, such as Na-22 and Ti-44, revealed past solar activity variations on different time scales.
In this contribution, we present the results of the gamma-activity measurement of Cavezzo and the techniques developed for the detection of low activity cosmogenic radionuclides, below 0.1 decay per minute. Using the radioactivities measured in Cavezzo, we can characterize the galactic cosmic ray fluxes during the last solar minimum.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Cosmic Radioactive Deposits in Solar-System Samples

2nd keyword (optional)

Meteoritic Materials and Stardust

3rd keyword (optional)

Nuclear physics - experimental

Primary authors: Dr BARGHINI, Dario (INAF –Osservatorio Astrofisico di Torino, Pino Torinese, Italy); Dr COLOMBETTI, Paolo (Dipartimento di Fisica, Università di Torino, Italy); Dr BIZZARRI, Ilaria (Dipartimento di Fisica, Università di Torino, Italy); Dr GARDIOL, Daniele (INAF –Osservatorio

Astrofisico di Torino, Pino Torinese, Italy); Dr RUBINETTI, Sara (Dipartimento di Scienze Ambientali, Informatica e Statistica, Università Ca'Foscari di Venezia, Mestre Venezia, Italy); Dr MANCUSO, Salvatore (INAF –Osservatorio Astrofisico di Torino, Pino Torinese, Italy); Dr DI MARTINO, Mario (INAF –Osservatorio Astrofisico di Torino, Pino Torinese, Italy); Prof. PRATESI, Giovanni (Dipartimento di Scienze della Terra, Università di Firenze, Italy); Dr MOGGI CECCHI, Vanni (Museo di Storia Naturale, Università degli Studi di Firenze); Dr GROSCHOPF, Nora (Department of Geosciences, Johannes Gutenberg University, Mainz); Dr AQUINO, Andrea (Dipartimento di Scienze della Terra, Università di Pisa); Dr LAUBENSTEIN, Matthias (INFN –Laboratori Nazionali del Gran Sasso, Assergi, Italy); Prof. BHANDARI, Narendra (Science and Spirituality Research Institute, Navrangpura, Ahmedabad, India); Prof. TARICCO, Carla (Dipartimento di Fisica, Università di Torino, Italy)

Presenter: Dr BARGHINI, Dario (INAF –Osservatorio Astrofisico di Torino, Pino Torinese, Italy)

Contribution ID: **72** Type: **Oral Presentation**

Radioactive molecules for astrophysics

Radioactive isotopes play an increasingly important role in our understanding of the Universe [Die18]. The benefits of observing them are two-fold; the presence of a given radioactive isotope itself provides a signature to probe the stellar nucleosynthesis processes that created it, and its radioactive half-life acts as a sensitive tracer of the timescale of the dynamics involved in its journey all the way from its parent star to the interstellar medium [Die21].

Until now, the distribution of radioactive isotopes across the galaxy has been investigated through detection of characteristic γ-rays resulting from their decay or through measured abundances of isotopes present in meteorites [Die21]. In an exceptional case, the rotational transitions of the radioactive molecule ^{26}AlF were scaled from laboratory data of stable ^{27}AlF leading to its identification near CK Vul [Kam18].

This contribution presents data from an experimental campaign performing high-resolution rotationally resolved spectroscopy of radium monofluoride [Gar20, Udr21], a promising candidate for fundamental symmetry violation studies [Ber19], produced in miniscule quantities at the ISOLDE radioactive beam facility at CERN.

The demonstrated unprecedented combination of ultra-high sensitivity and high resolution of the employed technique paves the way for an experimental program dedicated to the study of radioactive molecules containing astrophysical isotopes of interest for which an outlook will be given. This will enable their unambiguous detection in space and allow their presence to be associated with single stellar objects owing to the exceptional resolution of millimetre-wave observatories in operation today.

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[Die18] Astrophysics, Space Sci. 453 (2018)
[Die21] Astrophysics, Space Sci. 366 104 (2021)
[Gar20] Nature 581 396–400 (2020)
[Kam18] Nat. Ast. 2 778–783 (2018)
[Udr21] Phys. Rev. Lett. 127 033001 (2021)

Authors: S. G. Wilkins[1] M. Athanasakis-Kaklamanakis[2,3], M. Au[4,5], I. Belošević[1,6], R. Berger[7], M. L. Bissell[8], A. Borschevsky[9], A. A. Breier[10], A. J. Brinson[1], K. Chrysalidis[4], T. E. Cocolios[3], R. P. de Groote[3], A. Dorne[3], K. T. Flanagan[8,11], S. Franchoo[12], R. F. Garcia Ruiz[1], K. Gaul[7], S. Geldhof[3], T. F. Giesen[10], D. Hanstorp[13], R. Heinke[4], T. A. Isaev[14], H. Kakioka[1], S. Kujanpää[15], L. Lalanne[3], J. Karthein[1], A. Kiuberis[9], Á. Koszorús[2], G. Neyens[3], B. McGuire[1], S. Moroch[1], M. Nichols[13], L. F. Pašteka[16], J. Reilly[8], S. Rothe[4], F. Pastrana Cruz[1], H. A. Perrett[8], S. M. Udrescu[1], B. van den Borne[3], A. R. Vernon[1], Q. Wang[17], J. Wessolek[8,18], X. F. Yang[19], C. Zülch[7].
[1]Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, [2]EP Department, CERN, CH-1211 Geneva 23, [3]KU Leuven, Instituut voor Kern-en Stralingsfysica, B-3001 Leuven, Belgium, [4]Systems Department, CERN, CH-1211 Geneva 23, Switzerland, [5]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany, [6]TRIUMF, Vancouver V6T 2A3, Canada, [7]Fachbereich Chemie, Philipps-Universität Marburg, Hans-Meerwein-Straße 4, 35032 Marburg, Germany, [8]School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, United Kingdom, [9]Van Swinderen Institute for Particle Physics and Gravity, University of Groningen, 9747 AG Groningen, The Netherlands, [10]Laboratory for Astrophysics, Institute of Physics, University of Kassel, 34132 Kassel, Germany, [11]Photon Science Institute Alan Turing Building, University of Manchester, Manchester M13 9PY, United Kingdom, [12]Laboratoire Irène Joliot-Curie, F-91405 Orsay, France, [13]Department of Physics, Gothenburg University, Gothenburg, Sweden, [14]Petersburg Nuclear Physics Institute, Gatchina, Leningrad

District 188300, Russia, [15]Department of Physics, University of Jyvaskyla, PB 35(YFL) FIN-40351 Jyvaskyla, Finland, [16]Department of Physical and Theoretical Chemistry, Faculty of Natural Sciences, Comenius University, Mlynská dolina, 84215, Bratislava, Slovakia, [17]School of Nuclear Science and Technology, Lanzhou University, Lanzhou 73000, China, [18]M Squared, 1 Kelvin Campus, West of Scotland Science Park, Glasgow G20 0SP, UK, [19]School of Physics and State Key Laboratory of Nuclear Physics and Technology, Peking University, 100971 Beijing, China.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary author: WILKINS, Shane (Massachusetts Institute of Technology)

Presenter: WILKINS, Shane (Massachusetts Institute of Technology)

Contribution ID: **73** Type: **Oral Presentation**

The production of 10Be in the supernova neutrino process

The radioactive isotope ^{10}Be is among those that have been present when the solar system formed. We review the production of this isotope in core-collapse supernovae via the ν-process considering results from modern multi-dimensional simulations, as well as the sensitivity to nuclear reactions. Recent nuclear experiments suggest that the cross-section of the most important destructive reaction, ^{10}Be(p,α)^{7}Li, is higher than previously assumed, significantly reducing the expected production of ^{10}Be by supernovae.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Primary author: SIEVERDING, Andre (Oak Ridge National Laboratory)

Co-authors: Dr RANDHAWA, Jaspreet (University of Notre Dame); Mr ZETTERBERG, Daniel (University of Tennessee); Dr DE BOER, Robert (University of Notre Dame); Prof. AHN, Tan (University of Notre Dame); Dr MANCINO, Riccardo (TU Darmstadt); Prof. MARTINEZ-PINEDO, Gabriel (TU Darmstadt); Prof. HIX, William Raphael (Oak Ridge National Laboratory)

Presenter: SIEVERDING, Andre (Oak Ridge National Laboratory)

Contribution ID: **74** Type: **Oral Presentation**

Mass measurements of neutron-rich gallium and indium isotopes for r-process studies

The astrophysical rapid neutron-capture process (r-process) is believed to be responsible for the production of approximately half of the chemical elements heavier than iron. The accurate modelling of the r-process nucleosynthesis needs reliable experimental nuclear data, especially for nuclei around closed neutron shells serving as waiting points, this has been shown by sensitivity studies [1]. One of the important nuclear physics inputs influencing the final r-process abundances is the nuclear masses. Observing the gravitational waves from the binary neutron star (BNS) merger (GW170817) and the subsequent detection of the electromagnetic counterpart (AT2017gfo) served as the first direct evidence that heavy elements, including the lanthanide region, were synthesized by the r-process, but the production of the elements of the first r-process abundance peak remains uncertain. To gain more knowledge on the formation of the first r-process peak and investigate whether the ejecta of a BNS merger can indeed be one of the possible sites for the formation of A ≈ 80-84 r-process elements is of general interest.

Exotic nuclei can be produced with very high rates at the ISOL facility ISAC at TRIUMF (Vancouver, Canada). TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) is a multiple ion-trap system for high-precision mass measurements and in-trap decay spectroscopy. A multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) has been installed and integrated into the TITAN experiment. It is based on an established concept tested at the FRS Ion Catcher at GSI. It is well suited to perform high precision mass measurements, particularly for short-lived isotopes produced at low rate. Furthermore, the ion of interest can be separated from isobaric contaminations with mass-selective re-trapping prior to the mass measurement itself, thus improving the background handling capabilities of the MR-TOF-MS.

Such improved capabilities of TITAN have been used to investigate the r-process nucleo-synthesis for masses at A ≈ 84. The measurements determine the masses of $^{80-85}$Ga with uncertainties between 25-48 keV; the masses of ^{84}Ga and ^{85}Ga were measured for the first time [2]. The new mass values reduce the nuclear uncertainties associated with the production of A ≈ 84 isotopes by the r-process for astrophysical conditions that might be consistent with a BNS merger producing a blue kilonova. In addition, high-precision mass measurements of neutron-rich indium isotopes were performed by TITAN's MR-TOF-MS covering the N = 76–85 region and including measurements of ground states as well as isomeric states. The masses of ^{133,134}In were measured for the first time and the ^{132}In marks the first direct mass measurement [3]. The uncertainties of several neutron-rich indium ground-state masses and isomer excitation energies have been improved compared to previous literature values providing valuable input for future r-process calculations.

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[3] C. Izzo et al., Phys. Rev. C 103, 025811 (2021).

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Primary authors: KRIPKÓ-KONCZ, Gabriella (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany); AYET SAN ANDRES, Samuel (GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany); IZZO, Christopher (TRIUMF, Vancouver, British Columbia, Canada); LIPPUNER, Jonas (CCS-2, Los Alamos National Laboratory, Los Alamos, New Mexico, USA); NIKAS, Stylianos (GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany); REITER, Moritz P. (School of Physics and Astronomy, University of Edinburgh, Edinburgh, Scotland, United Kingdom); DICKEL, Timo (GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany); DILLING, Jens (Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA); JACOBS, Andrew (TRIUMF, Vancouver, British Columbia, Canada); KOOTTE, Brian (TRIUMF, Vancouver, British Columbia, Canada); KWIATKOWSKI, Anna A. (TRIUMF, Vancouver, British Columbia, Canada); MARTINEZ-PINEDO, Gabriel (Institut für Kernphysik (Theoriezentrum), Technische Universität Darmstadt, Darmstadt, Germany); MUKUL, Ish (TRIUMF, Vancouver, British Columbia, Canada); PAUL, Stefan F. (TRIUMF, Vancouver, British Columbia, Canada); PLASS, Wolfgang R. (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany); SCHATZ, Hendrik (National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan, USA); SCHEIDENBERGER, Christoph (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany); WILL, Christian (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany)

Presenter: KRIPKÓ-KONCZ, Gabriella (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany)

Contribution ID: **75** Type: **Oral Presentation**

Beta-Delayed Neutron-Emission Probabilities of 20 neutron-rich Ag, Cd, In and Sn isotopes: Impacts on the second r-process peak formation

V. H. Phong[1,2], S. Nishimura[1], G. Lorusso[1,3,4], T. Davinson[5], A. Estrade[6], O. Hall[5], T. Kawano[7], J. Liu[1,8], F. Montes[9], N. Nishimura[10,1], J. Agramunt[11], D.S. Ahn[1,12], A. Algora[11], J.M. Allmond[13], H. Baba[1], S. Bae[12], N.T. Brewer[13,14], C.G. Bruno[5], R. Caballero-Folch[15], F. Calvino[16], P.J. Coleman-Smith[17], G. Cortes[16], I. Dillmann[15,18], C. Domingo-Pardo[11], A. Fijalkowska[19], N. Fukuda[1], S. Go[1], C.J. Griffin[5], R. Grzywacz[14], J. Ha[1,20], L.J. Harkness-Brennan[21], T. Isobe[1], D. Kahl[5,22], L.H. Khiem[23,24], G.G. Kiss[1,25], A. Korgul[19], S. Kubono[1], M. Labiche[17], I. Lazarus[17], J. Liang[26], Z. Liu[27,28], K. Matsui[1,29], K. Miernik[19], B. Moon[12], A.I. Morales[11], P. Morrall[17], N. Nepal[6], R.D. Page[21], M. Piersa-Silkowska[19], V.F.E. Pucknell[17], B. C. Rasco[13], B. Rubio[11], K.P. Rykaczewski[13], H. Sakurai[1,29], Y. Shimizu[1], D.W. Stracener[13], T. Sumikama[1], H. Suzuki[1], J.L. Tain[11], H. Takeda[1], A. Tarifeno-Saldivia[16], A. Tolosa-Delgado[11], M. Wolinska-Cichocka[30], P.J. Woods[5], and R. Yokoyama[14]

[1]RIKEN Nishina Center, Japan, [2]VNU University of Science, Vietnam, [3]National Physical Laboratory, UK, [4]University of Surrey, UK, [5]University of Edinburgh, UK, [6]Central Michigan University, USA, [7]Los Alamos National Laboratory, USA, [8]University of Hong Kong, Hong Kong, [9]National Superconducting Cyclotron Laboratory, USA, [10]Cluster for Pioneering Research, RIKEN, Japan, [11]Instituto de F´sica Corpuscular, Spain, [12]Institute for Basic Science, Republic of Korea, [13]Oak Ridge National Laboratory, USA, [14]University of Tennessee, Knoxville, TN, USA, [15]TRIUMF, Canada, [16]Universitat Politecnica de Catalunya, Spain, [17]STFC Daresbury Laboratory, UK, [18]University of Victoria, Canada, [19]University of Warsaw, Poland, [20]Seoul National University, Republic of Korea, [21]University of Liverpool, UK, [22]IFIN-HH, Romania, [23]Institute of Physics, Vietnam, [24]Graduate University of Science and Technology, Vietnam, [25]MTA Atomki, Hungary, [26]McMaster University, Canada, [27]Institute of Modern Physics, CAS, China, [28]School of Nuclear Science and Technology, CAS, China, [29]University of Tokyo, Japan, [30]HIL, University of Warsaw, Poland

Nuclear physics imprints on the r-process nucleosynthesis manifest themself in the so-called r-process peaks. In particular, the second r-process peak around mass number A=130 is thought to be formed robustly by the accumulation of nuclear matter along the neutron magic number N=82, due to the nuclear closed-shell effect. Therefore, experimental data on nuclear properties in this nuclear region will provide important constraints for a better understanding of the formation of the peak. Using the BRIKEN setup at RIKEN, the β-delayed one- and two-neutron branching ratios (P_{1n} and P_{2n} values) of 20 neutron-rich nuclei $^{129-131}$Ag, $^{131-134}$Cd, $^{132-136}$In, and $^{134-138}$Sn has been measured. Our results offer, for the first time, a systematic picture of the evolution of (P_{1n} and P_{2n} values crossing the N=82 and Z=50 shell closure in daughter nuclei, and provide stringent benchmarks for the newly developed global theoretical calculations of β-decay properties. The impact of measured P_{1n} and P_{2n} values on the formation of the second r-process peak has been studied. It was found that it is significant in shaping odd-even abundance pattern and it directly contributes to the β-decay flowing to the stable isotopes of Te and Cs.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Primary author: VI, Phong

Presenter: VI, Phong

Contribution ID: **76** Type: **Oral Presentation**

The ^{39,41,42}Ar nuclides as probes of neutron-induced reactions in a high-density plasma at the National Ignition Facility: a proposed experiment and calibration measurements

Inertial fusion laser-induced implosions at the National Ignition Facility (NIF) are a unique environment to reproduce astrophysical conditions in the laboratory. The laser energy is used to compress and heat a capsule filled with deuterium-tritium fuel to conditions (density, temperature, and pressure) comparable to or exceeding those in the center of stars. Recent experiments at NIF first passed the burning-plasma threshold [1,2], where self-heating exceeded the external heating applied to the fuel and produced record fusion yields of ≈1 MJ . Neutrons are produced in a volume with a radius of ˜50 μm within ˜100 ps, representing a uniquely high neutron density approaching 10^{22} cm^{-3} close to those of the astrophysical r process and fluxes of 10^{31} cm^{-2}s^{-1}. In a dedicated NIF high-power laser shot, we plan to investigate the following neutron-induced reactions on ^{40}Ar incorporated in the capsule gas; the chemical inertness of noble gas Ar allows for reliable collection of reaction products. The ^{40}Ar$(n, 2n)^{39}$Ar reaction is a direct monitor of the fast-neutron flux and the ^{40}Ar$(n, \gamma)^{41}$Ar and ^{40}Ar$(2n, \gamma)^{42}$Ar reactions are sensitive to energy downgraded neutrons. The latter reaction is a monitor of extreme neutron densities produced in the process and may provide an indication of the feasibility to study the important ^{58}Fe$(2n, \gamma)^{60}$Fe reaction [3] in the laboratory. The long-lived ^{39}Ar ($t_{1/2}$ = 268 y) and ^{42}Ar (33 y) nuclides are detected via noble-gas accelerator mass spectrometry at Argonne National Laboratory. We report here on calibration measurements of the total yield of the ^{40}Ar$(n, 2n)^{39}$Ar reaction in a 14 MeV neutron activation, investigated for the first time. The neutron activation was performed with the DT neutron generator of Technical University Dresden located at Helmholtz-Zentrum Dresden-Rossendorf. Direct detection of the ^{42}Ar nuclide in a ^{40}Ar sample activated by the slow double-neutron capture reaction ^{40}Ar$(n, \gamma)^{41}$Ar$(n, \gamma)^{42}$Ar at the high flux reactor of Institut Laue-Langevin was successfully demonstrated for the first time. Preliminary results of these calibration experiments are presented.

Support from the Pazy Foundation (Israel) and USA-Israel Binational Science Foundation is gratefully acknowledged. This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357. This research used resources of ANL's ATLAS facility, which is a DOE Office of Science User Facility.

[1] A. B. Zylstra et al., Nature 93, 542 (2022).
[2] A. L. Kritcher et al., Nature Phys. 18, 251 (2022).
[3] W. Wang et al., Astrophys. J. 889, 169 (2020)

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Instrumentation

Primary authors: CLARK, Adam; Dr ZYLSTRA, Alex (Lawrence Livermore National Laboratory); Dr VELSKO, Carol (Lawrence Livermore National Laboratory); Prof. PAUL, Michael (The Hebrew University of Jerusalem); Mr NELSON, Austin (University of Notre Dame); DICKERSON, Clayton (Argonne National Lab); Mr HOFFMANN, Hans F. R. (Technical University Dresden); JAYATISSA, Heshani; Dr TOLTSUKHIN, Ivan (Argonne National Laboratory); MCLAIN, Jake; ZUBER, Kai (Technische Universitaet Dresden); REHM, Karl Ernst; Mrs CALLAHAN, Lauren (University of Notre Dame); Mrs PICHOTTA, Marie (Technical University Dresden); AVILA, Melina; Dr TESSLER, Moshe (Soreq Nuclear Research Center); Prof. COLLON, Philippe (University of Notre Dame); PARDO, Richard (Argonne National Laboratory); SCOTT, Robert (Argonne National Laboratory); SCHWENGNER, Ronald (Helmholtz-Zentrum Dresden-Rossendorf); Ms SAHOO, Rudra N. (The Hebrew University of Jerusalem); Mr BAILEY, Thomas (University of Notre Dame); Mr DOERING, Toralf (Helmholtz-Zentrum Dresden-Rossendorf); KOESTER, Ulli (Institut Laue-Langevin (FR)); Dr KASHIV, Yoav (University of Notre Dame); VONDRASEK, richard (Argonne National Laboratory)

Presenter: Prof. PAUL, Michael (The Hebrew University of Jerusalem)

Contribution ID: **77** Type: **Oral Presentation**

How do pozitron-trapping and titanium decay change light curve models of SESNe?

Stripped-envelope (Type IIb and Ib/c) supernovae form a special group within core-collapse SNe because their progenitor lost a significant amount of the H and He layers during the pre-supernova evolution. And as far as we know, there are some discrepancies between the physical parameters derived from their early- and late-time light curve models. Moreover, most of these events show a peculiar slope in the late time that can not be explained only by the radioactive decay of Ni and Co. One possibility to solve this issue is the gamma-ray and positron trapping, which plays an important role in forming the shape of the late-time light curve of SESNe. Or it is also possible that this effect is due to titanium decay, which can be taken into account besides nickel and cobalt decay.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - theory

2nd keyword (optional)

3rd keyword (optional)

Primary author: NAGY, Andrea

Presenter: NAGY, Andrea

Contribution ID: **78** Type: **Oral Presentation**

'Ni problem' in Canonical and Ultrastripped Supernova Explosions

Details of the explosion mechanism of core-collapse supernovae (CCSNe) are not yet fully understood. There is now an increasing number of successful examples of reproducing explosions in the first-principles simulations, which have shown a slow increase of explosion energy. However, it was recently pointed out that the growth rates of the explosion energy of these simulations are insufficient to produce enough ^{56}Ni mass to account for observations. We refer to this issue as the "nickel mass problem" (Ni problem, hereafter; Sawada et al. 2019, Suwa et al. 2019, Sawada & Suwa 2021).
Also similar to this issue, the apparent 56Ni problem in Ultrastripped supernovae (USSNe) with a relatively low ejecta mass of $\sim 0.1 M_{\odot}$ (e.g., iPTF 14gqr and SN 2019dge) has been recently reported (Sawada et al. 2022).
From these perspectives, radioisotope ^{56}Ni is an important indicator of the supernova explosions, which characterizes light curves. Nevertheless, rather than 56Ni, explosion energy has often been paid attention from the explosion mechanism community, since it is, at a glance, easier to estimate from numerical data than the amount of ^{56}Ni. In this talk, I will discuss the relationship between the radioisotope ^{56}Ni and the explosion mechanism of supernovae, and "Ni problem", focusing on my own study.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - theory

2nd keyword (optional)

Astronomy

3rd keyword (optional)

Stellar explosions and mergers - observations

Primary author: SAWADA, Ryo (The University of Tokyo)

Presenter: SAWADA, Ryo (The University of Tokyo)

Contribution ID: **79** Type: **Oral Presentation**

Short-lived radioactive isotopes from massive binary stars and the early Solar System

Massive stars eject the products of their nuclear burning into the stellar medium via stellar winds and supernova explosion. Chemical yields from single massive stars are widely available in the literature. However, massive stars are often found in binary systems, and the effects of binary interactions on the yields have not been taken into account in most previous studies. We present our work aimed to fill this gap. We have used the MESA stellar evolution code to compute massive stars with initial masses from 10-80Msun both rotating and non-rotating at solar metallicity (Z=0.014) and their massive non-rotating binary counterparts. From these simulations we have calculated the wind yields for the single stars and for those binary systems where mass transfer plays a major role. We studied the short-lived radioactive nuclei aluminium-26, which is of relevance for to galactic gamma-rays and to the formation of the Solar System as a case study. We found that for binary systems with massive stars up to ˜35-40Msun the yield can increase up to two orders of magnitude, while above ˜45Msun the yield becomes similar to the single star yield, or even decreases. We also considered the radioactive isotopes chlorine-36 and calcium-41 to identify which stellar sources are potentially responsible for the injection of these isotopes into the early Solar System. We find that for the single stars, only the most massive, rotating stars in our sample can match the early Solar System abundances. Especially chlorine-36 is hard to match. However, when we include binary interactions, the upper limit for the mass lowers, and we find more potential sources for these three isotopes.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Origin of the Solar System

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Nucleosynthesis

Primary authors: BRINKMAN, Hannah; LUGARO, Maria

Presenter: BRINKMAN, Hannah

Contribution ID: **80** Type: **Oral Presentation**

The radiogenic heating of planets and the 40K question

The quantity of radioactive isotopes in a planet's mantle and the evolution of its heating due to the isotopes' radioactive decay determines the capability of that planet to develop geological features associated with a habitable environment, such as surface crust and plate tectonics. When our solar system was formed, large quantities of Potassium (K), a major element available in the interstellar medium at the time, got subsequently deposited inside our planet's mantle and crust. Potassium's long-lived radioactive isotope ^{40}K is still present in large quantities inside the planet. The beta particles that it emits heat up earth's mantle for the last several billions of years and largely contribute to the habitable nature of Earth. Predicting the amount of ^{40}K enrichment in the solar system of a given exoplanet would be fundamental for a reliable calculation of the planet's heating evolution and would allow us to make estimates on the likely existence of a habitable environment. Potassium, however, has a complex production and (destruction) mechanism in the cosmos. From a nucleosynthesis point of view, the uncertainty in the abundance of ^{40}K is associated with the reactions that create and destroy 40K in stellar nucleosynthesis processes and the corresponding reaction rates. In my talk, I will discuss the importance of potassium in the context of exoplanet-related research, the origin of potassium in stars, the nuclear physics aspects that affect the existence of ^{40}K, and current experimental efforts to constrain the relevant reaction rates.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Habitability, Exoplanets

Primary author: PERDIKAKIS, Georgios (Central Michigan University)

Presenter: PERDIKAKIS, Georgios (Central Michigan University)

Contribution ID: **81** Type: **Oral Presentation**

Simulation of production of the cosmogenic radionuclides in loess

Development of a Geant4 application which models propagation and interaction of cosmic rays with the soil - loess, including the simulation of creation of cosmogenic radionuclides in soil is reported. CORSIKA is used to simulate the propagation of cosmic rays through atmosphere to the ground. The distribution of concentration of produced radionuclides by depth from simulation is presented thus allowing alternative method of study loess geomorfology but also to study cosmic ray flux modulated by the sun activity on long-term scale. The possibility of detection using laboratory equipment of these cosmogenic radionuclides created in soil is discussed.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Cosmic Rays

2nd keyword (optional)

Nuclear physics - experimental

3rd keyword (optional)

Primary authors: VESELINOVIC, Nikola; MALETIC, Dimitrije; SAVIC, Mihailo (Institute of Physics Belgrade); Dr DRAGIĆ, Aleksandar (Institute of Physics Belgrade); JOKOVIC, Dejan (Institute of Physics, University of Belgrade); Dr BANJANAC, Radomir (Institute of physics Belfrade); Dr KNEŽEVIĆ, David (Institute of physics Belgrade); Dr UDOVIČIĆ, Vladimir (Institute of Phyisics Belgrade)

Presenter: VESELINOVIC, Nikola

Contribution ID: **82** Type: **Oral Presentation**

Spectroscopy of ^{48}Cr by the ^{50}Cr$(p,t)^{48}$Cr reaction

The radioactive nucleus ^{44}Ti is thought to be produced in Core-Collapse Supernovae (CCSNe) with the amount produced being sensitive to internal dynamics of the explosion. As such, ^{44}Ti is a potential diagnostic tool for understanding the behaviour of these stellar explosions.

The amount of ^{44}Ti produced depends not only on the production reactions but also on the destruction reactions, most notably the ^{44}Ti$(\alpha,p)^{47}$V reaction which proceeds through states in the compound nucleus ^{48}Cr. This reaction is usually treated through statistical models (see, for example, the recent study by Chipps and collaborators Phys. Rev. C 102, 035806) but it is not clear that this is valid given the limitations of the levels which can be populated in ^{44}Ti$+\alpha$ fusion (natural parity, isoscalar) and the influence of α-particle clustering behaviour on other α-particle induced reactions.

Spectroscopy in the Gamow Window of the ^{44}Ti$(\alpha,p)^{47}$V reaction has been performed using the ^{50}Cr$(p,t)^{48}$Cr reaction with the K600 magnetic spectrometer at iThemba LABS in South Africa. A number of excited states have been observed, many for the first time, giving insights into the validity of statistical models for the ^{44}Ti$(\alpha,p)$$ˆ{47}V reaction.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary authors: ADSLEY, Philip (Texas A&M University); Mr BINDA, Sifundo (WITS/iTL)

Presenter: ADSLEY, Philip (Texas A&M University)

Contribution ID: **83** Type: **Oral Presentation**

Measurement of the 7Be(p,γ)8B at astrophysical energies using a radioactive 7Be ion beam

The cross section of $^{7}\mathrm{Be}(\mathrm{p},\gamma)^{8}\mathrm{B}$ represents one of the more important reaction for the prediction of high energy component of solar neutrino spectrum and it has also a direct impact on the $^{7}\mathrm{Li}$ abundance after the Big Bang Nucleosynthesis. The importance of this reaction triggered an intense experimental work over the last decades, where discrepancies were observed between the results of different measurements.
Considering that all measurements share the same experimental approach, i.e. an intense proton beam impinging on a $^{7}\mathrm{Be}$ radioactive target, common systematic effects due to the complicated target stoichiometry and the deterioration under beam bombardment might possibly be the origin of the discrepancies observed. Inverse kinematics, i.e. a $^{7}\mathrm{Be}$ ion beam and a hydrogen target, with the direct measurement of the total reaction cross section by means of the detection of the $^{8}\mathrm{B}$ recoils, can shed light on such systematic effects. Efforts attempted so far were limited by the low $^{7}\mathrm{Be}$ beam intensity.
Here we present the results obtained using the intense $^{7}\mathrm{Be}$ beam in combination with a windowless gas target available at the Tandem Accelerator Laboratory at CIRCE (Center for Isotopic Research on Cultural and Environmental heritage), University of Campania, Italy coupled to the recoil mass separator ERNA (European Recoil mass separator for Nuclear Astrophysics) in the energy range $E_{cm} = 367$ to 812 keV.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

3rd keyword (optional)

Primary authors: DI LEVA, Antonino (University of Naples and INFN - National Institute for Nuclear Physics); GIALANELLA, Lucio (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); BUOMPANE, Raffaele (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics)

Co-authors: D'ONOFRIO, Antonio (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); SANTONASTASO, Claudio (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); Dr SCHÜRMANN, Daniel (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); RAPAGNANI, David (University of Naples ”Federico II”); Dr ROGALLA, Detlef (Ruhr-Universität Bochum, Bochum); MARZAIOLI, Fabio (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); Dr PALUMBO, Giancarlo (Università degli Studi di Napoli "Federico II", Napoli, Italy, EU); Dr PORZIO, Giuseppe (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); GYÜRKY, György; GARCIA DUARTE, Jeremias (INFN - National Institute for Nuclear Physics); GASQUES, Leandro; MORALES-GALLEGOS, Lizeth (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics); DE CESARE, Mario (Italian Aerospace Research Centre - CIRA); Dr ROMOLI, Mauro (INFN sez. Napoli); Prof. ROCA, Vincenzo (University of Campania ”Luigi Vanvitelli”); FÜLÖP, Zsolt (ATOMKI)

Presenter: BUOMPANE, Raffaele (University of Campania ”Luigi Vanvitelli” and INFN - National Institute for Nuclear Physics)

Contribution ID: **84** Type: **Oral Presentation**

A detailed look at the production of Fe-group elements in core-collapse supernovae

Core-collapse supernovae mark the death of massive stars above ~8-10 Msun. In this spectacular explosion, elements are synthesized and ejected. The details of the isotopes produced depend on many factors, including the composition of the star prior to explosion, the weak reactions during the collapse and onset of the explosion, and the strength of the explosion. In this talk, I will highlight recent nucleosynthesis work from our group. I will compare the calculations with relevant observations to identify the areas of greatest need for future work.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - theory

2nd keyword (optional)

3rd keyword (optional)

Primary author: Prof. FROHLICH, Carla (North Carolina State University)

Presenter: Prof. FROHLICH, Carla (North Carolina State University)

Contribution ID: **85** Type: **Oral Presentation**

Verifying footprints of solar cycles and supernovae in polar ice cores

Polar ice cores can yield information about astronomical phenomena as well as information about climate changes of the past. More than 40 years ago, Rood and his colleagues suggested a possibility that such a polar ice core preserved footprints of historical supernovae and solar cycles (Rood et al., Nature, 1979). In the Rood's work, the signatures of three historical supernovae were identified as "spikes"found in the depth profile of nitrate ion concentrations. This was a preliminary result, however, as the authors themselves mentioned in the literature, and was followed by criticism based on analyses from several other ice cores in traditional glaciology. The group finally withdrew their original hypothesis in 1983 as contamination with analysis of their second ice core. The report of detection of nuclear gamma-rays associated with 44Ti decays from the young supernova remnant Vela Jr. (RX J0852.0-4622) shed light again on the Rood's work. This was because the third "unknown"spike out of four identified spikes in the Rood's paper was suggested to correspond to a footprint of the supernova explosion of the newly detected Vela Jr. remnant (and, also the withdrawal was not well known in our field of astronomy). I will review this following line of work in glaciology, and why nitrate observations in ice cores are difficult. I will also present our new result of chemical analyses in Dome Fuji ice cores (Antarctica) which clearly show solar cycles and will discuss its meaning as a touchstone to detect supernova candidate spikes as well as spike structures we observed simultaneously. Perspectives to access the supernova rate in the Milky Way will also be mentioned.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - observations

2nd keyword (optional)

3rd keyword (optional)

Primary author: MOTIZUKI, Yuko (RIKEN)

Presenter: MOTIZUKI, Yuko (RIKEN)

Contribution ID: **86** Type: **Oral Presentation**

Galactic Chemical Evolution of Short-Lived Radioactive Isotopes in the Milky Way galaxy

We have developed Galactic Chemical Evolution (GCE) models to understand the spatial and temporal distribution of the short-lived radionuclides (SLRs), ^{26}Al, ^{36}Cl, ^{41}Ca, ^{53}Mn, and ^{60}Fe in the Milky way galaxy. In our simulations, the galaxy is radially divided into eight annular rings of 2 kpc width from 2-18 kpc to study the evolution of each galactic ring individually. Further, the solar neighbourhood (8-10 kpc) is divided into independent spatial grids of area, 0.1–1 kpc^2, to understand the canonical abundances of the SLRs in the early solar system (ESS). In GCE models, various generations of stars (in the mass range 0.1-100 M) form and evolve from the accreted gas according to star formation rate and initial mass function to enrich the interstellar gas with their nucleosynthetic yields.

The results from the GCE models explain the abundance trends of SLRs, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{53}Mn, and ^{60}Fe in the galaxy from 2-18 kpc. The SLRs have a higher abundance in the inner galactic regions and a decrease in the galaxy's outer regions. The abundance of SLRs is also higher in the early phase of the galaxy formation due to the increased star formation rate. In our simulations, the solar system forms inside a stellar cluster and has canonical values of ^{60}Fe/^{56}Fe and ^{53}Mn/^{55}Mn in the ESS. We have also proposed a hypothesis for a possible scenario to explain the observed abundance of ^{26}Al/^{27}Al and ^{41}Ca/^{40}Ca in the early solar system.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Chemical Evolution: the Milky Way

2nd keyword (optional)

Nucleosynthesis

3rd keyword (optional)

Origin of the Solar System

Primary author: Dr KAUR, Tejpreet (Punjab University, India)

Co-author: Prof. SAHIJPAL , Sandeep (Punjab University, India)

Presenter: Dr KAUR, Tejpreet (Punjab University, India)

Contribution ID: **87** Type: **Oral Presentation**

Reaction rates of alpha-induced reactions from the new Atomki-V2 α-nucleus potential

α-induced reactions play an essential role in various astrophysical scenarios. For intermediate mass and heavy target nuclei, various α-nucleus optical model potentials (AOMP) predict reaction rates which may differ by orders of magnitude. This wide range of predictions complicates nucleosynthesis calculations in reaction networks, in particular for the p-process with uncertain (γ,α) rates and for the weak r-process with uncertain (α,xn) rates.

The reason for this wide range of predictions is mainly the tail of the imaginary part of the AOMP (as identified in [1]). The new Atomki-V2 potential was suggested to overcome this problem, and it was found that predictions of the Atomki-V2 potential match the available experimental data with deviations of less than a factor of two in all cases [1]. Reaction rates from the Atomki-V2 potential have been calculated for 4359 nuclei between iron ($Z = 26$) and bismuth ($Z = 83$) [2].

This talk will present:
(i) the derivation of the Atomki-V2 AOMP [1,2] and a comparison to other global AOMPs;
(ii) the verification of the Atomki-V2 AOMP using latest data for the ^{96}Zr(α,n)^{99}Mo and ^{100}Mo(α,n)^{103}Ru reactions which are relevant of the weak r-process [3,4];
(iii) the impact of the reaction rates from the Atomki-V2 AOMP and its reduced uncertainties on the weak r-process [5].

As an outlook, it will become possible in the near future to test the Atomki-V2 predictions of cross sections of α-induced reactions for unstable nuclei in several upcoming experiments with radioactive beams.

[1] P. Mohr et al., Phys. Rev. Lett. 124, 252701 (2020).
[2] P. Mohr et al., At. Data Nucl. Data Tables 142, 101453 (2021).
[3] G. G. Kiss et al., Astroph. J. 908, 202 (2021).
[4] T. N. Szegedi et al., Phys. Rev. C 104, 035804 (2021).
[5] A.\ Psaltis et al., Astroph. J., submitted (arXiv:2204.07136).

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Nuclear physics - theory

2nd keyword (optional)

Nuclear physics - experimental

3rd keyword (optional)

Nucleosynthesis

Primary author: Dr MOHR, Peter (Atomki Debrecen, Huingary)

Presenter: Dr MOHR, Peter (Atomki Debrecen, Huingary)

Contribution ID: **88** Type: **Oral Presentation**

A short history of gamma-ray line astrophysics

I will present a short historical overview of the ideas regarding
a) our theoretical understanding of the production of several key radioactivities in gamma-ray astrophysics
b) their role as probes of various astrophysical sites (physics of supernovae, distribution of massive stars in the Galaxy, etc)

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Astronomy

2nd keyword (optional)

3rd keyword (optional)

Primary author: PRANTZOS, nikos (Institute of Astrophysics in Paris)

Presenter: PRANTZOS, nikos (Institute of Astrophysics in Paris)

Contribution ID: **89** Type: **Discussion (Introduction and Facilitation)**

All the different 60Fe/26Al ratios

I would like to discuss together the diversity of observed and predicted 60Fe/26Al ratios: in the Galaxy, in core-collapse supernova models, in the early Solar System, and in Earth's samples, and how could all these be reconciled.

Length of presentation requested

Discussion: Introduction 5 min + Facilitation 25 min

Please select between one and three keywords related to your abstract

Chemical Evolution: the Milky Way

2nd keyword (optional)

Cosmic Radioactive Deposits in Solar-System Samples

3rd keyword (optional)

Stellar explosions and mergers - theory

Primary author: LUGARO, Maria

Presenter: LUGARO, Maria

Contribution ID: **90** Type: **Oral Presentation**

Constraining the nu-p process via directly measured 56Ni(n,p) cross section

For the increased interest on the impact of nu-p process in the search of an answer to the heavy element production puzzle in core-collapse supernovae, a direct (n,p) reaction measurement with the radioactive ^{56}Ni (a half-life of 6 days) was performed at Los Alamos Neutron Science Center (LANSCE). The radioactive 56Ni was produced by irradiating protons on a ^{59}Co foil through the (p,4n) reaction at the Isotope Production Facility and the thin-deposited 56Ni target was chemically separated, fabricated and characterized at the Hot Cell facility. Using the LENZ (Low Energy NZ) instrument, the first directly measured cross sections of ^{56,59}Ni(n,p), ^{56}Co(n,p), and ^{59}Ni(n,α) will be reported. With the currently obtained experimental information, the reaction rate of 56Ni(n,p) was updated and compared with other theoretical predictions. The final impact on the nu-p process will be discussed along with a plan of improving experimental uncertainty through optimized solenoidal spectrometer development at LANSCE.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - experimental

2nd keyword (optional)

Nuclear physics - theory

3rd keyword (optional)

Nucleosynthesis

Primary authors: GEORGIADOU, Anastasia (Los Alamos National Laboratory); DIGIOVINE, Brad (Los Alamos National Laboratory); LEE, Hye Young (Los Alamos National Laboratory); EIROA-LLEDO, Cecilia (Los Alamos National Laboratory); VERMELEN, Christian (Los Alamos National Laboratory); VOTAW, Daniel (Los Alamos National Laboratory); PERDIKAKIS, Georgios (Central Michigan University); HERMAN, Michal (Los Alamos National Laboratory); GASTIS, Panos (Los Alamos National Laboratory); TSINTARI, Pelagia (Central Michigan University); KUVIN, Sean (Los Alamos National Laboratory); MOSBY, Shea (Los Alamos National Laboratory); KAWANO, Toshihiko (Los Alamos National Laboratory); MOCKO, Veronika (Los Alamos National Laboratory)

Presenter: LEE, Hye Young (Los Alamos National Laboratory)

Contribution ID: **91** Type: **Oral Presentation**

Galactic evolution of radio- and rock-forming nuclides and their expression in terrestrial exoplanet geodynamics

Unlike the Hertzsprung–Russell diagram for stars, there remains no formal classification for solid exoplanets composed of varying proportions of gas, rock+metals and ice. Still, as with stars, planetary mass and composition –expressed in geochemical and cosmochemical terms –mold bulk physical characteristics. Two physical attributes control terrestrial-type planet interior dynamics: viscosity (**η**) and intrinsic heat production (**A**) [1]. *Viscosity* can differ by orders of magnitude between different common mantle silicate minerals (e.g. olivine, pyroxene), so that even small proportional changes yield large differences to η. A key parameter to consider in this context is (Mg:Si:Fe), because this value largely determines which minerals will be present in silicate mantles. Bulk Silicate Earth's (Mg:Si:Fe) is close to solar values [2-4], and we can assume that this also holds for terrestrial-type exoplanets in that they follow the compositions of their host stars. Transition between mechanically weak (olivine-dominated at (Mg/Si)≤1, **low η**) vs. strong (pyroxene-dominated at (Mg/Si)>1, **high η**) mantle convective regimes occurs over a narrow transitional range of (Mg/Si) values because small volume fractions of a weak phase are sufficient to form an interconnected network that in turn governs the strain response of mantle rocks to deforming stresses acting upon them [5,6]. *Heat production* in younger planets ought to be greater from more radioactivity and latent accretionary/gravitational heating vs. older (cooler) ones. This has important consequences for how heat loss is accommodated by interior dynamics and how it is expressed via outgassing to secondary atmospheres. Here we show how combining geodynamics with Galactic Chemical Evolution (GCE) models and astrophysical observations provides insights to terrestrial exoplanet **η** and **A** vs. **age**. As predicted by GCE, younger (≤2 Gyr) stars have low (Mg/Si)≤1. If these stars mirror the silicate mantles of their rocky exoplanet companions [7-9], we forecast that such younger low (Mg/Si) pyroxene-rich rocky exo-mantles ought to tend towards both **high η and A**, with episodic sluggish/rapid convection and thus slow cooling, and low oxygen fugacity that degas H2 and CH4 under profuse near-surface partial melting conditions [10]. Contrariwise, older (>5 Gyr) olivine-rich (high Mg/Si) oxidized (like Earth) exo-mantles should tend towards both **low η and A**, effectively cool, and degas N2, CO2, H2O. By implication, a fundamental age-composition dichotomy is anticipated to exist between young (hot, reduced, Fe-rich) and old (cold, oxidized, Fe-poor) rocky exoplanets that can already be evaluated by mass-radius-density-age data.

[1] D. L. Turcotte and G. Schubert, Geodynamics - 2nd Edition. Apr. 2002; [2] A. Ringwood, Significance of the terrestrial Mg/Si ratio. EPSL, vol. 95, pp. 1–7, Oct. 1989; [3] H. Palme and H. S. C. O'Neill, Cosmochemical Estimates of Mantle Composition, Treatise on Geochemistry, vol. 2, p. 568, Dec. 2003. [4] K. Lodders, Solar System Abundances and Condensation Temperatures of the Elements, ApJ, vol. 591, pp. 1220–1247, July 2003; [5] D. Yamazaki and S.-i. Karato, Some mineral physics constraints on the rheology and geothermal structure of Earth's lower mantle, Am Mineral, vol. 86, pp. 385–391, Apr. 2001; [6] D. Yamazaki, T. Yoshino, T. Matsuzaki, T. Katsura, and A. Yoneda, Texture of (Mg,Fe)SiO3 perovskite and ferro-periclase aggregate: Implications for rheology of the lower mantle, PEPI, vol. 174, pp. 138–144, May 2009; [5] E. A. Frank, B. S. Meyer, and S. J. Mojzsis, A radiogenic heating evolution model for cosmochemically Earth-like exoplanets, Icarus, vol. 243, pp. 274–286, Nov. 2014; [6] L. Spina, J. Melendez, A. I. Karakas, I. Ramirez, T. R. Monroe, M. Asplund, and D. Yong, Nucleosynthetic history of elements in the Galactic disk. [X/Fe]-age relations from high-precision spectroscopy, A&A, vol. 593, p. A125, Oct. 2016; [7] P. E. Nissen, High-precision abundances of elements in solar twin stars. Trends with stellar age and elemental condensation temperature, A&A, vol. 579, p. A52, July 2015; [10] S. Lambart, M. B. Baker, and E. M. Stolper, The role of pyroxenite in basalt genesis: Melt-PX, a melting parameterization for

mantle pyroxenites between 0.9 and 5 GPa, JGR (Solid Earth), vol. 121, pp. 5708–5735, Aug. 2016.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Chemical Evolution

2nd keyword (optional)

Habitability, Exoplanets

3rd keyword (optional)

Origin of the Solar System

Primary author: Prof. MOJZSIS, Stephen J. (CSFK, ORI)

Co-authors: Prof. HENG, Kevin (University of Bern, & LMU-Munich); Dr HOEIJMAKERS, H. Jens (University of Lund); LUGARO, Maria

Presenter: Prof. MOJZSIS, Stephen J. (CSFK, ORI)

Contribution ID: **92** Type: **not specified**

A short history of gamma-ray line astrophysics

Monday 13 June 2022 09:00 (30 minutes)

Presenter: PRANTZOS, Nikos (Institute of Astrophysics in Paris)

Session Classification: Morning session 1

Contribution ID: **93** Type: **not specified**

Pathways of metal flows in the Milky Way as traced by 26Al

Monday 13 June 2022 09:30 (20 minutes)

Presenter: KRAUSE, Martin (University of Hertfordshire)

Session Classification: Morning session 1

Contribution ID: **94** Type: **Oral Presentation**

The origin of elements and the formation of the Milky Way

Heavier elements then helium are created inside stars; alpha elements are mainly produced from core-collapse supernovae, while the majority of iron-peak elements are from Type Ia supernovae. Neutron-capture elements are produced from AGB stars, electron-capture supernovae, magneto-rotational supernovae, and neutron-star megers. Mass loss from AGB stars and (rotating) massive stars produce a significant fraction of C, N, F, and minor isotopes of O and Mg, as well as the slow-neutron capture elements. I will summarize the origin of stable elements using my Galactic chemical evolution model, and discuss the roles of stellar rotation. I will then show predictions from chemodynamical simulations of Milky Way type galaxies, compare with observational data from the galactic archaeology surveys, and discuss the effects of the stellar migrations and metal flows during galaxy formation.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Chemical Evolution: the Milky Way

2nd keyword (optional)

3rd keyword (optional)

Primary author: Prof. KOBAYASHI, Chiaki (Univ. of Hertfordshire)

Presenter: Prof. KOBAYASHI, Chiaki (Univ. of Hertfordshire)

Contribution ID: **95** Type: **Oral Presentation**

A Review: Molecular Chemical Enrichment of the ISM / IPM Due to Carbon Isotopes

The very intriguing chemical properties of the carbon isotopes can generate unique molecular compounds within the interstellar and interplanetary media. As stellar evolutionary processes collect plasma, gas, and dust, energy provided by shock waves, cosmic rays, and ion bombardment may stimulate chemical reactions on the surface of grains, which provide a substrate for the nucleation and condensation of various atomic, ionic, and molecular species. The interplay between these carbon molecules and grains can be observed in various celestial objects such as dust lanes of nebulae, molecular clouds, carbon stars, planetary surfaces, and meteorites. In this presentation, we will review the organic and other carbon-based, molecular species that have previously been reported to exist, review conditions for their formation, and explore the spectroscopic methods used to track these molecules through the ISM and IPM.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Interstellar Medium

2nd keyword (optional)

3rd keyword (optional)

Primary author: HAMPTON, Christine (CV Hampton Consulting, LLC)

Presenter: HAMPTON, Christine (CV Hampton Consulting, LLC)

Contribution ID: **96** Type: **Oral Presentation**

Constraining r-process nucleosynthesis using ^{129}I and ^{247}Cm in the early Solar system

A recent study by Côté et al. (2021) has shown that ratio of the observed abundances of short-lived radioisotopes ^{129}I and ^{247}Cm in the early solar system (ESS), that are almost exclusively produced by *r*-process, can be used to directly constrain the "*last*" *r*-process source that contributed before the formation of the Solar system due to fact that these two isotopes have almost identical half-lives. This conclusion is critically based on the result that the ^{129}I and ^{247}Cm in the ESS come from one single *r*-process event. We study the evolution of ^{129}I and ^{247}Cm along with reference isotopes ^{127}I and ^{235}U at the Solar location using the turbulent gas diffusion formalism. We find that when 2-3 different *r*-process sources that are equally frequent but have distinct ^{129}I/^{247}Cm production ratios are considered, the ^{129}I and ^{247}Cm in the ESS do not come entirely from a single major event but get contributions from at least two more minor contributors. This has a dramatic effect on the evolution of the ^{129}I/^{247}Cm ratio, such that the measured ESS value in meteorites does not necessarily correspond to that of the "*last*" major *r*-process event and consequently cannot be used to constrain it. We also find that the requirement of concordance of the observed ^{129}I/^{127}I and ^{247}Cm/^{235}U ratio in the ESS has a major impact on the distribution of the ^{129}I/^{247}Cm ratio in the ESS. We find that when the concordance criteria is taken into account, important constraints on the properties of *r*-process sources that were operating during the formation of the Solar system can still be made using the observed value of ^{129}I/^{247}Cm ratio in the ESS.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Chemical Evolution

2nd keyword (optional)

Cosmic Radioactive Deposits in Solar-System Samples

3rd keyword (optional)

Chemical Evolution: the Milky Way

Primary author: Dr BANERJEE, Projjwal (Indian Institute of Technology Palakkad)

Co-authors: Dr WU, Meng-Ru (Institute of Physics, Academia Sinica, Taipei, Taiwan); Ms S K, Jeena (Indian Institute of Technology Palakkad)

Presenter: Dr BANERJEE, Projjwal (Indian Institute of Technology Palakkad)

Contribution ID: **97** Type: **Oral Presentation**

Production of short-lived radioactive isotopes in the ejecta of core-collapse supernovae

The relic of short-lived radioactive isotopes (SLRs) with half-lives between 0.1 to 100 Myr can be used to probe the origin of the Solar System. While these isotopes were made in stars shortly before the formation of the solar system, their comparison with theoretical stellar models is extremely challenging. In this talk I discuss the comparison between the signature of 15 SLRs in different sets of core collapse supernovae models with the signature in the Early Solar System (ESS). Different progenitor masses and supernova explosion energies are considered. In particular, I will show that the discrepancy between the ESS and CCSNe models is not limited to the relative abundance of Al26 and Fe60, but many more SLRs isotope abundances are not reproduced. Some potential solutions are proposed, to be explored with future CCSN models.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Origin of the Solar System

3rd keyword (optional)

Primary author: Dr PIGNATARI, Marco (Hull University)

Presenter: Dr PIGNATARI, Marco (Hull University)

Contribution ID: **98** Type: **Oral Presentation**

Decay properties of the nuclei with neutron number N=126: A stretch of the r-process pathway

Neutron-rich nuclei around the closed neutron shell N = 126 are of great importance for understanding the astrophysical r-process, specially for the solar r-abundance distribution [1,2]. These radioactive isotopes can also be used as projectiles for synthesizing super-heavy nuclei which is one of the most interesting challenges in nuclear physics. In the present work, inspired from recent experimental and theoretical studies on N=126, we have investigated the decay modes such as α-decay, β−decay, and β+/EC-decay, and spontaneous fission (SF) for N=126 within the range 54≤Z≤98 by the calculation of half-lives using several empirical formulas. For α-decay we have used QF formula [3], for weak decay we adopt an empirical formula given by Fiset and Nix [4] and for spontaneous fission we have used modified Bao formula [5]. Firstly, these formulas tested to reproduced experimental half-lives and known decay modes of isotones of N=126 which are in consequence applied to estimate half-lives and decay modes of unknown isotones of N=126. These decay properties are expected to shed light on the r-process waiting-point nuclei.

References: -
1. H. Grawe, K. Langanke, and G. Martínez-Pinedo, Rep Prog Phys. 70, 1525 (2007).
2. Y. S. Watanabe et al. Phys. Rev. Lett. 115, 172503 (2015).
3. A. R. Farhan and M. M. Sharma, Phys. Rev. C, 73, 045803 (2006).
4. G. Saxena et al., Phys. Scr. 96, 125304 (2021).
5. E. Fiset and J. Nix, Nucl. Phys. A, 193, 647 (1972).
6. G. Saxena et al., J. Phys. G: Nucl. Part. Phys. 48, 055103 (2021).

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nuclear physics - theory

2nd keyword (optional)

Origin of the Solar System

3rd keyword (optional)

Primary authors: Mr JAIN, A. (Department of Physics, School of Basic Sciences, Manipal University Jaipur-303007, India); SAXENA, Gaurav

Presenter: Mr JAIN, A. (Department of Physics, School of Basic Sciences, Manipal University Jaipur-303007, India)

Contribution ID: **99** Type: **Oral Presentation**

Universal relations for rapidly rotating cold and hot hybrid stars

Various global parameters of compact stars can be related via some empirical relations, that are independent of the equation of state (EOS). These are known as universal relations. They seem to hold for the maximum mass and the corresponding radii of non-rotating and maximally rapidly rotating configurations, as well as their moment of inertia. Numerous studies have focused on the case of hadronic, zero-temperature EOS, as well as some including a first-order phase transition from hadrons to deconfined quark matter in their interior. On the other hand, many astrophysical scenarios, e.g., protoneutron stars that result from core-collapse supernovae and binary neutron star
mergers, feature finite temperatures. Therefore, the study of Ref. [1] focused on the universal relations for isentropic hadronic EOS. In this presentation I will discuss the universal relation results obtained in Ref. [2], which is an extension of the previous work including large, representative samples of hadronic and hybrid EOS, i.e., featuring first-order hadron-quark phase transitions, both for zero temperature as well as finite entropy per particle configurations.

References
[1] Khadkikar et al, 'Maximum mass of compact stars from gravitational wave events with finite-temperature equations of state', Phys. Rev. C 103, 055811
[2] Khosravi et al, 'Universal relations for rapidly rotating cold and hot hybrid stars', Mon. Not. R. Astron. Soc, (submitted) arxiv astro-ph.HE/2112.10439

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Stellar explosions and mergers - theory

2nd keyword (optional)

3rd keyword (optional)

Primary author: LARGANI, Noshad (University of Wroclaw)

Presenter: LARGANI, Noshad (University of Wroclaw)

Contribution ID: **100** Type: **Oral Presentation**

Live Pu-244 in deep-sea archives and the r process

The recent detection of interstellar Pu-244 in deep-sea samples points to an influx into the solar system of short-lived r-process nuclides over the past 10 million years. The Pu was found in a terrestrial sample that has grown over million years, together with supernova (SN)-produced Fe-60 (2.6 Myr half-life). Pu-244 is radioactive (81 Myr) and must have been produced within a few half-lives; this is, within the past few hundred million years. The measured signal does not tell whether Pu was produced in the same event as the Fe-60, i.e. in SNe, or independently in an older event and had been deposited later as swept-up material concomitantly with the younger Fe-60. The absolute influx of Pu-244, however, suggests that SNe are not dominant producers of the heavy r-process elements. Comparison with the early solar system abundance ratios of actinides such as Pu-244 vs Cm-247 may help to exclude some production scenarios.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Cosmic Radioactive Deposits in Solar-System Samples

2nd keyword (optional)

3rd keyword (optional)

Primary author: WALLNER, Anton (Australian National University (AU))

Presenter: WALLNER, Anton (Australian National University (AU))

Contribution ID: **101** Type: **not specified**

Radioactive isotopes as tracers for the origin of micrometeorites

Monday 13 June 2022 09:50 (20 minutes)

Presenter: FEIGE, Jenny

Session Classification: Morning session 1

Contribution ID: **102**   Type: **not specified**

Short-lived radioactive isotopes from massive binary stars and the early Solar System

Monday 13 June 2022 10:10 (20 minutes)

Presenter: BRINKMAN, Hannah

Session Classification: Morning session 1

Contribution ID: **103** Type: **not specified**

A detailed look at the production of Fe-group elements in core-collapse supernovae

Monday 13 June 2022 10:30 (30 minutes)

Presenter: FROHLICH, Carla (North Carolina State University)

Session Classification: Morning session 1

Contribution ID: **104** Type: **not specified**

Very massive stars winds as sources of the short-lived 26Al radioactive isotope

Monday 13 June 2022 11:30 (20 minutes)

Presenter: MARTINET, Sébastien (Université de Genève)

Session Classification: Morning session 2

Contribution ID: **105** Type: **not specified**

Chemical Evolution of 26Al and 60Fe in the Milky Way

Monday 13 June 2022 11:50 (10 minutes)

Presenter: VASINI, Arianna

Session Classification: Morning session 2

Contribution ID: **106** Type: **not specified**

The γ-process nucleosynthesis in core-collapse supernovae

Monday 13 June 2022 12:00 (20 minutes)

Presenter: ROBERTI, Lorenzo (Konkoly Observatory, CSFK)

Session Classification: Morning session 2

Contribution ID: **107** Type: **not specified**

Looking for dust in core-collapse supernovae with a Bayesian approach

Monday 13 June 2022 12:20 (10 minutes)

Presenter: ZSÍROS, Szanna

Session Classification: Morning session 2

Contribution ID: **108** Type: **not specified**

Prospects for Nucleosynthesis Observations with NASA's new Gamma-Ray Mission COSI

Monday 13 June 2022 12:30 (30 minutes)

Presenter: SIEGERT, Thomas (JMU Würzburg)

Session Classification: Morning session 2

Contribution ID: **109** Type: **not specified**

Spectroscopy of 48Cr by the 50Cr(p, t)48Cr reaction

Monday 13 June 2022 14:30 (10 minutes)

Presenter: ADSLEY, Philip (Texas A&M University)

Session Classification: Afternoon session 1

Contribution ID: **110** Type: **not specified**

First direct measurement of the 13N(alpha,p)16O reaction relevant for core-collapse supernovae

Monday 13 June 2022 14:40 (20 minutes)

Presenter: JAYATISSA, Heshani

Session Classification: Afternoon session 1

Contribution ID: **111** Type: **not specified**

Uncertainty Analysis of 23Mg(p,γ)24Al reaction rate occurring in Classical Novae

Monday 13 June 2022 15:00 (10 minutes)

Presenter: AMANDA CRYSTAL, Edwin (Saint Mary's University, Halifax)

Session Classification: Afternoon session 1

Contribution ID: **112** Type: **not specified**

The production of 10Be in the supernova neutrino process

Monday 13 June 2022 15:10 (20 minutes)

Presenter: SIEVERDING, Andre (Oak Ridge National Laboratory)

Session Classification: Afternoon session 1

Contribution ID: **113** Type: **not specified**

Accounting for Short-Lived Radionuclides in the Early Solar System in the Context of a Triggered Star Formation Origin of the Solar System

Monday 13 June 2022 15:30 (30 minutes)

Presenter: DWARKADAS, Vikram (Univ of Chicago)

Session Classification: Afternoon session 1

Contribution ID: **114** Type: **not specified**

A statistical exploration of CEMP star classification with s-process models

Monday 13 June 2022 16:30 (20 minutes)

Presenter: YAGÜE LÓPEZ, Andrés

Session Classification: Afternoon session 2

Contribution ID: **115** Type: **not specified**

Constraining the nu-p process via directly measured 56Ni(n,p) cross section

Monday 13 June 2022 16:50 (20 minutes)

Presenter: LEE, Hye Young (Los Alamos National Laboratory)

Session Classification: Afternoon session 2

Contribution ID: **116** Type: **not specified**

A Review: Molecular Chemical Enrichment of the ISM / IPM Due to Carbon Isotopes

Monday 13 June 2022 17:10 (20 minutes)

Presenter: HAMPTON, Christine (CV Hampton Consulting, LLC)

Session Classification: Afternoon session 2

Contribution ID: **117** Type: **not specified**

PIC simulations of relativistic jets with toroidal magnetic field

Tuesday 14 June 2022 16:50 (20 minutes)

Presenter: NISHIKAWA, Kenichi (Alabama A&M University)

Session Classification: Afternoon session 2

Contribution ID: **118** Type: **not specified**

Simulation of production of the cosmogenic radionuclides in loess

Tuesday 14 June 2022 16:40 (10 minutes)

online

Presenter: VESELINOVIC, Nikola

Session Classification: Afternoon session 2

Contribution ID: **119** Type: **not specified**

Universal relations for rapidly rotating cold and hot hybrid stars

Tuesday 14 June 2022 17:30 (10 minutes)

Presenter: NOSHAD KHOSRAVI LARGANI

Session Classification: Afternoon session 2

Contribution ID: **120** Type: **not specified**

The Emerging Theory of Three-Dimensional Core-Collapse Supernova Explosions

Tuesday 14 June 2022 09:00 (30 minutes)

Presenter: BURROWS , Adam (Princeton)

Session Classification: Morning session 1

Contribution ID: **121** Type: **not specified**

The radiogenic heating of planets and the 40K question

Tuesday 14 June 2022 09:30 (30 minutes)

Presenter: PERDIKAKIS, Georgios (Central Michigan University)

Session Classification: Morning session 1

Contribution ID: **122** Type: **not specified**

On the discrepancy between the observed and predicted abundances of the radioactive isotope 7Be produced in nova explosions

Tuesday 14 June 2022 10:00 (20 minutes)

Presenter: DENISSENKOV, Pavel (University of Victoria)

Session Classification: Morning session 1

Contribution ID: **123** Type: **not specified**

Galactic evolution of radio- and rock-forming nuclides and their expression in terrestrial exoplanet geodynamics

Tuesday 14 June 2022 10:20 (30 minutes)

Presenter: MOJZSIS, Steve

Session Classification: Morning session 1

Contribution ID: **124** Type: **not specified**

Chemical abundance study on a large set of P-rich stars

Tuesday 14 June 2022 10:50 (10 minutes)

Presenter: BRAUNER, Maren (Instituto de Astrofísica de Canarias (IAC))

Session Classification: Morning session 1

Contribution ID: **125** Type: **not specified**

Cosmogenic isotopes activity measured in Cavezzo, an anomalous L5 chondrite recovered in Italy

Tuesday 14 June 2022 14:50 (20 minutes)

Presenter: BARGHINI, Dario (INAF - National Institute for Astrophysics, Astrophysical Observatory of Turin)

Session Classification: Afternoon session 1

Contribution ID: **126** Type: **not specified**

r-Process sites and their role in producing the heaviest elements and their radioactive isotopes

Monday 13 June 2022 17:30 (20 minutes)

Presenter: THIELEMANN, Friedrich (University of Basel)

Session Classification: Afternoon session 2

Contribution ID: **127** Type: **not specified**

Measurement of the 7Be(p,γ)8B at astrophysical energies using a radioactive 7Be ion beam

Tuesday 14 June 2022 15:10 (20 minutes)

Presenter: BUOMPANE, Raffaele

Session Classification: Afternoon session 1

Contribution ID: **128** Type: **not specified**

Understanding 22Na cosmic abundance

Tuesday 14 June 2022 15:30 (10 minutes)

Presenter: FOUGERES, Chloe (Argonne National Laboratory (USA))

Session Classification: Afternoon session 1

Contribution ID: **129** Type: **not specified**

First preliminary results on the s-process branchings 79Se(n,g) and 94Nb(n,g) and future prospects

Tuesday 14 June 2022 15:40 (20 minutes)

Presenter: DOMINGO PARDO, Cesar (Univ. of Valencia and CSIC (ES))

Session Classification: Afternoon session 1

Contribution ID: **130** Type: **not specified**

Technetium in and Mass-Loss from Mira Stars

Tuesday 14 June 2022 11:30 (20 minutes)

Presenter: UTTENTHALER, Stefan

Session Classification: Morning session 2

Contribution ID: **131** Type: **not specified**

Galactic Chemical Evolution with radioactive isotopes

Tuesday 14 June 2022 11:50 (20 minutes)

Presenter: WEHMEYER, Benjamin (Konkoly Obs & Univ Hertfordshire)

Session Classification: Morning session 2

Contribution ID: **132** Type: **not specified**

Verifying footprints of solar cycles and supernovae in polar ice cores

Tuesday 14 June 2022 12:30 (30 minutes)

online

Presenter: MOTIZUKI, Yuko (RIKEN)

Session Classification: Morning session 2

Contribution ID: **133** Type: **not specified**

The tunable Laue lens –a new telescope for MeV gamma ray

Tuesday 14 June 2022 12:10 (20 minutes)

Presenter: LUND, Niels (Technical University of Denmark (DTU))

Session Classification: Morning session 2

Contribution ID: **134** Type: **not specified**

The intermediate neutron capture process in AGB stars

Tuesday 14 June 2022 16:30 (10 minutes)

online

Presenter: CHOPLIN, Arthur (Université Libre de Bruxelles)

Session Classification: Afternoon session 2

Contribution ID: **135** Type: **not specified**

Neutron induced reactions and unstable nuclei: recent THM investigations at astrophysical energies

Tuesday 14 June 2022 14:30 (20 minutes)

Presenter: SERGI, Maria Letizia (UniCT & INFN-LNS)

Session Classification: Afternoon session 1

Contribution ID: **136** Type: **not specified**

DISCUSSION: Distributing nucleosynthesis ejecta

Wednesday 15 June 2022 17:00 (30 minutes)

Presenter: DIEHL, Roland

Session Classification: Afternoon session 2

Contribution ID: **137** Type: **not specified**

Production of short-lived radioactive isotopes in the ejecta of core-collapse supernovae

Tuesday 14 June 2022 17:40 (10 minutes)

Presenter: PIGNATARI, Marco (Hull University)

Session Classification: Afternoon session 2

Contribution ID: **138** Type: **not specified**

Live Pu-244 in deep-sea archives and the r process

Tuesday 14 June 2022 17:10 (20 minutes)

Presenter: WALLNER, Anton (Australian National University (AU))

Session Classification: Afternoon session 2

Contribution ID: **139** Type: **not specified**

Cosmic radioactivity probing the epoch of SN or merger nucleosynthesis and neutrino interactions

Wednesday 15 June 2022 09:30 (30 minutes)

online

Presenter: KAJINO, Toshitaka

Session Classification: Morning session 1

Contribution ID: **140** Type: **not specified**

New 59Fe Stellar Decay Rate and its Implications for the 60Fe Radioactivity in Massive Stars

Wednesday 15 June 2022 10:00 (20 minutes)

online

Presenter: GAO, Bingshui

Session Classification: Morning session 1

Contribution ID: **141** Type: **not specified**

Galactic Chemical Evolution of Short-Lived Radioactive Isotopes in the Milky Way galaxy

Wednesday 15 June 2022 12:40 (20 minutes)

Presenter: KAUR, Tejpreet (Department of Physics, Panjab University, Chandigarh)

Session Classification: Morning session 2

Contribution ID: **142** Type: **not specified**

Deep underground laboratory measurement of 13C(α,n)16O in the Gamow windows of the s- and i-processes

Wednesday 15 June 2022 10:40 (20 minutes)

online

Presenter: LIN, Weiping (Institute of Nuclear Science and Technology, Sichuan University)

Session Classification: Morning session 1

Contribution ID: **143** Type: **not specified**

’Ni problem’in Canonical and Ultrastripped Supernova Explosions

Wednesday 15 June 2022 11:30 (20 minutes)

online

Presenter: SAWADA, Ryo (The University of Tokyo)

Session Classification: Morning session 2

Contribution ID: **144** Type: **not specified**

Beta-Delayed Neutron-Emission Probabilities of 20 neutron-rich Ag, Cd, In and Sn isotopes: Impacts on the second r-process peak formation

Wednesday 15 June 2022 11:50 (20 minutes)

online

Presenter: VI, Phong

Session Classification: Morning session 2

Contribution ID: **145** Type: **not specified**

r-Process Radioisotopes from Near-Earth Supernovae and Kilonovae

Wednesday 15 June 2022 12:10 (20 minutes)

online

Presenter: WANG, Xilu

Session Classification: Morning session 2

Contribution ID: **146**   Type: **not specified**

Constraining r-process nucleosynthesis using 129I and 247Cm in the early Solar system

Wednesday 15 June 2022 10:20 (20 minutes)

online

Presenter: BANERJEE, Projjwal

Session Classification: Morning session 1

Contribution ID: **147** Type: **not specified**

An astrochemical perspective on Radioactive Molecules

Wednesday 15 June 2022 14:30 (20 minutes)

Presenter: BREIER, Alexander Axel (University of Kassel (DE))

Session Classification: Afternoon session 1

Contribution ID: **148** Type: **not specified**

Using 31Cl β-Delayed Proton Decay to Constrain 30P(p, γ)31S in ONe novae

Wednesday 15 June 2022 15:30 (20 minutes)

Presenter: BUDNER, Tamas

Session Classification: Afternoon session 1

Contribution ID: **149** Type: **not specified**

Mass measurements of neutron-rich gallium and indium isotopes for r-process studies

Wednesday 15 June 2022 15:10 (20 minutes)

Presenter: KRIPKÓ-KONCZ, Gabriella (II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany)

Session Classification: Afternoon session 1

Contribution ID: **150** Type: **not specified**

Alpha-induced cross section measurements for explosive nucleosynthesis scenarios by the activation method

Thursday 16 June 2022 11:30 (20 minutes)

Presenter: SZEGEDI, Tibor Norbert

Session Classification: Morning session 2

Contribution ID: **151** Type: **not specified**

How do positron-trapping and titanium decay change light curve models of SESNe?

Wednesday 15 June 2022 15:50 (10 minutes)

Presenter: NAGY, Andrea

Session Classification: Afternoon session 1

Contribution ID: **152** Type: **not specified**

The origin of elements and the formation of the Milky Way

Wednesday 15 June 2022 16:30 (20 minutes)

Presenter: KOBAYASHI, Chiaki (Univ of Hertfordshire)

Session Classification: Afternoon session 2

Contribution ID: **153** Type: **not specified**

First β-decay spectroscopy of 135In and new β-decay branches of 134In

Presenter: PIERSA-SILKOWSKA, Monika (CERN)

Session Classification: Afternoon session 2

Contribution ID: **154** Type: **not specified**

Decay properties of the nuclei with neutron number N=126: A stretch of the r-process pathway

Wednesday 15 June 2022 12:30 (10 minutes)

online

Presenter: SAXENA, Gaurav

Session Classification: Morning session 2

Contribution ID: **155** Type: **not specified**

Upgrading the dppn45 post-processing nucleosynthesis code

Tuesday 14 June 2022 17:50 (10 minutes)

Presenter: SZÁNYI, Balázs (Konkoly Observatory, University of Szeged)

Session Classification: Afternoon session 2

Contribution ID: **156** Type: **not specified**

Investigation of cross section and reaction rate for 155Gd (n,g)156Gd reaction in the range of 0-0.5 MeV

Wednesday 15 June 2022 16:50 (10 minutes)

Presenter: YILDIRIR, Unal (Göynük Science High School)

Session Classification: Afternoon session 2

Contribution ID: **157** Type: **not specified**

Neutrino sources, Neutrino background, and Radioactivity in Meteorites

Presenter: WIESCHER, Michael

Session Classification: Morning session 1

Contribution ID: **158** Type: **not specified**

The 39,41,42Ar nuclides as probes of neutron-induced reactions in a high-density plasma at the National Ignition Facility: a proposed experiment and calibration measurements

Thursday 16 June 2022 09:50 (20 minutes)

Presenter: PAUL, Michael

Session Classification: Morning session 1

Contribution ID: **159** Type: **not specified**

Dating supernova grain formation using radioactive isotopes

Thursday 16 June 2022 10:10 (10 minutes)

Presenter: OTT, Ulrich

Session Classification: Morning session 1

Contribution ID: **160** Type: **not specified**

Astrophysical properties for the 197Au(a,n)200Tl reaction in the energy range of 10-40 MeV

Thursday 16 June 2022 10:30 (10 minutes)

Presenter: OZSOY, Cengiz (Goynuk High School)

Session Classification: Morning session 1

Contribution ID: **161** Type: **not specified**

Measurement of (d, p) and (d, 3He) reactions with 7Be in the context of lithium abundance anomaly

Thursday 16 June 2022 10:40 (20 minutes)

Presenter: ALI, Mustak (Bose Institute)

Session Classification: Morning session 1

Contribution ID: **162** Type: **not specified**

Radioactive molecules for astrophysics

Wednesday 15 June 2022 14:50 (20 minutes)

Presenter: WILKINS, Shane (Massachusetts Institute of Technology)

Session Classification: Afternoon session 1

Contribution ID: **163** Type: **not specified**

Reaction rates of alpha-induced reactions from the new Atomki-V2 α-nucleus potential

Thursday 16 June 2022 11:50 (30 minutes)

Presenter: MOHR, Peter (Atomki Debrecen, Huingary)

Session Classification: Morning session 2

Contribution ID: **164** Type: **not specified**

DISCUSSION: All the different 60Fe/26Al ratios

Thursday 16 June 2022 12:20 (30 minutes)

Presenter: LUGARO, Maria

Session Classification: Morning session 2

Contribution ID: **165** Type: **not specified**

CLOSING

Presenter: DIEHL, Roland

Session Classification: Morning session 2

Contribution ID: **166** Type: **not specified**

Welcome

Presenters: SZABÓ, Róbert; PIGNATARI, Marco (Hull University)

Session Classification: Morning session 1

Contribution ID: **167** Type: **not specified**

Welcome: Róbert Szabó (Director of Konkoly Observatory), Marco Pignatari

Monday 13 June 2022 08:45 (15 minutes)

Contribution ID: **168** Type: **not specified**

Social toast: Informal presentation by Roland Diehl

Monday 13 June 2022 17:50 (20 minutes)

Presenter: DIEHL, Roland

Contribution ID: **169** Type: **not specified**

Closing

Thursday 16 June 2022 12:50 (10 minutes)

Presenter: DIEHL, Roland

Contribution ID: **170** Type: **not specified**

Barium stars classification with s-process models using machine learning techniques

Thursday 16 June 2022 10:20 (10 minutes)

Presenter: DEN HARTOGH, Jacqueline

Session Classification: Morning session 1

Contribution ID: **171** Type: **Oral Presentation**

Barium stars classification with s-process models using machine learning techniques

On Monday, Andrés Yagüe López already presented our research on using machine learning techniques to compare models and observations of CEMP stars. In this talk, we will present our results on Ba stars (submitted to A&A). This analysis is done by systematically comparing a database of 169 Ba stars (de Castro et al 2016) with Asymptotic Giant Branch stellar models from FRUITY (Cristallo et al. 2016) and Monash (Karakas et al, 2018). The elements that we use in the classification are selected by systematically removing s-process elements from our AGB models to identify the elements whose removal has the biggest positive effect on the classification. Our final set includes: Fe, Rb, Sr, Zr, Ru, Nd, Ce, Sm, and Eu and excludes Nb, Y, Mo, and La. Our algorithms found final classifications for 166 of the 169 Ba stars in our sample. The classifications of both sets of AGB final surface abundances show similar distributions and both peak at 2.25 Mo and Z = 0.01. We also investigated why the removal of Nb, Y, Mo, and La improves our classification and identified 43 stars for which the exclusion had the biggest effect. These stars have a statistically significant different abundances for Mo, Nb, La and Sm than the other Ba stars in our sample. We discuss potential reasons for these differences in abundance patterns.

Length of presentation requested

Oral presentation: 8 min + 2 min questions (Poster-type talk)

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar evolution

3rd keyword (optional)

Primary author: DEN HARTOGH, Jacqueline

Presenter: DEN HARTOGH, Jacqueline