JINA-CEE

Center for the Evolution of the Elements

September 2019

A note from the Director, Hendrik Schatz

Dear JINA-CEE Community,

Another successful JINA-CEE cycle concludes in August after a busy summer with many of the uniquely interdisciplinary JINA-CEE workshops and schools organized in the US and abroad with our international partners. I was particularly impressed by how our broad multi-institutional community of young researchers came together and organized both, the new First Frontiers Summer School (proposed by a group of students and postdocs) and the annual Frontiers in Nuclear Astrophysics meeting. The young organizers used innovative approaches, emphasized inclusiveness, and incorporated, in addition to exciting interdisciplinary science, many professional development activities.

A major goal for the coming year will be to significantly strengthen international cooperation by leveraging complementary capabilities in experiment, theory, and astronomical observations available in foreign networks. These collaborations will enable new JINA-CEE science both here in the United States and internationally. As we build these research networks, it will be important to be inclusive, embrace diversity, and to create opportunities for the engagement of young scientists.

I hope you enjoy the exciting science and educational experiences reported in this newsletter. I also encourage you to explore our new website at jinaweb.org, and to follow us on twitter, for even more news.

Inside this issue

Image: artistic representation of a neutron star on the cusp of being swallowed by a black hole. Credit: Dana Berry, NASA

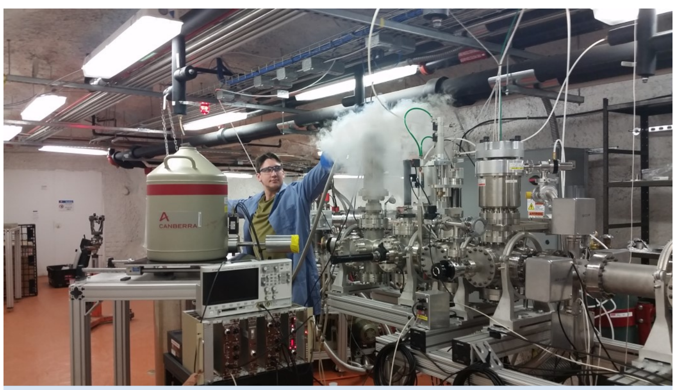
CASPAR secures funding to continue operations

Adapted from original published by Janet Weikel at isnap.nd.edu

From left to right: Anna Simon, Joachim Goerres, Manoel Couder, Dan Robertson and Michael Wiescher.

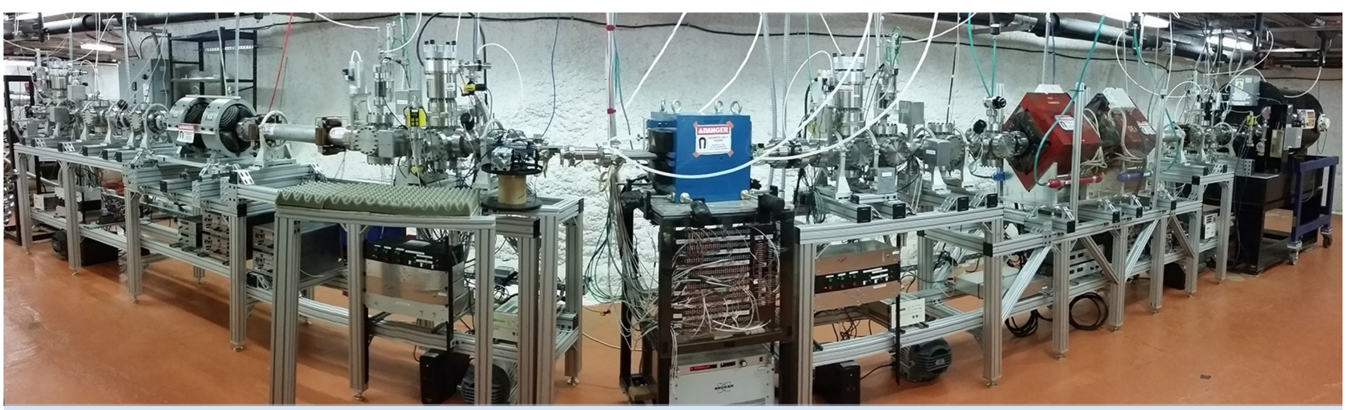
A team of JINA-CEE collaborators from the University of Notre Dame: Daniel Robertson, Manoel Couder, Anna Simon, Joachim Goerres and Michael Wiescher, received a 4-year award from the National Science Foundation (NSF) to continue measurements of nuclear reactions important for stellar nucleosynthesis processes at the Compact Accelerator System for Performing Astrophysical Research (CASPAR).

Located in the Black Hills of South Dakota, and housed within the Sanford Underground Research Facility (SURF) 4850 ft beneath the ground, CASPAR is the only deep underground accelerator laboratory in the United States. Going underground is crucial for the planed measurements as the cross sections of the reactions of interest drop dramatically at the energies relevant for stellar burning and thus the cosmic-ray induced background usually overwhelms the detection systems in laboratories above ground. CASPAR provides a low background environment thanks to its 4300 meter water equivalent shielding. The facility's 1-MV accelerator delivers high-intensity beams required for measurements of the very low cross section reactions that drive the evolution of stars during their different burning stages, and determine their final fate.



Graduate student Bryce Frentz setting up detectors at CASPAR

Measurements funded within the $750,000 NSF award will focus on alpha-induced reactions important for the understanding of nucleosynthesis in the first stars. These reactions' signatures are seen in spectroscopic observations of extreme carbon-enhanced metal-poor (CEMP) stars. These experiments are also crucial for the understanding of the s-process nucleosynthesis in Red Giant Branch (RGB) and Asymptotic Giant Branch (AGB) stars.



CASPAR beamline

Alternatives to the CNO cycle in first stars

Contributed by James deBoer (University of Notre Dame, USA)

The very first generation of stars that formed directly after the Big Bang only contained hydrogen, helium, and lithium. In particular, they did not contain any carbon, nitrogen, or oxygen – key elements involved in the CNO cycle that is the main nuclear energy source of current massive stars. An open question is whether these stars can create their own carbon, nitrogen, and oxygen prior to the onset of helium burning towards the end of their lifetime. Such production is difficult as there is no stable nucleus with mass 8. Alternative reaction chains to reach Nitrogen would be $^{2}H(\alpha,\gamma)^{6}Li(\alpha,\gamma)^{10}B(\alpha,n)^{13}N$ and $^{10}B(p,\alpha)^{7}Be(\beta\nu)^{7}Li(\alpha,\gamma)^{11}C(\beta\nu)^{11}B(\alpha,n)^{14}N$ but the rates of the involved reactions are uncertain. With this motivation, new measurements of the ^{10}B and $^{11}B(\alpha,n)$ reactions have been carried out at the University of Notre Dame. The $^{10}B(\alpha,n)$ reaction has been measured for the first time down to an alpha particle beam energy of 0.58 MeV using a deuterated liquid scintillator detector. These measurements extend to significantly lower energies than the previous measurements and are closer to the energies of relevance in the stellar interior. These lower energy measurements were well described by an R-matrix analysis that simultaneously also fits data from the $^{10}B(\alpha,p_0)$, $^{10}B(\alpha,p_1)$, $^{10}B(\alpha,p_2)$, $^{10}B(\alpha,p_3)$, $^{10}B(\alpha,d)$, and $^{10}B(\alpha,\alpha)$ reactions. For the $^{11}B(\alpha,n)$ reaction, a new measurement was made over the energy range from 0.52 to 2.0 MeV with a ^{3}He counter. The cross section is in good agreement with previous measurements, and an R-matrix analysis has been performed that includes data from the $^{14}C(p,n)$, $^{14}N(n,p)$, $^{14}C(p,p)$, $^{14}N(n,total)$, and $^{11}B(\alpha,\alpha)$ reactions over a similar excitation energy range. These reactions result in not only CNO elements as their final products but also provide a neutron source, an additional avenue for further nucleosynthesis. The results of these measurements are being prepared for publication in Physical Review C. With successful measurements completed at the University of Notre Dame, lower energy measurements are currently being pursued at the CASPAR underground facility.

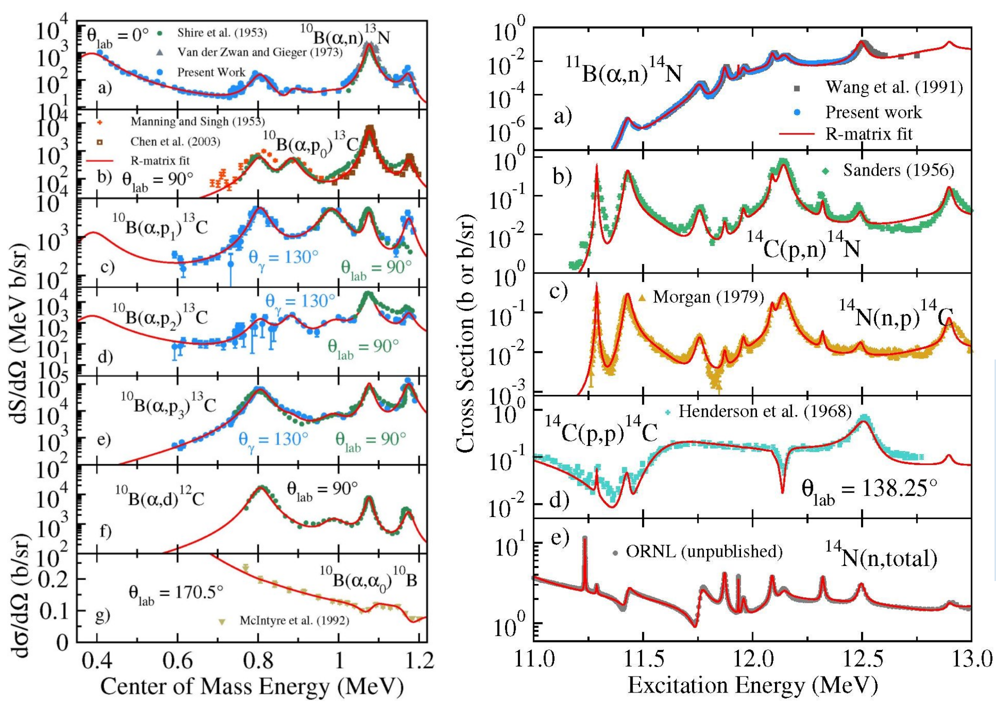


Figure 1. Newly measured cross sections of the $^{10}B(\alpha,n)^{13}N$ (left) and $^{11}B(\alpha,n)^{14}N$ (right) reactions in comparison to previous works.

Researchers: Q. Liu, M. Febbraro, R.J. deBoer, A. Boeltzig, Y. Chen, M. Couder, G. Gilardy, J. Görres, E. Lamere, K.T. Macon, K. Manukyan, L. Morales, S. Pain, W.A. Peters, C. Seymour, R. Toomey, B. Van de Kolk, J. Weaver, and M. Wiescher.

Software Instruments for Nuclear Astrophysics

Contributed by Frank Timmes (Arizona State University, USA)

Software is an integral enabler of experiment, observation, and theory. It is a primary modality for realizing the discoveries and innovations in nuclear astrophysics expressed, for example, in the nuclear physics decadal surveys, the astronomy and astrophysics decadal surveys, and programs supported by several federal and private funding agencies.

Software is also directly responsible for increasing scientific productivity and enhancements of JINA-CEE researchers' capabilities. For example, it is straightforward to put a new nuclear reaction rate in the Modules for Experiments in Stellar Astrophysics (MESA) software instrument to assess the impact of the new reaction rate on stellar models. MESA models also form a basis for many of the activities and explorations within JINA-CEE. The MESA V instrument paper and a new public version of MESA has been released: We updated the capabilities of the open-knowledge software instrument Modules for Experiments in Stellar Astrophysics (MESA). RSP is a new functionality in MESA that models the non-linear radial stellar pulsations that characterize RR~Lyrae, Cepheids, and other classes of variable stars. We significantly enhance numerical energy conservation capabilities, including during mass changes. For example, this enables calculations through the He flash that conserve energy to better than 0.001%. To improve the modeling of rotating stars in MESA, we introduce a new approach to modifying the pressure and temperature equations of stellar structure, and a formulation of the projection effects of gravity darkening. A new scheme for tracking convective boundaries yields reliable values of the convective-core mass, and allows the natural emergence of adiabatic semiconvection regions during both core hydrogen- and helium-burning phases. We quantify the parallel performance of MESA on current generation multicore architectures and demonstrate improvements in the computational efficiency of radiative levitation. We also report updates to the equation of state and nuclear reaction physics modules. We briefly discuss the current treatment of fallback in core-collapse supernova models, and the thermodynamic evolution of supernova explosions. We close by discussing the new MESA Testhub software infrastructure to enhance source-code development.

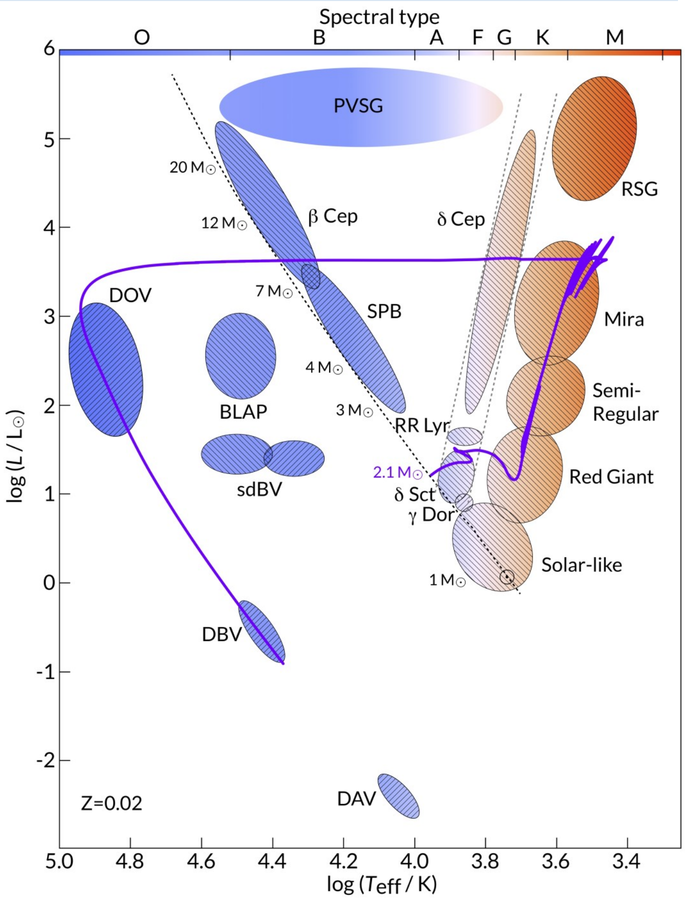


Figure 1. Classes of pulsating variable stars in the Hertzsprung-Russell diagram, including regions driven by the Helium bump (δ Ceph, δ Sct, RR Lyrae) and Fe bump (β Ceph, SPB) in the opacity. Backslash (\) fills represent pressure modes and slash (/) fills represent gravity modes. The zero age main-sequence (black dashed curve) is labeled with the locations of selected masses. The classical instability strip for radial pulsations is shown by the gray dashed curves. Evolution of a 2.1 solar mass MESA model at solar metallicity from zero age main-sequence to a white dwarf (WD) is shown by the purple curve.

Further reading: https://arxiv.org/abs/1903.01426 . Software: http://mesa.sourceforge.net

Nuclear Reaction Rates Prioritized to Constrain Ultradense Matter

Contributed by Zach Meisel (Ohio University, USA)

Accreting neutron stars provide a unique window into the properties of ultradense matter [1]. Type I X-ray bursts are a particularly important class of probes, with several bursts observed for over 100 sources in the galaxy. When coupled with model-observation comparisons, X-ray burst light curves can be used to probe the conditions of the outer layers, as well as bulk properties, of the underlying neutron star. Matching models with observations requires tuning the rate and composition of accreted material, the heat emerging from layers below the burst, and the neutron star compactness. In principle, these sensitivities can be used to constrain neutron star properties. However, additional sensitivity to nuclear physics uncertainties muddles this process. While this much is known, little work has been done to assess to what extent nuclear physics uncertainties obfuscate astrophysical constraints. Zach Meisel and undergraduate researchers Grant Merz and Sophia Medvid recently investigated this question for the "textbook burster" GS 1826-24 (hereafter GS), using the JINA-supported tool MESA [2,3,4].

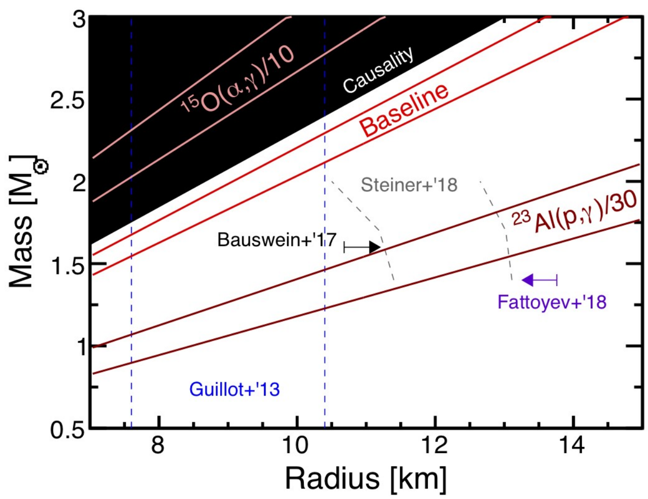


Figure 1. Neutron star mass/radius (M/R) constraints from model-observation comparisons of X-ray bursts from GS 1826-24. Red lines mark M/R uncertainty bands corresponding to surface gravitational redshift constraints obtained using MESA bursts calculated with the JINA-CEE REACLIB V2.2 reaction rate library (Baseline) and for two reaction rate variations. For context, radius constraints from other neutron star observables are shown, as well as the region forbidden by causality.

Using X-ray burst model calculations performed for roughly 100 combinations of astrophysical conditions, the Ohio University team determined the most probable accretion conditions for GS. Using the best-fit conditions as a baseline, the nuclear reaction rates identified as high-impact by a previous JINA study [5] were varied within plausible nuclear physics uncertainties and their impact on burst properties was quantified. While inferred accretion properties were robust for varied nuclear physics inputs, reaction rates that significantly modified the shape of the X-ray burst light curve were found to alter the compactness (mass/radius ratio) extracted from model-observation comparisons. Additionally, several reaction rates modified the surface composition, which influences the crust composition and thermal structure, on a scale comparable to significant modifications in accretion conditions. For GS, six reaction rates are prioritized for future laboratory experiments. Especially important reactions are $^{15}O(\alpha,\gamma)$, $^{23}Al(p,\gamma)$, $^{59}Cu(p,\gamma)$, $^{18}Ne(\alpha,p)$, $^{14}O(\alpha,p)$, and $^{61}Ga(p,\gamma)$. An indirect measurement to constrain $^{18}Ne(\alpha,p)$ was performed at the Edwards Accelerator Laboratory, and the present analysis indicates a significant rate enhancement is unlikely. A beta-Oslo measurement was performed in April at NSCL to constrain properties of ^{60}Zn important for $^{59}Cu(p,\gamma)$ and the analysis is ongoing.

References:

[1] Z. Meisel, A. Deibel, L. Keek, P. Shternin, and J. Elfritz, J. Phys. G 45, 093001 (2018)
[2] Z. Meisel, Astrophys. J. 860, 147 (2018)
[3] Z. Meisel, G. Merz, and S. Medvid, Astrophys. J. 872, 84 (2019)
[4] http://inpp.ohio.edu/~meisel/MESA/mesaresults.html
[5] R. Cyburt et al., Astrophys. J. 830, 55 (2016)

JINA-CEE Faces:
Interview with Nathalie Degenaar

Nathalie Degenaar is a Dutch astrophysicist working at the Anton Pannekoek Institute for Astronomy of the University of Amsterdam, Netherlands. She recalls that her first inspiration to study astronomy came at an early age when she read books about astronomy with her father, and he said he would love to learn more about planets. She thought she should become an astronomer to then teach her father. For many years though, she was decided to become a doctor, and that's why she studied biomedical sciences in college for a while. She realized, however, that she wanted more challenge, and what could be more challenging than physics and math? ... that's how she rediscovered her love for astronomy.

Nathalie obtained her PhD from the University of Amsterdam, and after graduation she became a Hubble fellow at the University of Michigan, in Ann Arbor. She then moved to the University of Cambridge to be a Marie Curie fellow, and afterwards she headed back to the Netherlands where she now leads her own research group.

Nathalie Degenaar
Anton Pannekoek Institute for Astronomy, University of Amsterdam, Netherlands

What is the focus of your research?

I try to understand how neutron stars accrete material from their surroundings and then eject it back into space via winds and jets. To understand all these processes you need information in all wavelengths, so I use observations from X-ray satellites such as Chandra, Newton, Swift, NuSTAR, optical telescopes like Hubble, and VLT, radio arrays such as VLA in New Mexico and ATCA in Australia.

How do you interact with JINA-CEE?

I first came in contact with JINA as an undergrad, during a research stay with Ed Brown at Michigan State University, where I worked on neutron star cooling processes. Currently, I also use observations of accreting systems to understand the physics of neutron stars. For example: thermonuclear bursts give us information on the structure of the stars, and when the star stops accreting you can see the thermal glow, and from that we can infer how the star looks like in the inside. These topics are at the center of my collaboration with other JINA-CEE researchers.

What's your favorite part of your job?

Having discussions with my group members, thinking about strategies to answer new questions, designing observational campaigns. I really enjoy the dynamic interaction, and creativity within our group.

What message would you like to give to young aspiring scientists?

I have found inspiration in female researchers that have come before me. It's important to seek role models. I have been to conferences where I was the only female speaker, and that was not uncomfortable, as I always felt support from many colleagues. Happily, there are more and more women coming into the field nowadays. I think that combining an academic career with family has its challenges but it is definitely worth the effort, and it should not be a reason to drop out. It is great the in US universities it is possible to have your spouse hired as well. That is not the case in Europe, but I was fortunate to have a husband who was willing to relocate as I moved to new positions. Hopefully the hiring policies in Europe change in the future.

Anything else?

I greatly appreciate that JINA-CEE exists, and that it encourages researchers to get in touch with international colleagues to build their own scientific networks. This is especially good for young researchers. Thanks to JINA-CEE we were able to hold a conference on neutron stars in Amsterdam this past April. This was sort of my dream conference, and I was able to bring together a lot of researchers that I collaborate with closely, which is awesome!

Rahul Jain’s experience at Santa Tecla School

Rahul Jain is a second year graduate student at Michigan State University working on both, experimental and theoretical studies of neutron star crusts in the group of Hendrik Schatz. Rahul is originally from India, where he completed his bachelors and masters studies with an emphasis on nuclear physics. Looking to improve his education on astrophysics, he attended the 10th European Summer School on Experimental Nuclear Astrophysics (also known as the Santa Tecla School), which this year took place at INFN LNS in Catania, Italy.

Rahul was named one of the most active students at the end of the school thanks to his excellent oral contribution “*Sensitivity Studies of Fusion Reactions in the Crusts of Accreting Neutron Stars*”, and his engagement in lively discussions.

Rahul Jain, graduate student of nuclear astrophysics at Michigan State University

"Attending the week-long school helped me learn the useful astrophysical aspects of Nuclear Astrophysics in a focused and concise manner. It also gave me a chance to network with European scientists working in the field as well as make friends across the continents." - Rahul Jain

Tim Beers receives awards in the UK and China

Tim Beers, Grace-Rupley Professor of Physics at University of Notre Dame

We are happy to congratulate JINA-CEE co-PI Timothy Beers, professor at the University of Notre Dame for being awarded a Leverhulme Trust Distinguished Visiting Professorship at the University of Hull, UK. These professorships are awarded to eminent researchers from overseas to enhance the skills and knowledge of the academic staff and/or students at UK institutions. Tim will be spending a little over three months at the University of Hull collaborating with Brad Gibson, director of the E. A. Milne Centre for Astrophysics.

Earlier this year, Tim was also named a PIFI Distinguished Scientist by the Chinese Academy of Sciences, their highest award for a visiting international scholar. As part of this award, Tim conducted a lecture tour in Shanghai and Beijing last May.

First Frontiers Summer School

Students hold up letters to answer multiple-choice questions during the school.

Owing to the great enthusiasm and bold initiative of a group of early -career JINA-CEE scientists, the First Frontiers Summer School took place at Michigan State University on May this year, prior to the annual Frontiers Meeting. By recognizing the lack of a multidisciplinary education in nuclear astrophysics at their own institutions, junior researchers Louis Wagner, Chelsea Harris, Daniel Votaw, Matt Mumpower, Benoit Côté, Cathleen Fry, Erika Holmbeck, MacKenzie Warren, Alex Ji and Jinmi Yoon, lead by Matt Caplan, put together a proposal for a JINA-CEE supported summer school aimed to train astronomers in nuclear physics, and nuclear physicists in astronomy. Their proposal was funded, and they put together a school program that would equip participants with interdisciplinary training on the major areas of JINA-CEE science:

- Where do the elements come from that make up our world?
- What are the basic properties of matter when compressed to high density?

The school was participant-driven, and all lectures were taught by graduate students and postdocs, covering experimental and theoretical nuclear physics (e.g. shell structure, driplines, reactions, and direct/indirect measurements), astrophysical modelling (e.g. galactic chemical evolution, core-collapse supernovae, neutrinos, neutron stars, and gravitational waves), and astronomical observations (e.g. stellar evolution, halo stars, first stars, CEMP stars, dwarf galaxies and cosmology).
A total of 46 participants with diverse backgrounds and academic levels (from undergraduate, to senior postdoc) and from 19 different institutions around the world attended the school. The program also included plenty of time for free discussion, which helped networking, and even initiate some scientific collaborations. "*Having speakers who are early career scientists themselves helped foster a great learning environment. Responses to post-event survey were overwhelmingly positive!"* said Matt Caplan, who lectured at the summer school as a postdoc, but is now an assistant professor at Illinois State University.

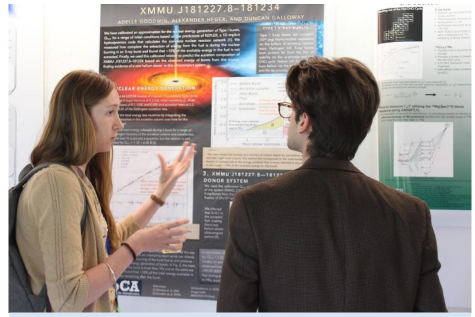
Attendees reported finding great value in the school, and felt comfortable asking lots of questions.
Some testimonials:
-"*This field requires knowledge from a lot of physics that is often taught separately in classes, and this summer school gave us a space to discuss how everything comes together* […] *it felt like we were active participants (as opposed to simply passive listeners being talked to).*"
-"*Some of the theoretical nuclear stuff was pretty cool and I didn't know anything about it until I came to the school.*"
-"*The talks and pace was phenomenal! I really appreciated that. The organizers were absolutely wonderful too. The question & answer section was great for my confidence too."*
-"*I really liked how the lectures were set at a level that was easy to understand for undergrad and new grad students. The lecturers did a good job in making us familiar with some of the buzz words that are often used in the field."*

All school lectures are publicly available at the school website: https://sites.google.com/view/ffss2019/home?authuser=0


Chelsea Harris (postdoc at MSU) lectures participants on white dwarfs, classical novae, and Type Ia supernovae.

Frontiers in Nuclear Astrophysics 2019

Contributed by Stephanie Lyons, and Andrea Richard (Michigan State University)



A discussion during the poster session

The 2019 Frontiers Meeting took place at the National Superconducting Cyclotron Laboratory at Michigan State University last May. More than 120 researchers from 35 national and international institutions came together to discuss progress and the direction of research regarding the understanding of the origin of the elements, and the nature of neutron star matter.

The main meeting was preceded by the **Junior Researchers Workshop**, which was aimed at postdoctoral researchers and graduate students, and provided an introduction to the various subfields within the JINA-CEE community. Besides being a forum to discuss their own work, the Junior Researchers Workshop offered participants a variety of professional development mini-workshops. One of these workshops was on interactive science communication, presented by the RELATE communications training and community engagement program based at U. of Michigan. Another workshop on science writing was presented by Marialuisa Aliotta based on her recent book, *Mastering Academic Writing in the Sciences.* The Junior Researchers Workshop also included both academic and non-academic career panels highlighting the breadth of possibilities for careers after a PhD in physics.

Testimonials: -*"Man, some of those review talks were really good. Also, the communication exercise of distilling your research down to a few seconds was enlightening."*

-"I liked the non-talk sessions (like science communication). Those feel unique to this conference, at least the fact that they aren't simultaneous with a bunch of other things so you feel like you have to choose science talks vs career panels and stuff. I like the emphasis on career development and the tools needed to do that effectively."

The 2019 Frontiers Main meeting featured presentations and posters on a variety of topics, ranging from the frontiers of research on the r-process in the multi-messenger era to understanding our galactic history through the analysis of ^{60}Fe in ocean sediment samples. This year's Frontiers Meeting also began the JINA-CEE Mentoring Program with a round table discussion luncheon for mentors and mentees to get to know one another, and to set the foundation for future interactions. Participants even enjoyed dining with dinosaurs at the MSU Museum for the conference dinner. Both the Main Meeting and Junior Researchers Workshop were organized by student and postdoctoral researchers of the JINA-CEE community.

Conference group photo

Testimonials: -*"Great event this year as always, well done to the organizers. Will continue to be on my list of annual "must-attend" meetings!"*

-"The atmosphere was fun and easy to interact with people."

-"The varied and interactive format was fantastic. I especially enjoyed the career panels, the mentoring sessions and the many opportunities to really connect with other participants"

Upcoming JINA-CEE Events

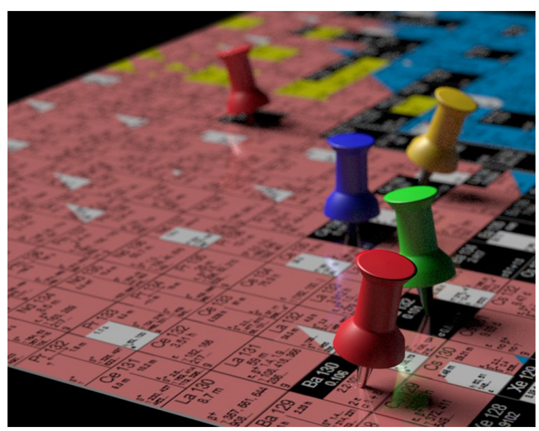
Nuclear Physics in Astrophysics IX

Castle Waldthausen, Frankfurt, Germany
September 15-20, 2019

Every two years the NPA Conference brings together researchers from a multi-disciplinary community of experimental and theoretical nuclear physicists, astronomers, astrophysicists, and cosmo-chemists to discuss the current challenges of this exciting and fast developing research field. The 9th edition of NPA will take place at the Schloß Waldthausen, west of Frankfurt, Germany.

https://exp-astro.de/meetings/npa-2019/

7th edition of the p-process workshop



Boscareto Resort, Serralung D'Alba, Italy
September 23-27, 2019

The goals of the workshop are to:

- Investigate the role of different kids of supernovae in the synthesis of p-nuclei, providing constraints on the still uncertain supernova models:
- Create a priority list for critical reaction rates during explosive conditions to be measured, identifying the relevant nuclear reactions for the g process;
- Compare prediction models to isotopic anomalies in pristine meteorites.

https://www.b2fh.org/pwork2019/index.html

Upcoming JINA-CEE Events

Lithium in the Universe: to Be or not to Be?

Observatory of Rome, Italy.
November 18-22, 2019

The meeting will bring together experts from various fields to discuss the role played by lithium in several astrophysical contexts and to highlight the extraordinary character of this chemical species, as a tracer of the structure and evolution of stars, galaxies and the Universe.

This conference is particularly timely because the last years have witnessed a significant improvement in the capability of major nuclear physics facilities, that will soon allow a high-quality description of the nuclear reactions involving lithium and beryllium. Also, a growing body of observational data of lithium in cluster stars will soon be available, such as the WYIN open cluster survey. Furthermore, there is considerable development of 3D and NLTE modelling and their application to large spectroscopic data sets, which, while being computationally demanding, will allow determinations of lithium abundances with much higher fidelity than until now.
https://lithiumintheuniverse.wixsite.com/lithium2019

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JINA-CEE Institutions

JINA-CEE is supported by the National Science Foundation through the Physics Frontiers Center Program

JINA-CEE Core Institutions:

Michigan State University, Physics and Astronomy Department, NSCL
University of Notre Dame, Department of Physics, ISNAP
Arizona State University, SESE
University of Washington, INT

JINA-CEE Associated and Participating Institutions:

CCAPP Ohio State University, CNA Shanghai Jiao Tong University Shanghai China, EMMI-GSI Helmholtz Gemeinschaft Germany, Florida State University, INPP Ohio University, Los Alamos National Laboratory / LANSCE-3, McGill University Canada, MoCA Monash University Australia, NAVI Germany, North Carolina State University, NUCLEI LANL, Argonne National Laboratory, Princeton University, Center for Nuclear Astrophysics China, Cluster of Excellence Origin and Structure of the Universe Germany, TRIUMF Canada, University of Amsterdam Netherlands, University of Chicago, University of Minnesota, University of Sao Paulo Brazil, University of Hull UK, University of Victoria Canada, Western Michigan University, Ball State University, Hope College, Indiana University South Bend, SUNY Geneso, University of Oslo Norway, ChETEC, and the National Astronomical Observatory of Japan.

JINA-CEE also has participants from:

Bucknell University, California Institute of Technology, Central Michigan University, Gonzaga University, Al-Balqa Applied University Jordan, LBNL, Louisiana State University, Massachusetts Institute of Technology, MPI for Extraterrestrial Physics Germany, UNAM Mexico, Ohio State University, Stony Brook University, TU Darmstadt Germany, University of Illinois, University of Michigan and Wayne State University.

For comments or questions about:

Outreach and Education
Newsletter and other JINA-CEE related issues

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