



A note from the Director, Hendrik Schatz

Spring is always an extra busy time in JINA-CEE. While new research highlights are published continuously, spring is the time where an extra effort is made to collect information on results across the center. Many new research highlights have been posted on jinaweb.org and I encourage you to browse through them. It is truly impressive to see all the new results and technical developments that cut across nuclear physics, theoretical astrophysics, and astronomy.

Spring is also the time of our annual “Frontiers in Nuclear Astrophysics” meeting that will take place on March 29-31 at the University of Notre Dame. As always, the meeting is organized by an amazing committee of dedicated students and postdocs. This year the meeting includes for the first time a day just for students and postdocs (March 28) with opportunities to present research and discuss career development. I hope to see you all at “Frontiers” this year to discuss the latest results, exchange ideas, and start new collaborations.

I would also like to direct your attention to the new online seminar series that has been initiated by JINA-CEE scientists at the University of Washington to enhance interdisciplinary communication within JINA-CEE and with the broader scientific community. Broadcast every other week, institutions take turns to present new results in the area of neutron stars and dense matter properties <https://sites.google.com/site/jinama2seminar/>. The audience joins individually or as a group via easy to use Zoom video conferencing. The talks are public, and all interested scientists are welcome to join. Presentations are also recorded and available online on the JINA-CEE YouTube channel, together with many other recorded seminars and lectures.



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New faces: JINA-CEE Post doc Rana Ezzeddine



New JINA-CEE Post doc Rana Ezzeddine from Beirut, Lebanon

Education: Master of science in Astrophysics: Joint Notre Dame University and Saint Joseph University degree, Lebanon.

PhD in Stellar Astrophysics: University of Montpellier, France.

When you were young, what did you want to be when you grew up? I've always wanted to be an astronomer. I was a member of the amateur "Lebanese Astronomy Group" since I was 15 years old.

When did you decide to pursue astrophysics/physics? I decided to pursue Physics as it was my favorite course in school. After obtaining a BS degree in Physics, I taught physics at school for two years until a masters program in Astrophysics was established in Lebanon in 2010. I was the first to enroll and graduate from this masters program.

What is your research focus? My research focus is on accurate abundance determination in cool stars, especially that of Iron which plays a very important role in understanding the chemical evolution of our Galaxy.

With whom and where will you work within JINA-CEE? I will work with Anna Frebel at MIT on the topic of accurate abundance determination of r-process and metal-poor stars and galactic archeology.

Where do you see yourself in 5 years? I see myself in a research and teaching position at a good University.

And what about 20 years? I would like to see myself in a permanent position doing research and teaching. I would also (hope to) see myself involved in many outreach programs, an example is women's education and involving more women in science.

Darshana Patel's (UND) thesis published by Springer



Darshana Patel (UND)

In a rare honor, the Ph.D. thesis of Darshana Patel of the University of Notre Dame has been published as a book by the well-known science publisher Springer under the "Springer Theses" series.

Described as the "best of the best", the series recognizes "Outstanding Ph. D. Research". Each thesis is chosen for its scientific excellence and impact on research. For greater accessibility to non-specialists, the published versions include an extended introduction, as well as a foreword by the student's supervisor explaining the special relevance of the work for the field.

The content of the series is available to millions of readers worldwide and, in addition to profiting from this broad dissemination, the author of each thesis is rewarded with a cash prize equivalent to € 500.

Darshana's dissertation, titled "A Study of the Isoscalar Giant Monopole Resonance: The Role of Symmetry Energy in Nuclear Incompressibility in the Open-shell Nuclei" was completed under the supervision of JINA-CEE participant Prof. Umesh Garg.

JINA-CEE at JUNA in CHINA

Contributed by JINA-CEE Co-PI Michael Wiescher (UND)

During the last JINA funding period, JINA members from Notre Dame have developed a competitive new concept for an underground accelerator facility DIANA consisting out of two accelerators located deep underground to measure critical nuclear reactions in stellar burning in a background free environment. The unfortunate funding situation in the US over the last few years has prohibited the construction of such a facility, but the concept is presently realized in China.

The conceptual design of the Jinping Underground accelerator for Nuclear Astrophysics (JUNA) follows closely the footsteps of the DIANA design. JUNA is located in a deep 17 km long tunnel connecting a bend of the Yalong River in the Jinping mountain of southwestern China for the Yalong Hydropower plant. JUNA is located in an excavation at the center of the mountain at a depth of 6720 m.w.e. . The construction of the facility is supported by Chinese funding agencies through Tsinghua University and the China Institute of Atomic Energy (CIAE) in Beijing. CIAE is an international collaborator of JINA-CEE. JINA-CEE members from Notre Dame and Ohio University serve as members of the international advisory committee. The excavation is completed and the construction of the first accelerator is projected to be completed by the end of 2016. The project will be completed by 2019 and will offer a unique opportunity for studies of stellar reactions with intense ion beams, next to the European underground accelerator facility LUNA and the future LUNA-MV .



Dan Robertson and Michael Wiescher from Notre Dame and JINA-CEE with Xiaodong Tang from Lanzhou on top of the 305 m high dam above the Yalong River. The laboratory is located deep within the Jinping mountain range at the right hand side.



Dan Robertson, Michael Wiescher from JINA-CEE and Frank Strieder from the South Dakota School of Mines & Technology in the 14x14x130m excavation that will house the JUNA accelerator facility.

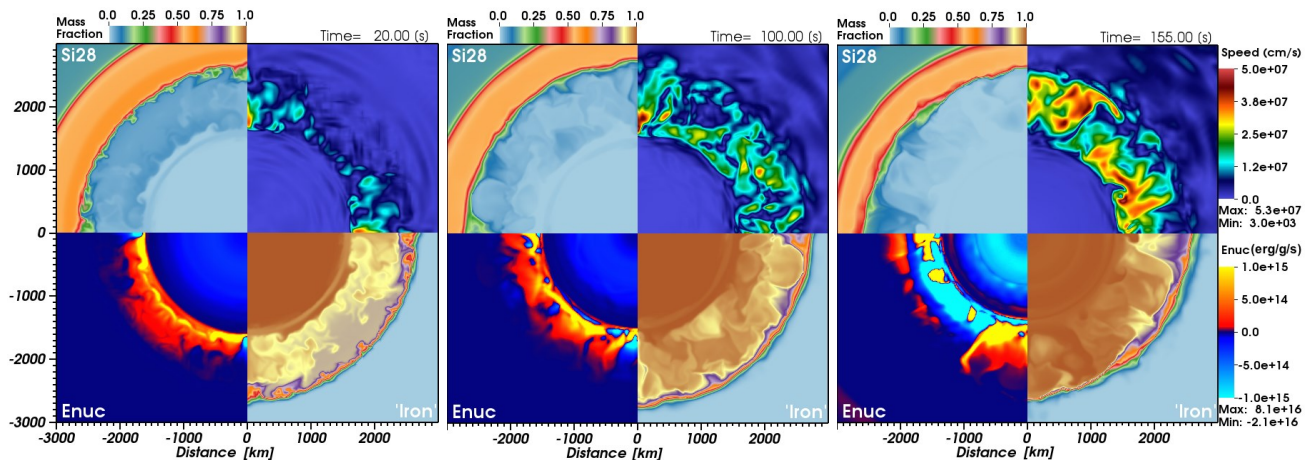
JINA-CEE Project: Forging the Elements From Massive Stars in 1D and 3D

The end states of massive stars are a rich site of fascinating and intrinsically three dimensional challenges that include convection, nuclear burning, mixing, waves, instabilities and eruptions. This bonanza of physical puzzles is closely linked with compact object formation in core-collapse supernovae and the wide diversity of observed massive-star transients. Given recent observational clues that challenge conventional wisdom about massive stars, the expectation of immense quantities of data from future surveys becoming available, and advances in stellar modeling, this JINA-CEE project will lead to significant improvements in our understanding of the end states of massive stars.

Our collaborative JINA-CEE team will integrate forefront stellar fluid dynamics (FLASH) and stellar evolution (MESA) software instruments for massive star evolution for the first time. Interleaving computational results with fundamental theory and informed by modern observations of massive stars, the project will quantify the effects of convection, composition mixing, and wave propagation on the structure and nucleosynthesis of non-spherical 3D progenitors and their explosions. With a series of crucial improvements to the physics over our initial exploratory approach, we will produce the most realistic core-collapse supernova progenitors to date. This work could have transformative impact on the long-standing problem of the core-collapse supernova mechanism and on our understanding of cosmic nucleosynthesis.

More specifically, this JINA-CEE project will directly quantify the non-spherical 3D nature of the end states of stellar evolution in massive stars and how 3D dynamics impacts the detailed nucleosynthesis resulting from subsequent supernova explosions in these stars. This project will make significant progress towards self-consistent 3D stellar evolution models of massive stars at the point of core collapse and the nuclei they forge in their explosions.

Contributed by JINA-CEE Co-PI
Frank Timmes, ASU



Visualizations of the 3D progenitor evolution simulation for a 15 solar mass star. Shown are slices of the 28Si mass fraction (top left), flow speed (top right), mass fraction of iron group nuclei (bottom right), and specific nuclear energy generation rate (bottom left). Each panel shows different times since the start of the 3D simulation: 20 s (left), 100 s (middle), and 155 s (right, about 5 s before gravitational core collapse). From Couch et al (2015).

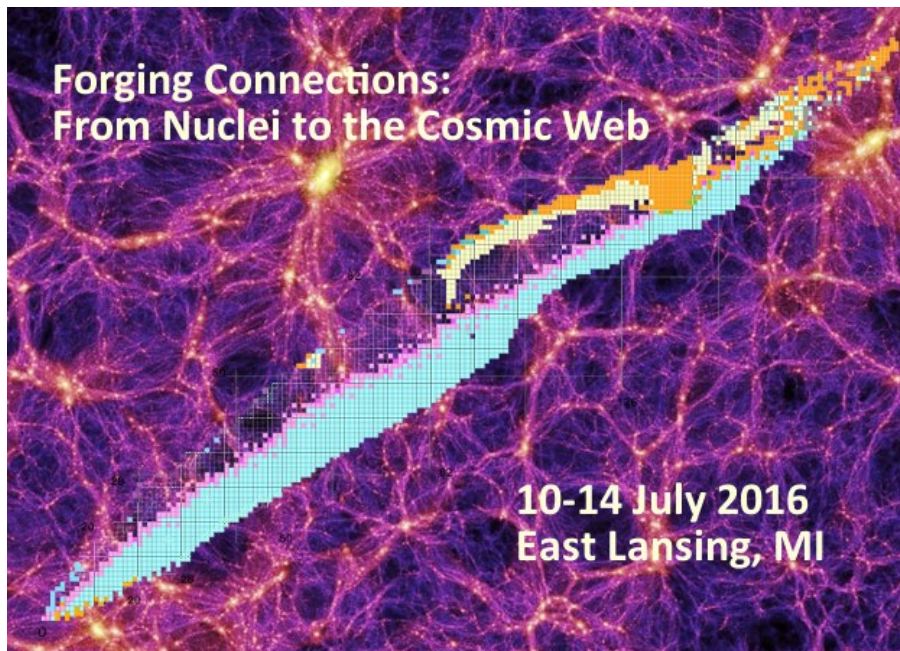
Forging the Elements From Massive Stars in 1D and 3D (continued from page 4)

To reach the goal of “getting the progenitor right,” this project will build a series of 3D simulations using a large 126 isotope reaction network. The initial conditions for the 3D calculations will be provided by state-of-the-art 1D stellar evolution models at various epochs before gravitational collapse computed using the same 126 isotope reaction network. The major physics outcomes of this project will be 3D simulations of massive star supernova progenitors, 3D simulations of the explosion of those non-spherical progenitors, and comparison to the corresponding 1D models. This project will begin to address crucial but unanswered questions about the fidelity of presupernova progenitors and nucleosynthesis yields from 1D stellar models.

Team: Sean Couch (MSU), Rob Farmer (ASU), Frank Timmes (ASU)

Upcoming Workshop: From Nuclei to the Cosmic Web

Roughly half of the elements in the universe that are heavier than helium are in stars and the interstellar medium, and the rest is in the circumgalactic and intergalactic medium. All of these elements are produced in stars or their remnants, and they are critical to both structure formation (i.e., star and galaxy formation) and stellar evolution. The purpose of this workshop is to bring together observers, experimentalists, and theorists whose expertise spans the range of subjects necessary to understand the full life cycle of the baryonic content of the universe, and to forge connections to address the challenges relating to studying chemical enrichment in the era of large stellar and IGM surveys. The workshop will be held July 10 — 14 2016 in East Lansing, Michigan, and will include a mixture of talks, panel discussions, breakout sessions, and working groups. Registration is now open and can be found on the workshop [website](#).



A Python Interface to the JINA Reaclib Database

The Stony Brook group started a python-interface to the JINA Reaclib database that provides an object oriented way to evaluate rates, create a network, and output the source code required for integrating a reaction network numerically. Plans include outputting OpenACC-enabled Fortran code for running on GPUs. The project is hosted on [github](#).

An example notebook showing off its capabilities can be found [here](#):

<https://github.com/pyreaclib/pyreaclib/blob/master/pyreaclib-examples.ipynb>

Questions? [Contact](#) Michael Zingale at Stony Brook University



JINA-CEE Frontiers in Nuclear Astrophysics 2016 meeting

The JINA-CEE Frontiers in Nuclear Astrophysics 2016 meeting will take place March 29-31, preceded by a one day meeting for students and post-docs on the 28th. This is the sixth in a series of meetings to bring together JINA participants, collaborators, and other interested researchers in nuclear physics, astronomy, and astrophysics to discuss progress and future directions related to the understanding of neutron stars and the origin of the elements. On-site registration will start at 8am on Tuesday March 29th and will end at noon on Thursday March 31st. It will comprise of a total of 8 sessions of oral presentations, a poster session, and a participant-organized breakout session, the 'unconference'.



Get the conversation started for the unconference at the [meeting wiki](#)! For more information, see the meeting website: <http://indico.fnal.gov/event/Frontiers2016>.

More upcoming JINA-CEE events

FRIB Theory Alliance Inaugural Meeting

April 31 — April 1 2016, East Lansing, Michigan

Workshop on Experiments for X-ray Burst Nucleosynthesis

May 22 2016, Athens, Ohio

Symposium on Neutron Stars in the Multi-Messenger Era

May 23 — 27 2016, Athens, Ohio

The r-process Nucleosynthesis: Connecting FRIB with the Cosmos

May 31 — June 17 2016, East Lansing, Michigan

R-Matrix on Methods and Applications

June 27 — July 1 2016, Santa Fe, New Mexico

The 12th Torino Workshop on Asymptotic Giant Branch Stars

July 31—August 5 2016, Budapest, Hungary

3rd Astrophysical Nuclear Reaction Network School

August 19 — 26, Schmitten, Germany



Recent Publications



A. Arcones et al. *White Paper on Nuclear Astrophysics*. arXiv:1603.02213 [astro-ph.SR] (2016).

A. Best, J. Görres, M. Junker, K.-L. Kratz, M. Laubenstein, A. Long, S. Nisi, K. Smith, and M. Wiescher. *Low energy neutron background in deep underground laboratories*. Nucl. Instr. Meth. Phys.812, 1 (2016).

M. Lugaro, M. Pignatari, U. Ott, K. Zuber, C. Travaglio, G. Gyürky, and Z. Fülöp. *Origin of the p-process radionuclides ^{92}Nb and ^{146}Sm in the early solar system and inferences on the birth of the Sun*. PNAS 113, 907 (2016).

S. Lipschutz, R.G.T. Zegers, J. Hill, S.N. Liddick, S. Noji, C.J. Prokop, M. Scott, M. Solt, C. Sullivan, and J. Tompkins. *Digital data acquisition for the Low Energy Neutron Detector Array (LENDA)*. Nucl. Instr. Meth. Phys.815, 1 (2016).

B.F. Griffen, A.P. Ji, G.A. Dooley, F.A. Gómez, M. Vogelsberger, B.W. O'Shea, and A. Frebel. *The Caterpillar Project: a Large Suite of Milky way Sized Halos*. APJ 818, 10 (2016).

A.P. Ji, A. Frebel, J.D. Simon, and M. Geha. *High-Resolution Spectroscopy of Extremely Metal-Poor Stars in the Least Evolved Galaxies: Boötes II*. APJ 817, 41 (2016).

D. Lazzati, and A. Heger. *The Interplay Between Chemistry and Nucleation in the Formation of Carbonaceous Dust in Supernova Ejecta*. ApJ 817, 134 (2016).

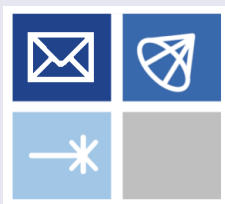
New JINA-CEE listservs

For communications within
JINA-CEE:

JINA-CEE@jinaweb.org
faculty@jinaweb.org
jr_researchers@jinaweb.org

For the broader community:
news@jinaweb.org

Want to sign up?
[Contact Lena Simon](#)



Isotopolis

The rare isotope iPad game "Isotopolis" is now available for free on the App Store.

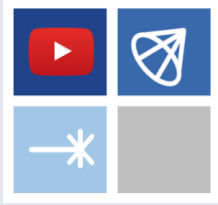
NSCL and JINA-CEE participants collaborated with MSU's Games for Entertainment and Learning (GEL) Lab on the game wherein players explore the chart of nuclides and try to discover new isotopes.

The experience demonstrates how isotopes that otherwise exist only in supernovae are created at NSCL and lets players step into the role of a nuclear astrophysicist. It should also be available on several other platforms in the next year, and possibly at installations in science museums or lobbies.

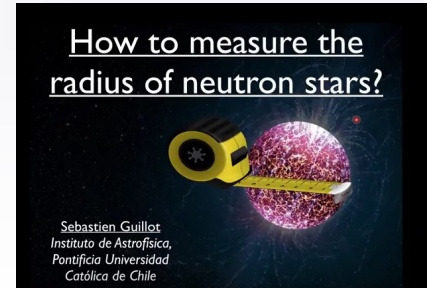
Isotopolis was funded by a grant from the American Physical Society, JINA-CEE, and several MSU units.



JINA-CEE YouTube channel



In the last newsletter, we provided an update about new videos posted on the **JINA-CEE YouTube channel**. Some of you responded with links to your own videos which we happily added to our playlists. If other members have online videos of lectures, talks, demos, etc, we would love to help share them. Please send links to jinaout@nd.edu so we can add them to our playlists or subscribe to your channels.



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



Links to our institutions websites:

JINA-CEE Core Institutions:

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

JINA-CEE Associated and Participating Institutions:

CCAP Ohio State University, EMMI-GSI Helmholtz Gemeinschaft Germany, Florida State University, INPP Ohio University, Los Alamos National Laboratory / LANSCE-3, McGill University Canada, MoCA Monash University Australia, North Carolina State University, NAVI Germany, 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 Chicago, University of Minnesota, University of Sao Paulo Brazil, University of Victoria Canada, Western Michigan University, Ball State University, Hope College, Indiana University South Bend, SUNY Geneseo

JINA-CEE also has participants from:

California Institute of Technology, Central Michigan University, Gonzaga University, Al-Balqa Applied University Jordan, Lawrence Berkeley National Laboratory, Louisiana State University, Massachusetts Institute of Technology, MPI for Extraterrestrial Physics Germany, UNAM Mexico, Ohio State University, Shanghai Jiao Tong University China, Stony Brook University, TU Darmstadt Germany, University of Hull UK, University of Illinois, University of Michigan, Wayne State University

For comments or questions about:

Outreach and Education
Newsletter and other JINA-CEE related issues

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