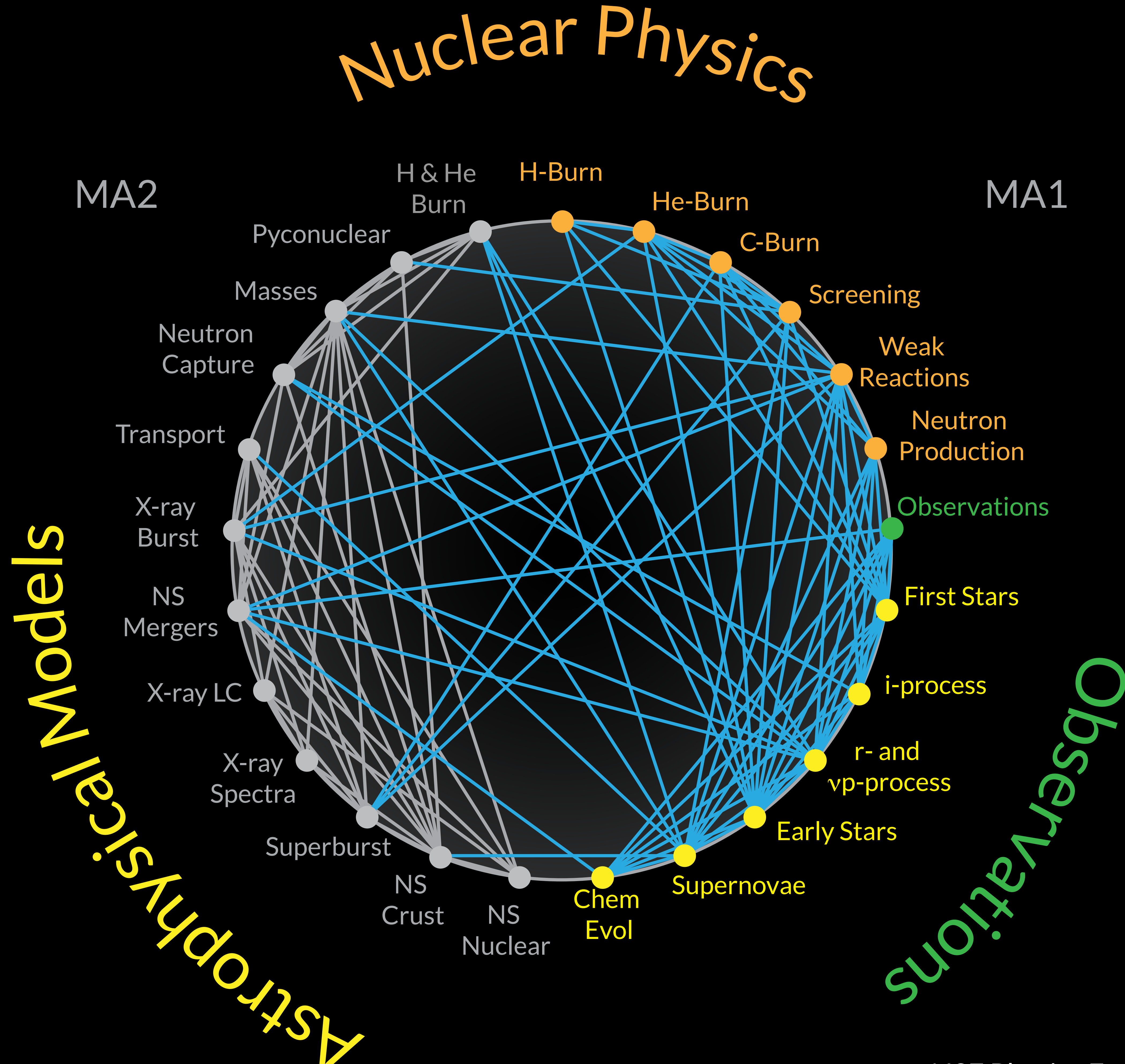


JINA-CEE

NSF Physics Frontiers Center

MA1 Strategic Areas

A1: Provide the new experimental and theoretical nuclear physics needed to quantitatively assess the contributions of individual nucleosynthesis events.

See Michael Wiescher's, Artemis Spyrou's, and Sanjay Reddy's talks

A2: Obtain heavy-element abundance data for chemically-primitive stars in the Local Group of galaxies.

See Tim Beer's and Anna Frebel's talks

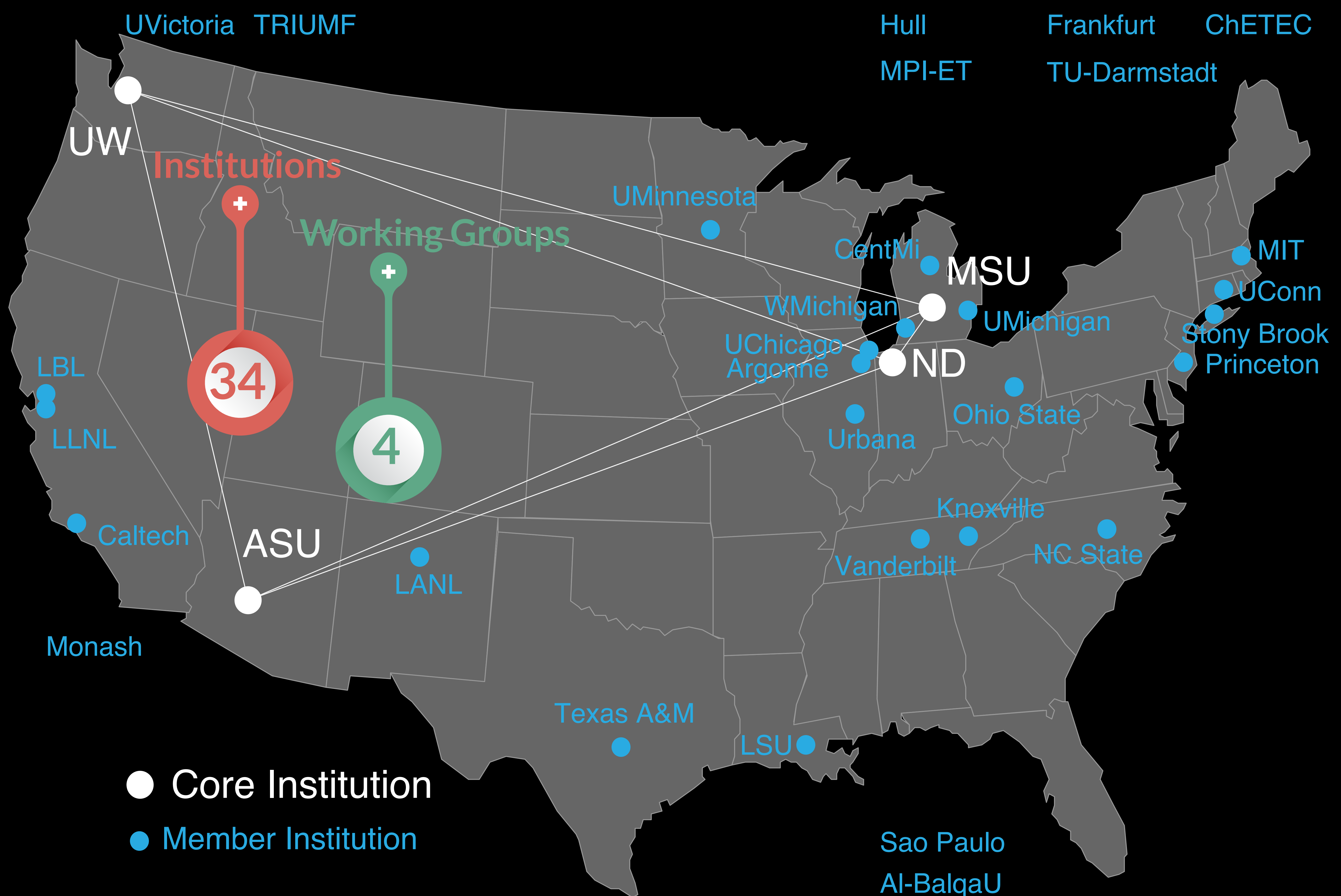
A3: Construct state-of-the-art astrophysical models that quantitatively predict nucleosynthesis contributions from stars and supernovae.

See Falk Herwig's and Gail McLaughlin's talks

A4: Integrate the nuclear physics, stellar abundance determinations, and stellar nucleosynthesis yields into classical and modern chemical-evolution models.

See Falk Herwig's and Anna Frebel's talks

MA1 Community Network



5 years of *presented* major achievements

New helium burning rates from stable beam experiments and R-matrix analysis

New measurement of 12C+16O and 12C+12C in concert with theoretical and observational studies

Constrain electron-capture rates via (t,3He) and 56Ni(p,n)

β-Oslo technique for indirect extraction of (n,γ) rates

New 20Ne(e−,ν)20F rates and electron-capture supernova

Survey nuclear level density and gamma-ray strength function options in TALYS Hauser-Feshbach models

Mapping helium burning

First 3D simulation of the final minutes of iron core growth in a massive star, up to and including core-collapse

First 3D GRMHD simulation of a core-collapse supernova driven by rapid rotation and strong magnetic fields

First 3D simulations of He-shell flash convection with proton-rich fuel entrainment

First converged 3D simulations of double WD mergers and collisions

Catching element formation in the act

Probing the isotopic evolution of massive stars with pre-SN ν

First 3D simulations of mixing of radionuclides into molecular clouds

First 3D simulations of r-process in jet driven supernovae

Discovery: Highly r-process enhanced stars in Reticulum II

r-process variations with nuclear mass model

r-process origin sites from neutron star mergers

Measurement of (α,n) reactions or weak r-process sensitivity

Neutron star merger rates from LIGO and chemical evolution models

Nugrid yields from non-rotating 1D stellar evolution models

12C+12C and Super Asymptotic Giant Branch Stars

i-process nucleosynthesis and contributions to chemical evolution

Discovery: CEMP-no stars hold the nucleosynthesis of the first stars

Exploring nucleosynthesis of first stars

First 3D simulations of carbon-oxygen shell mergers; a robust site for P, Cl, K ,Sc and p-process species

First 3D simulations of primordial metals generated and mixed by the first supernovae correlate well with CEMP halo stars

Chemical evolution informed from 3D cosmological simulations

Chemical cartography, e.g., carbon maps of the Milky Way.

Origin of the first supermassive black holes

NASA NuSTAR correlating JINA 44Ti and 56Ni results

Observing the first stars with the James Webb Space Telescope

Gravitational wave signals from 3D supernovae simulations

Impact of white dwarf luminosity profiles on oscillation frequencies

First Monte Carlo stellar evolution models exploring the impact of the experimental uncertainties in reaction rates

Modules for Experiments in Stellar Astrophysics (MESA)

JINA NuGrid chemical evolution pipeline

JINA reaclib for nuclear reaction rates

JINAbase compilation of chemical abundances of metal-poor stars

Hypatia compilation of chemical abundances of nearby stars

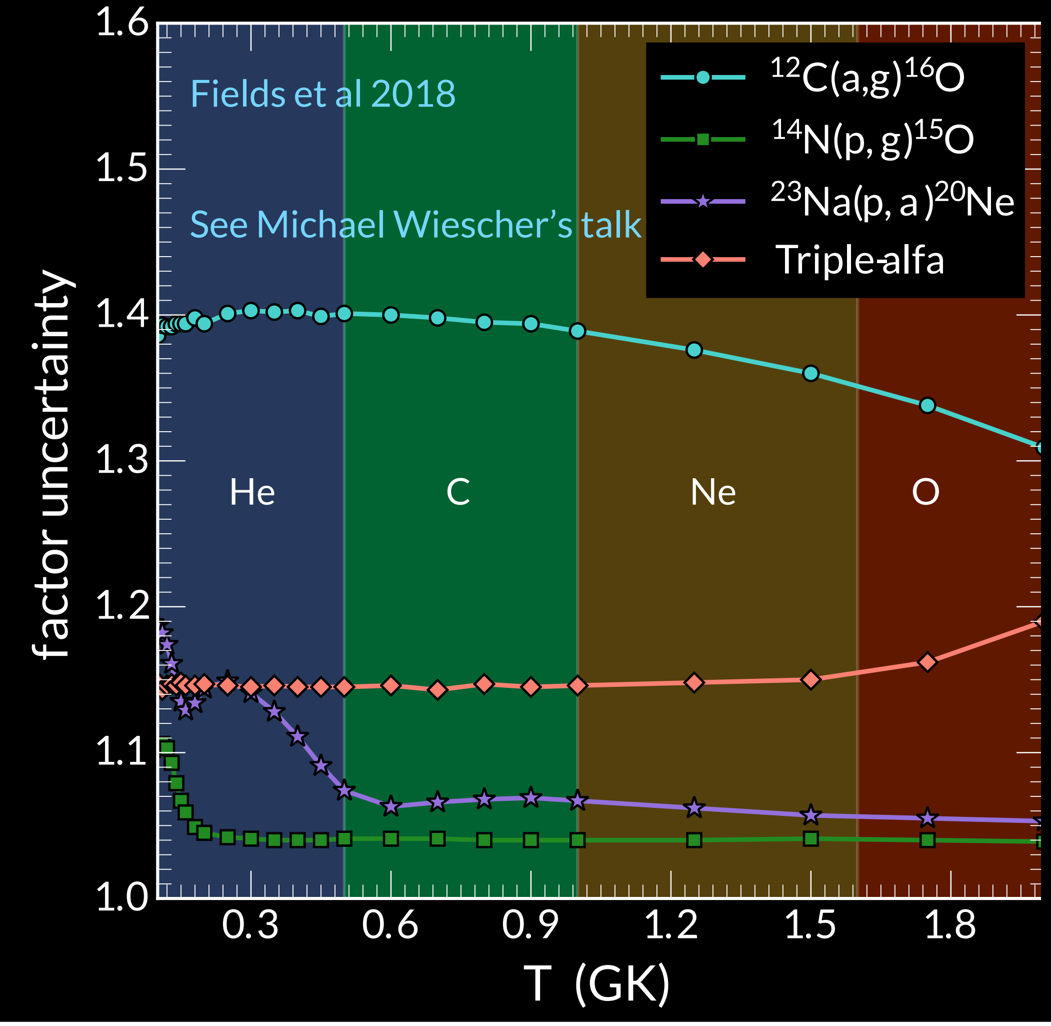
JINA-CEE Weak Interaction Library

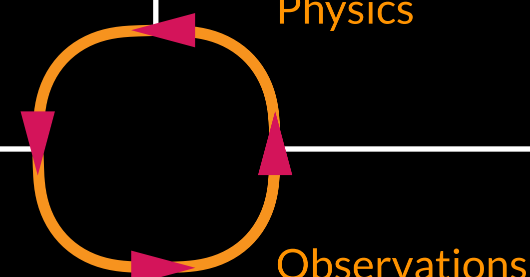
JINA AZURE R-matrix software instrument

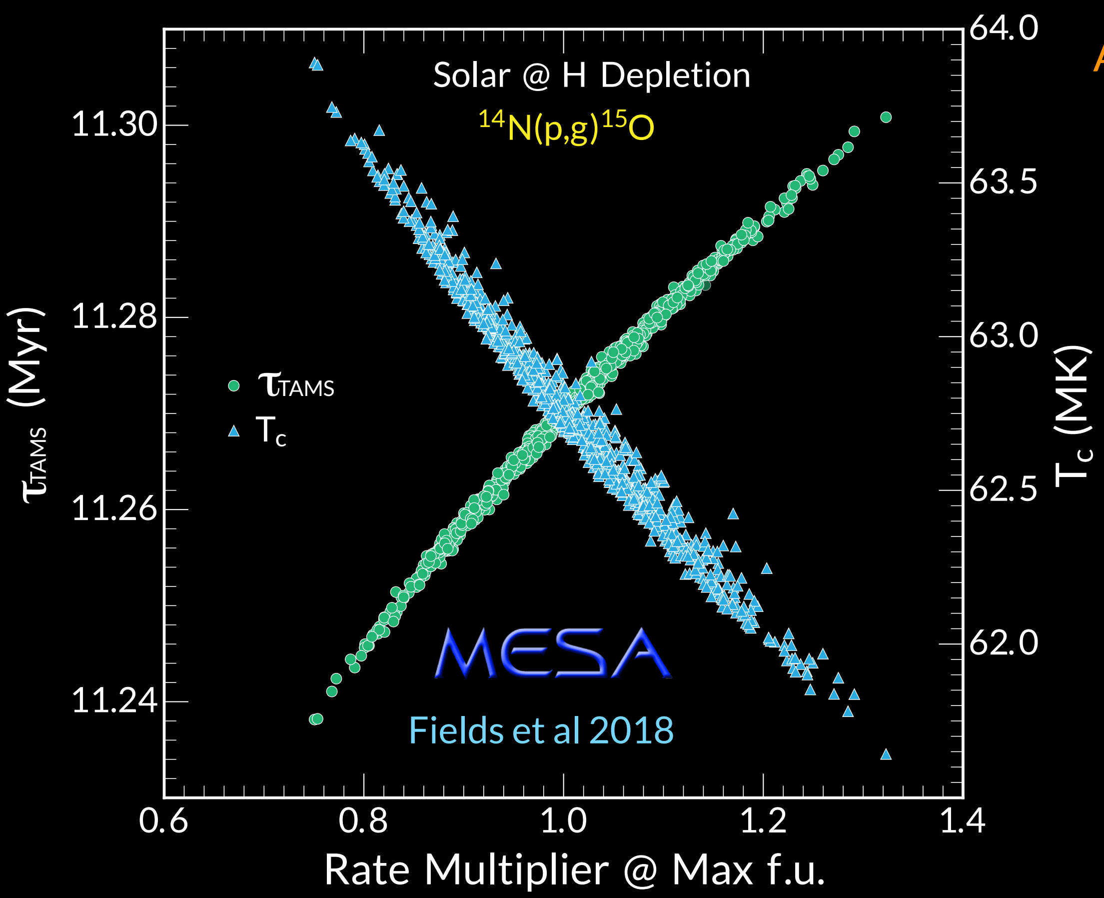
Cyberhubs: Virtual Research Environments for Astronomy

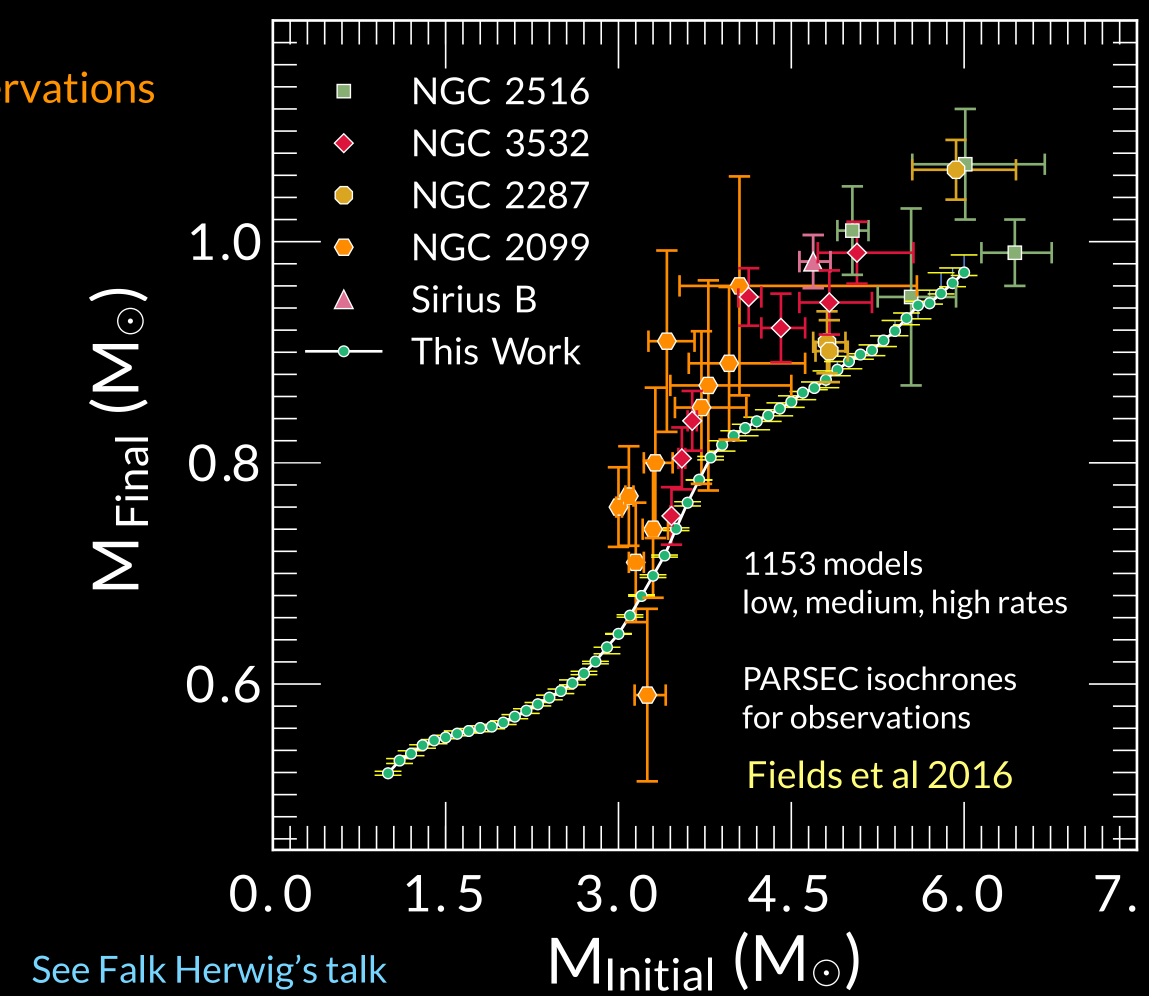
First Monte Carlo stellar evolution models exploring the impact of the experimental uncertainties in reaction rates. Originated, motivated and led by JINA-CEE.

A research outcome attributed to the existence of the Center.





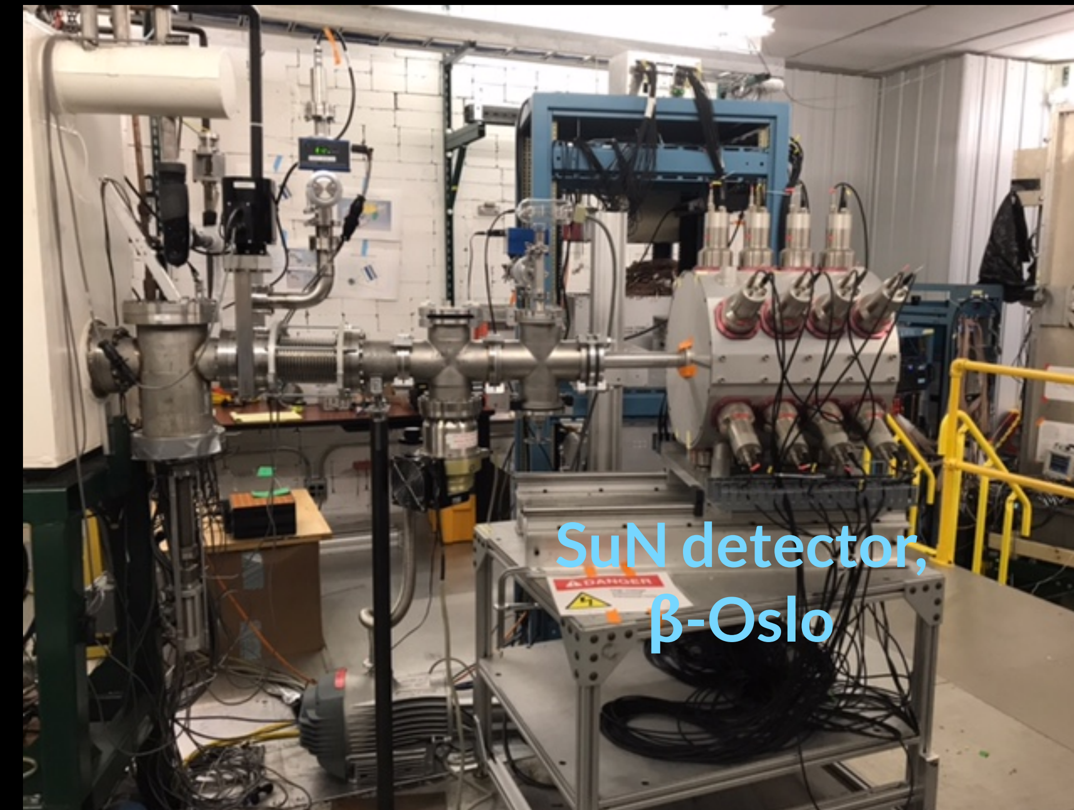




New insights in heavy element nucleosynthesis - the i-process.

An intermediate neutron-capture process that occurs in convective-reactive environments. Originated, motivated and led by JINA-CEE.

A Center enabled breakthrough at the intellectual frontier.



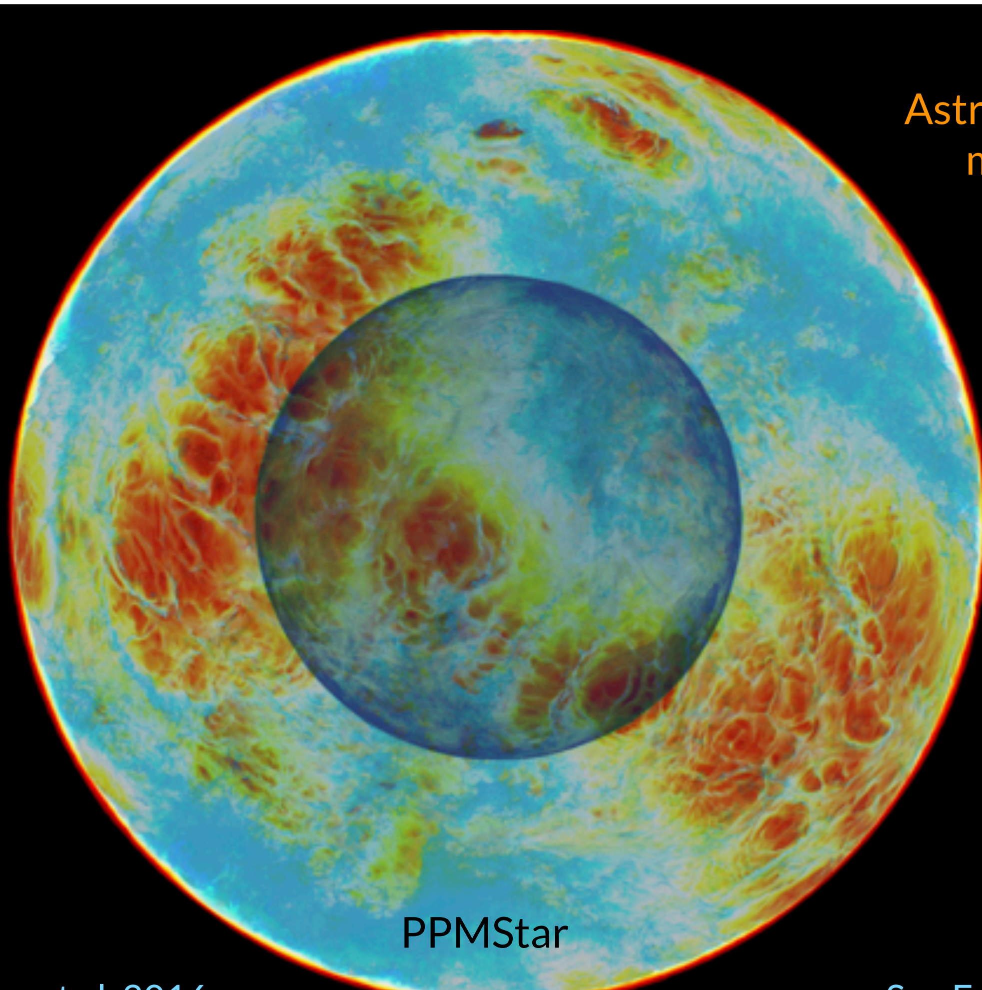
Nuclear Physics

See Artemis Spyrou's talk

Astrophysical models

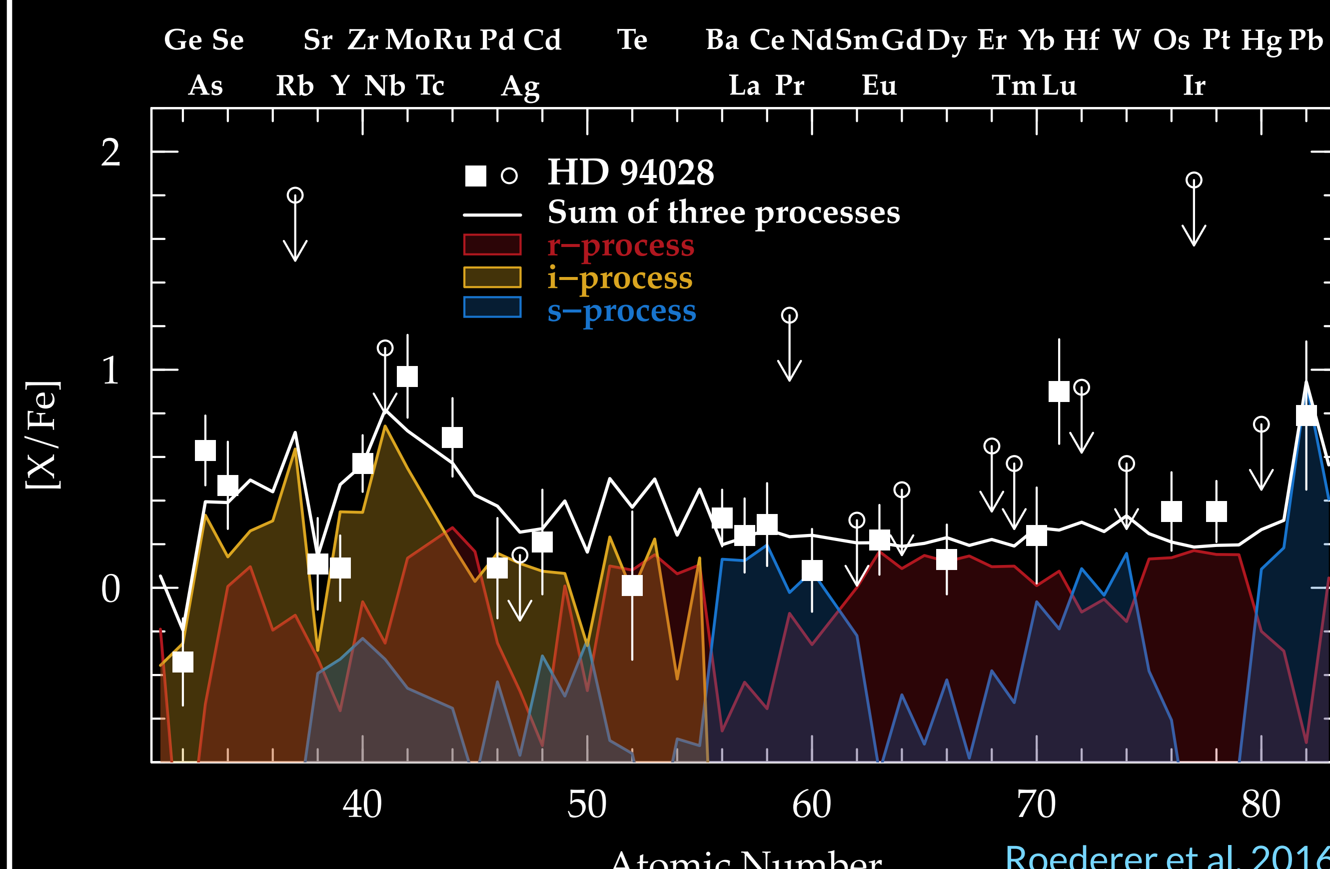
Observations

See Anna Frebel's talk



Jones et al. 2016

See Falk Herwig's talk

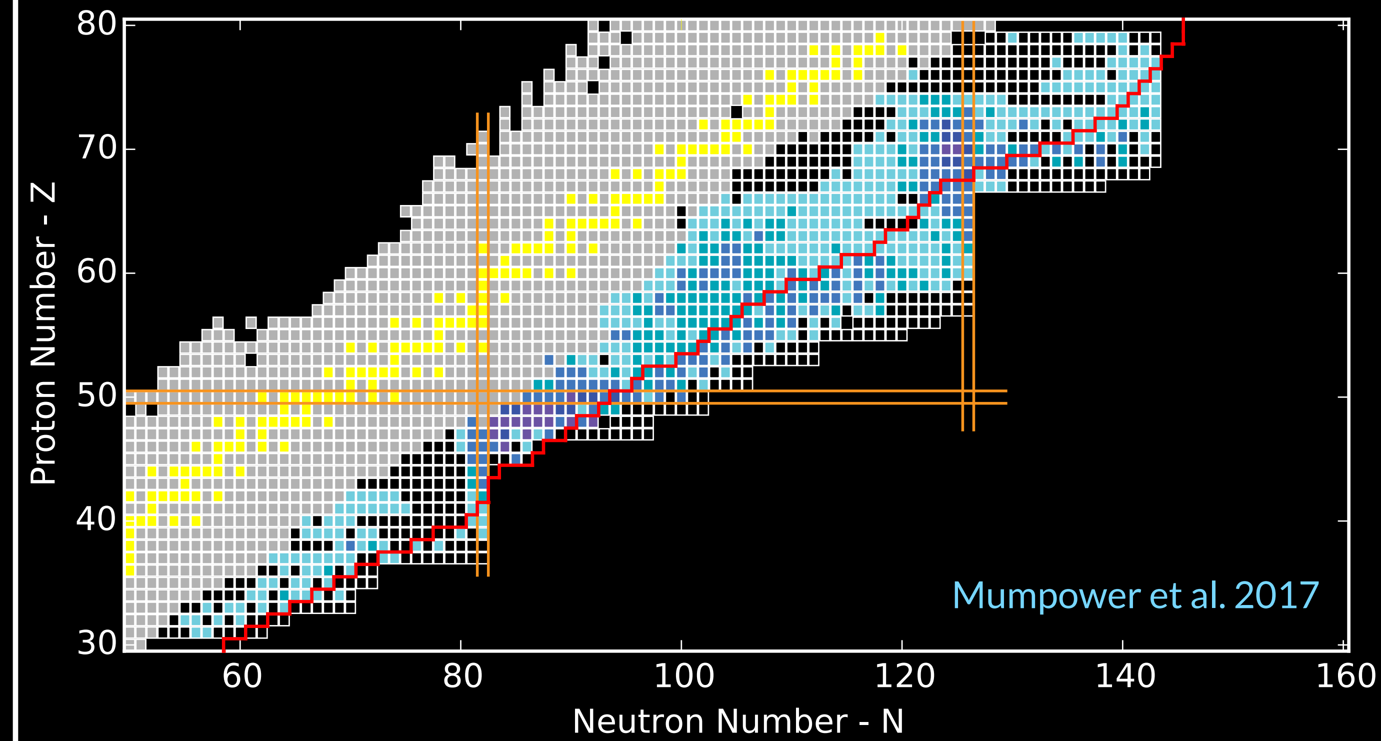


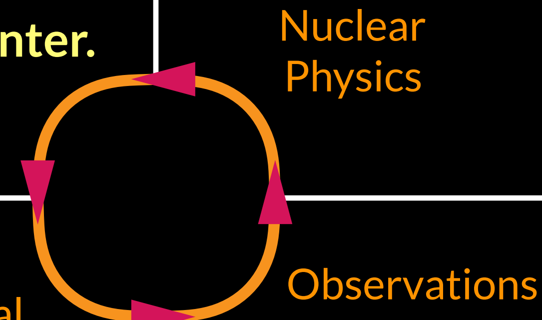
Roederer et al. 2016

New insights in heavy element nucleosynthesis - the r-process.

JINA-CEE is in a unique position to assess the nuclear physics of neutron star mergers and other sites for explaining the origin of the heavy elements.

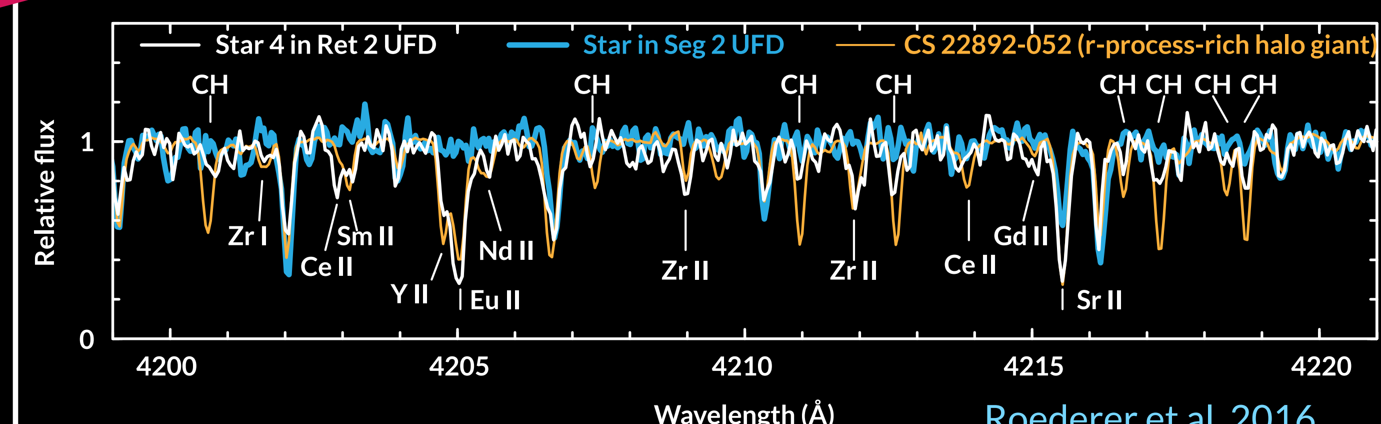
Research that could not have been done without the Center.



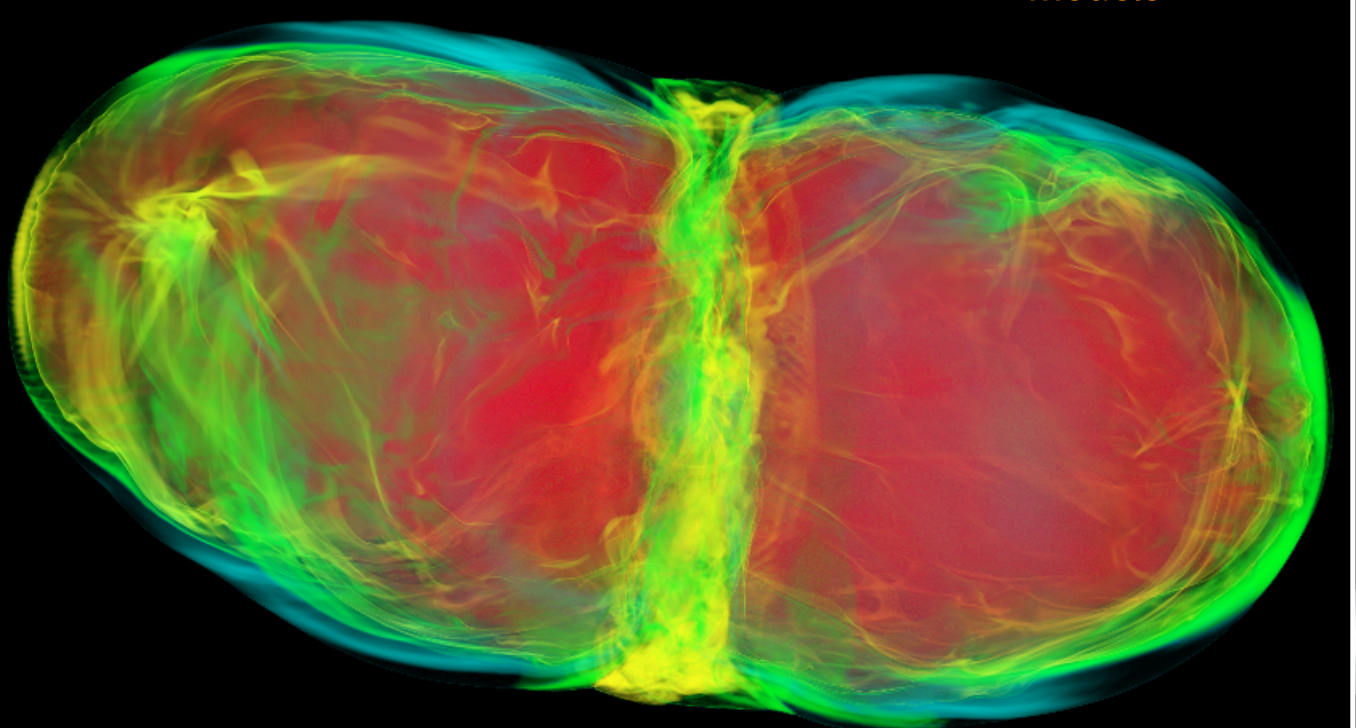


See Sanjay Reddy's talk

See Tim Beers' talk

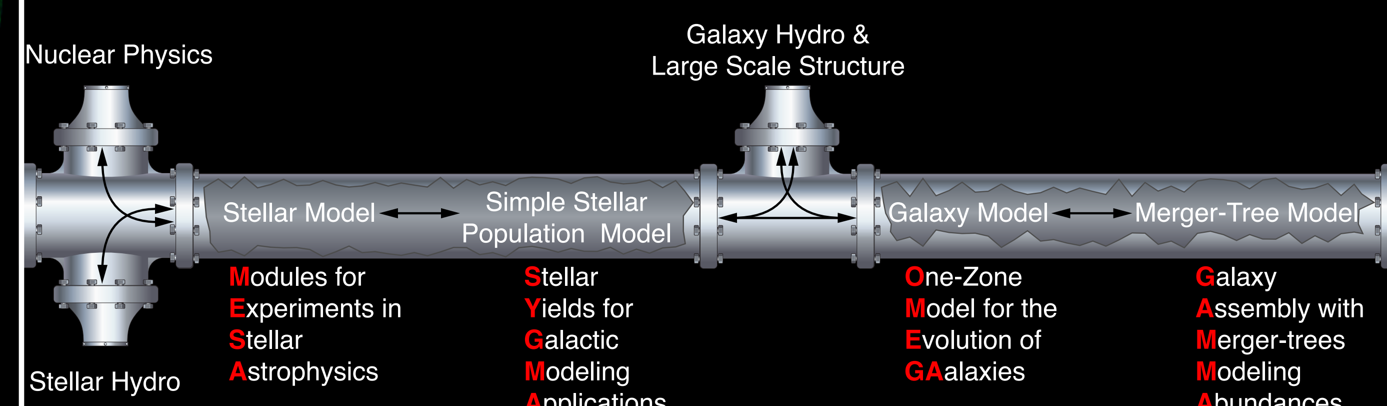


Roederer et al. 2016



Mösta, Roberts, et al. 2018

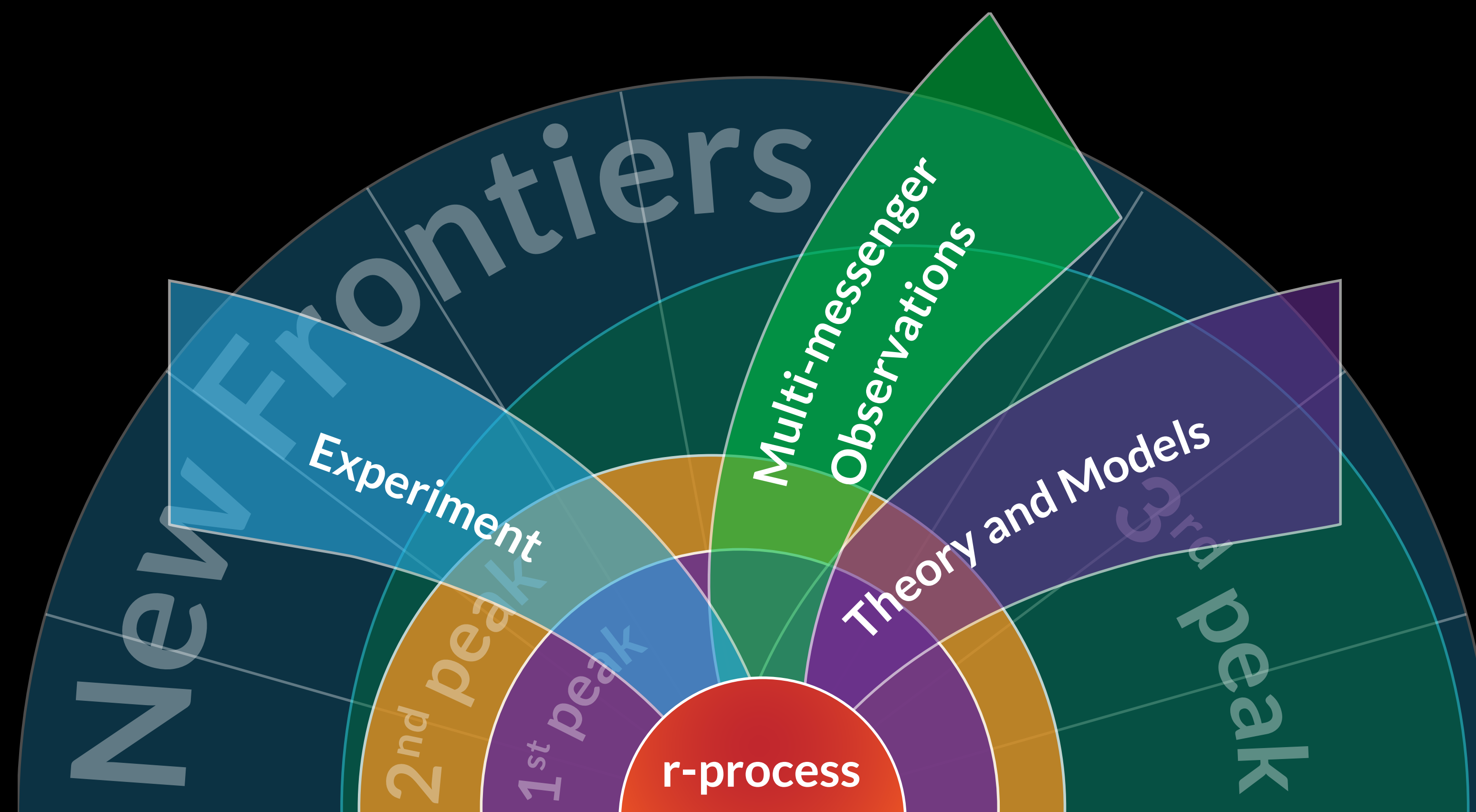
See Gail McLaughlin's talk



R-PROCESS SOURCES IN THE UNIVERSE

March 27-30, 2019, Arizona State University

Registration deadline: Jan 30th



Chairs: Timmes, Mohammad Safarzadeh , Evan Scannapieco

Topics covered:

(i) r-process production in GR simulations of the double neutron stars and CCSNe; the impact of neutrinos.

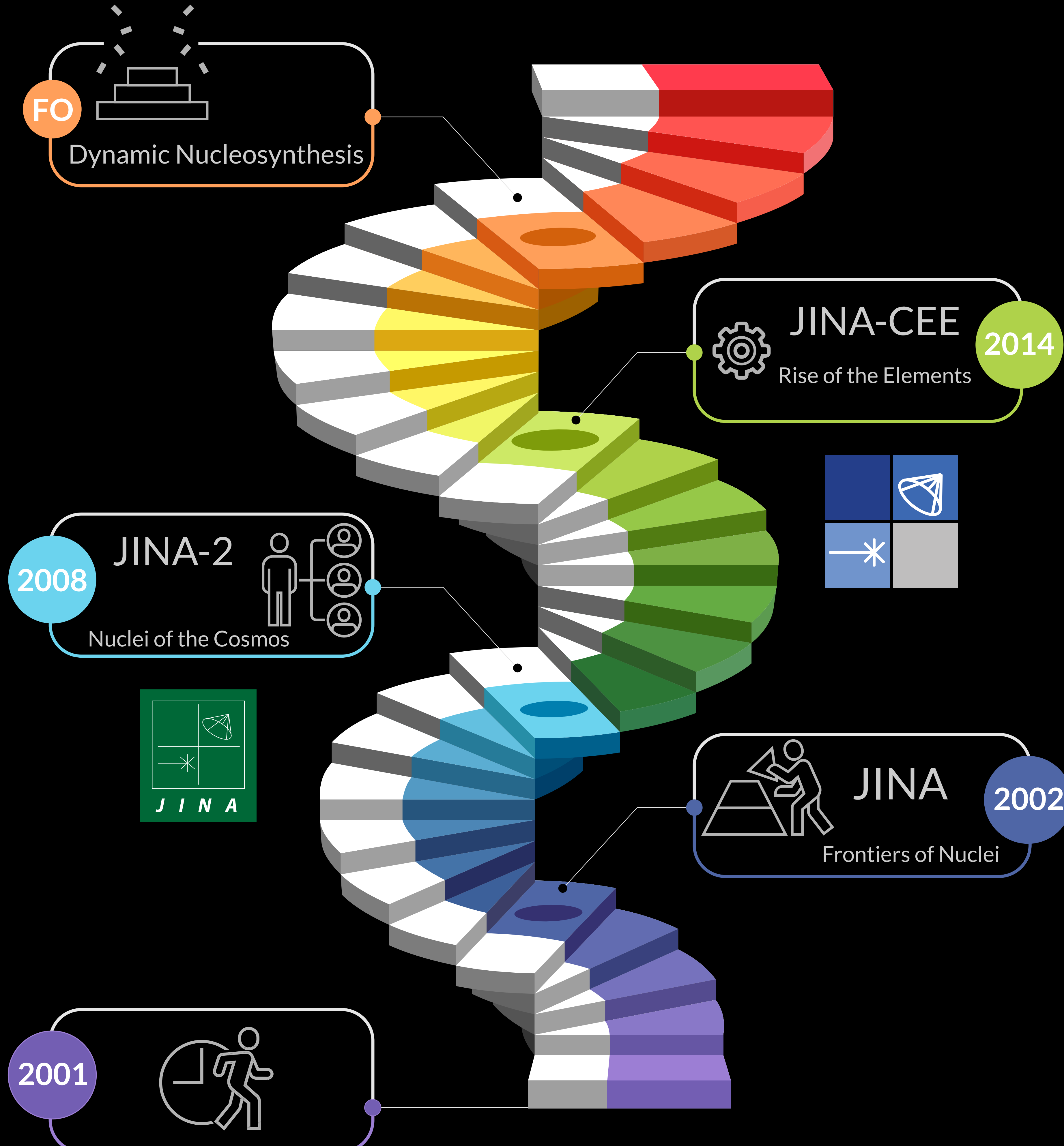
(ii) The assembly of double neutron stars and r-process enrichment of the Galaxy and its satellites.

(iii) GW170827; kilonova emission from theoretical perspective.

(iv) GW170817; Modeling and observations of the associated kilonova.

(v) r-process production from the experimental nuclear physics perspective.

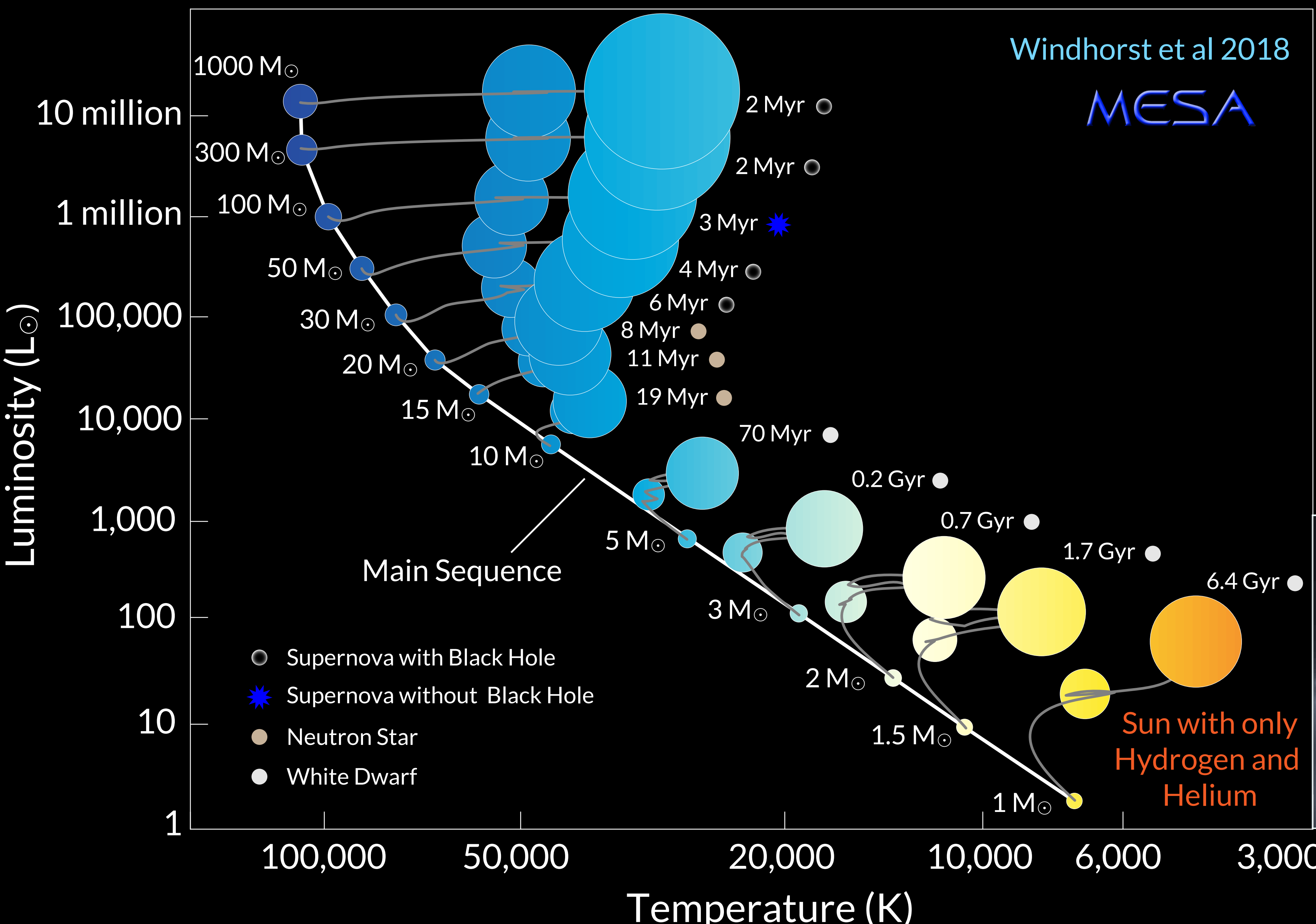
(vi) Observations of the r-process enhanced metal poor stars.


FO
Dynamic Nucleosynthesis
JINA-CEE
2014
Rise of the Elements
JINA-2
2008
Nuclei of the Cosmos
J I N A
JINA
2002
Frontiers of Nuclei
2001

Frontiers: First stars with JWST

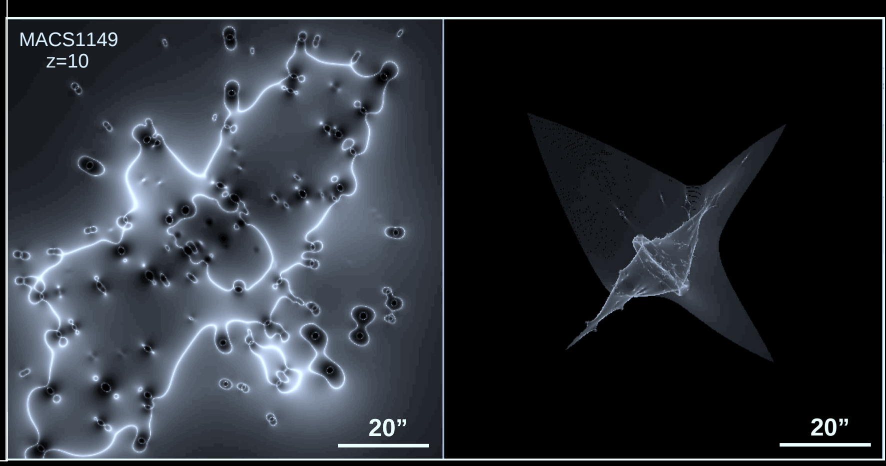
Explore the impact of $^{3}He(\alpha,\gamma)^{7}Be$, $^{7}Li(\alpha,\gamma)^{11}B$, $^{11}B(\alpha,n)^{14}C$, $^{10}B(\alpha,n)^{13}N$ and $^{10}B(p,\alpha)^{7}Be$ in zero-metal stellar models in concert with new experimental studies.

Survey the impact of close binary systems on nuclear burning and stellar evolution.



Supplemental Proposal: This activity effectively continues the Center's impacts.

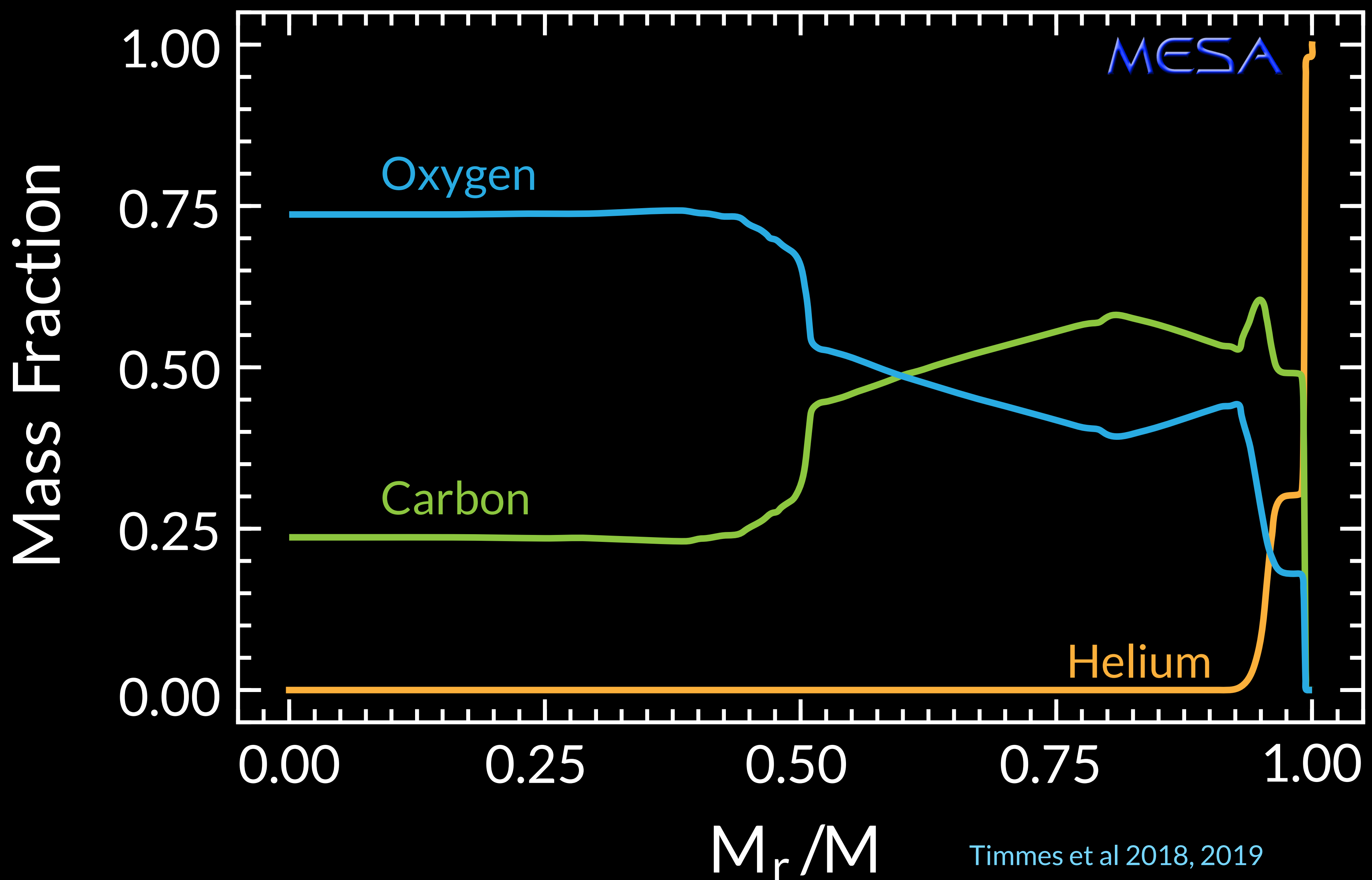
Y6



Frontiers: Nucleosynthesis and Asteroseismology

Combine new asteroseismology data (Kepler, TESS, and PLATO) with stellar evolution to constrain challenges in the origin of the elements.

For example, determine the effective $^{12}C(\alpha, \gamma)^{16}O$ reaction rate from the low-order g-mode frequencies observed in carbon-oxygen white dwarfs.



Timmes et al 2018, 2019

Supplemental Proposal: This activity extends the Center's ecosystem and impacts.

Y6 FO

Catching Element Formation In The Act

The Case for a New MeV Gamma-Ray Mission: Radionuclide Astronomy in the 2020s

A White Paper for the 2020 Decadal Survey

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Alan Calder, Stony Brook University
Regina Caputo, NASA Goddard Space Flight Center

225 co-authors;
enabled by JINA-CEE

This activity extends the Center's ecosystem and impacts.

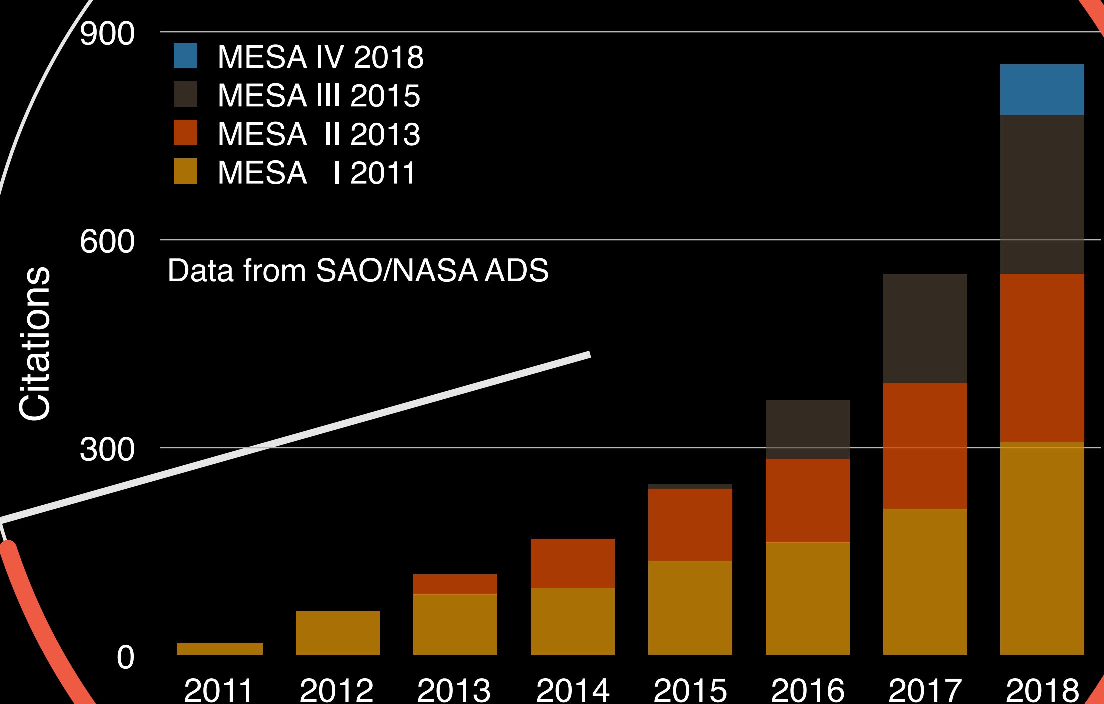
Y6 FO

A JINA-CEE leveraged activity that broadens opportunities and expands participation to the larger science community.

Y6 FO

Larger Science Community

MESA



Influence Radius ≈15

Citations: 2,456

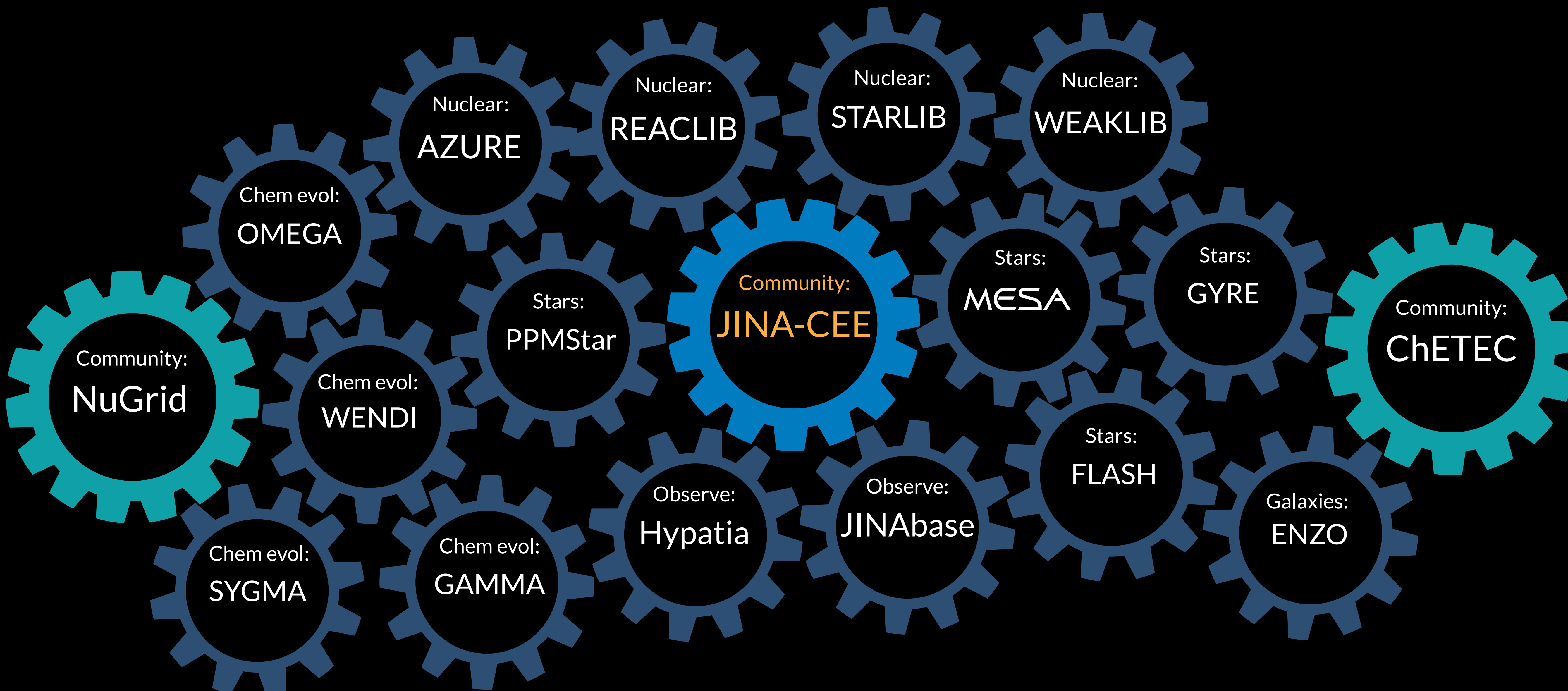
Citations to papers that cite MESA: 37,645

MESA I - Top 5 in 2011
MESA II - Top 10 in 2013

MESA III - Top 5 in 2015
MESA IV - Top 30 in 2018

JINA-CEE enables community-driven instruments and people that accelerate science and discovery.

NSCL FRIB CASPAR SECAR St. George



Gaia LIGO SDSS Hubble JWST TESS NuSTAR