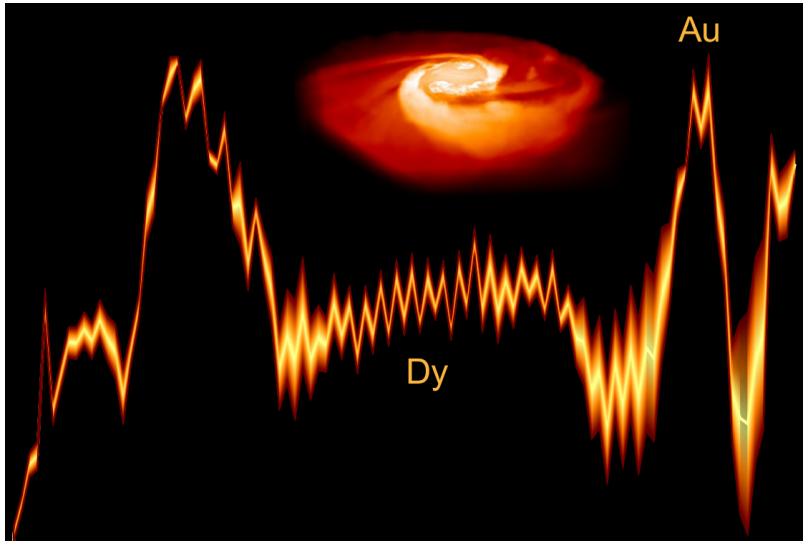
Heavy Elements From Deep Space

Objectives

- The heavy elements in our solar system (such as dysprosium and gold) are synthesized in stars through a complex chain of nuclear reactions and decays known as the rapid neutron capture process (r-process).
- The two leading astrophysical contenders for the site of the r-process are supernovae and neutron star mergers.
- We predict r-process nucleosynthesis yields using nuclear masses predicted within nuclear density functional theory.

Impact

- Enables predictive modeling that involves massive extrapolations into regions where no experimental information exists.
- Developed and utilized the database massexplorer.frib.msu.edu, which contains large-scale theoretical predictions of basic nuclear properties.
- Provides benchmark for future model developments.



Element abundance distributions predicted in this work for neutron star mergers. The systematic uncertainties are due to variations of the masses in the six nuclear interaction models employed. The mean predicted abundances are marked by the yellow solid line. Neutron star merger simulation courtesy of S. Rosswog.

Accomplishments

- We predict the yields of elements produced in the r-process for different astrophysical scenarios using different models of nuclear interactions.
- We found that features of nuclear interactions make an imprint on how the heaviest elements in the Universe are created.
- We have determined for the first time systematic uncertainties in predicted element abundances related to mass modeling for realistic astrophysical scenarios.
- We identified regions of the nuclear chart that are critical for heavy element production. FRIB will provide important checks on these predictions.

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NUCLEI Nuclear Computational Low-Energy Initiative

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