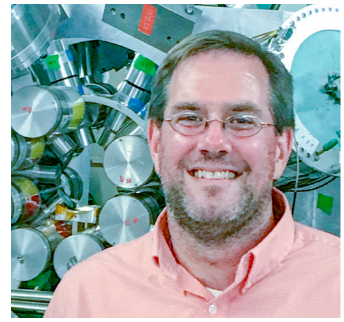

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B.S. Chemistry, 2001, Texas A&M Univ.;

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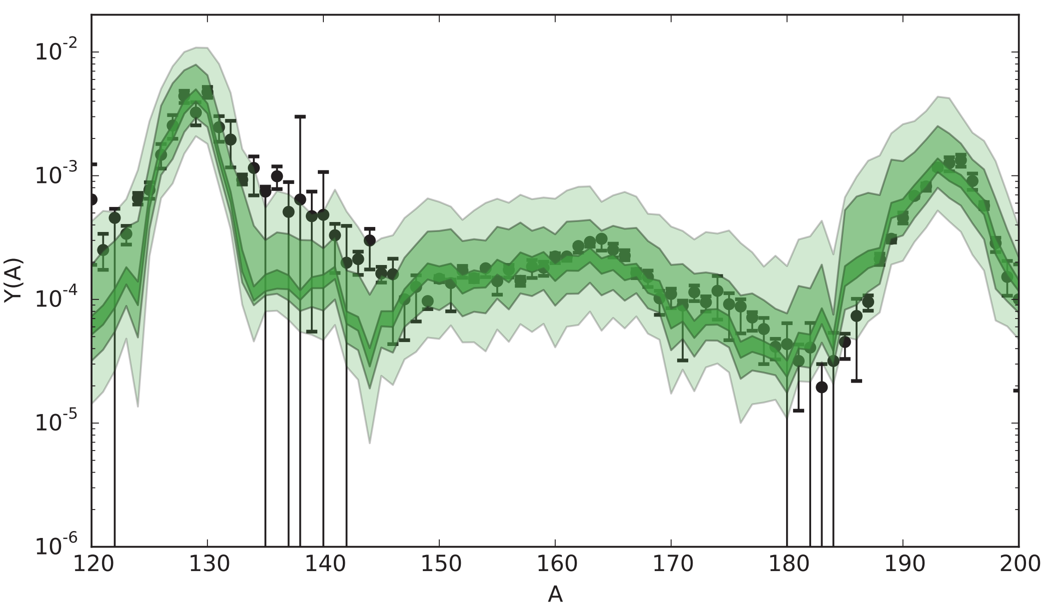
The ease of transitions between different states of the atomic nucleus carry a wealth of information and can be used in a variety of applications from describing the basic configuration of the nucleus' constituent protons and neutrons to constraining the synthesis of heavy elements in the energetic astrophysical events. Nuclear properties are expected to vary significantly as a function of proton or neutron number as departure is made from stable nuclei. My group focuses on characterizing transition rates of ground and excited states in nuclei as a function of proton and neutron number. Radioactive nuclei are produced and isolated at the National Superconducting Cyclotron Laboratory at Michigan State University. The nuclei of interest are deposited into a solid-state detector and their subsequent decay radiations are monitored. Decay spectroscopy provides a sensitive and selective means to populate and study low-energy excited states of daughter nuclei and a variety of different decay modes can be exploited depending on the nucleus of interest.

One branch of the groups recent experimental work has focused on $^{68}_{28}Ni_{40}$. It has been predicted that multiple spin-zero states exist with significantly different intrinsic deformations in ^{68}Ni. The energies, and decay transition rates of the excited states, can provide information on the coexisting structures. The first excited state spin-zero state of ^{68}Ni decays through the emission of a conversion electron (photon emission is forbidden) which is delayed with respect to the populating beta-decay electron resulting in a characteristic signal shape from the solid-state detector. The energy of the conversion electron provides the energy of the excited state in ^{68}Ni. Combined with the decay rate of the state, the strength of the transition can be determined and compared with expectations. The results confirm the theoretical picture of both single-particle and collective configurations coexisting at similar excitation energies.

The other focus of the group lies in inferring the photon strength functions (related to the photon transition rates) of highly-excited states populated in the beta-decay of a short-lived nucleus. The photon strength function combined with a knowledge of the number of nuclear states as a function of energy enables the calculation of various reactions that are expected to occur through statistical processes. One such reaction is the capture of a neutron onto the atomic nucleus increasing its mass by one unit. Neutron capture rates are a necessary ingredient to predict elemental abundances produced in energy astrophysical events, such as supernovae and neutron star mergers, which are expected to lead to the synthesis of a significant amount of the elements heavier than iron. Abundance predictions require neutron capture rate uncertainties of roughly a factor of two while current constraints can reach over two orders of magnitude. The resulting impact on abundance predictions is shown in the figure. Recent work from my group has investigated the neutron capture of $^{68,69}Ni$ and the resulting impact on elemental synthesis.



Predicted abundances as a function of mass number compared to solar r-process residuals (black dots). The shaded bands show the variances in a large number of predicted abundance patterns taken from network calculations. In each calculation a variation of all neutron capture rates is applied. The shaded bands correspond to neutron capture rate uncertainties of a factor of 100 (light), 10 (middle), and 2 (dark). All but the largest abundance pattern features are obscured by the rate uncertainties at a factor of 100. Only with uncertainties smaller than a factor of 10 can fine features be observed.

Selected Publications

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