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## Nuclei: From Structure to Exploding Stars[1]

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Our world is comprised of less than 300 different naturally occurring isotopes, but they exhibit rich structures, including tightly bound nuclei with "magic" numbers of protons or neutrons and nuclei whose energy spectra show simple collective patterns despite the many microscopic degrees of freedom. However, naturally occurring isotopes represent only the most stable combinations of protons and neutrons, and short-lived nuclei with more exotic combinations are key to developing a comprehensive model of nuclear structure and reactions. These isotopes provide new insights by amplifying aspects of the nuclear force that are less apparent in the most stable isotopes. For example, as new capabilities at existing facilities have reached deeper into the realm of unstable nuclei over the last decade, experiments have revealed that even some of the magic numbers, long a cornerstone of our understanding of nuclear structure, are modified. The study of short-lived nuclei and reactions with them are crucial to understanding the origins of the isotopes themselves in stellar explosions. While experiments have recently addressed some key uncertainties in environments like novae, the lack of data on unstable nuclei is still a major obstacle in more dramatic explosions like supernovae and X-ray bursts. Key rare isotopes also offer unique opportunities in fundamental physics and for societal applications. I will review some exciting recent highlights with rare isotope beams that are helping to develop a more comprehensive understanding of the structure of nuclei and their origins in stellar explosions. I will also describe the path towards the Facility for Rare Isotope Beams (FRIB) that will be a world-leading laboratory for the study of short-lived nuclei.

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