How can we understand the origin of elements in the Universe?

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The origin of chemical elements in the Universe is one of the fundamental questions that has been a focus in nuclear physics and astrophysics for several decades. The US Nuclear Scientific Advisory Committee recently published the Long Range Plan for US Nuclear Science, addressing two important open questions: "Where do nuclei and elements come from?" and "What combinations of neutrons and protons can form a bound atomic nucleus?" Furthermore, with the recent astonishing observation of the first neutron star merger by astronomers, understanding the nuclear spectroscopic properties of unstable isotopes has become crucial to interpreting the observables of such events, including gamma-ray, optical, and X-ray emissions. However, our understanding of short-lived nuclei involved in nucleosynthesis processes, such as the rapid proton capture process (*rp*-process) and the rapid neutron capture process (*r*-process), still lags behind the precision of the observations made.

To address these questions, new experimental studies of nuclear properties using heavy ion radioactive beam accelerators are critical. Additionally, since most of the key nuclei that allow us to explore new models of nuclear structure are far from stability, research can only be conducted with powerful rare isotope beam (RIB) facilities, including National Superconducting Cyclotron Laboratory, Oak Ridge National Laboratory, CARIBU at Argonne National Laboratory, MARS at Texas A&M University Cyclotron Institute, which provide short-lived radioactive beams. Moreover, new generation RIB accelerator facilities around the world will soon be available, such as the Radioactive Isotope Beam Factory (RIBF) in Japan, the Facility for Rare Isotope Beam (FRIB) in the US, and the Rare Isotope Accelerator complex for ON-line experiment (RAON) in South Korea.

Recent experimental studies of key nuclei performed at the existing facilities will be presented as well as new active research activities at the Center for Exotic Nuclear Studies (CENS), Institute for Basic Science (IBS). Future plans on how to leverage the new facilities, including RAON, will also be discussed.