Recent progress in nuclear astrophysics

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Nuclear astrophysics is an exciting collaborative research area where nuclear physicists, astrophysical modelers and observational astronomers work together to understand the structure and evolution of astrophysical objects. These can range from stars where the nuclear reactions occur under conditions of hydrostatic stability and often involve reactions between stable nuclei, to objects such as novae, x-ray bursters and supernovae where the reactions occur in explosive conditions and often involve unstable, short-lived nuclei. As the range of nuclei available as radioactive nuclei from new facilities increases and the quality and intensity of the beams improves, more of the key reactions which determine the development of these unique explosive objects can be studied.

The study of the key reactions involved in stars generally involves measuring very small cross sections at low energies and this brings particular challenges. Different, but equally challenging, are the measurements of explosive environment reactions with low intensity radioactive beams. Other reaction processes such as the s- and r- and p-processes require measurements of neutron capture or gamma absorption. New experimental approaches have had to be developed to meet these unique challenges. In many cases the beams required for the direct measurements are not available, or the cross sections are too low for present experimental approaches. In these situations we have to revert to calculating the reaction rates using models or knowledge of the structure of the interacting nuclei. This in turn may involve using indirect techniques to determine this information from other reaction measurements.

In this talk I will review the main nucleosynthesis processes and the astrophysical sites where they occur, as well as presenting some recent results on the key reactions involved in novae and AGB stars which we have obtained recently using the ISAC radioactive beam facility at the TRIUMF Laboratory.