The Physics Program at the ISAC Radioactive Beam Facility at TRIUMF: First results and Future Plans

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In June 1995 the Canadian Federal government funded the construction of a new radioactive beam facility at TRIUMF called ISAC (Isotope Separator and ACcelerator). The ISAC facility is designed to produce radioactive beams by the ISOL method using a very intense beam (up to 100μA) of protons at 500 MeV to bombard thick production targets. A wide range of radioactive beams at low energy ($\leq$ 60 keV) will be provided for a number of experimental programs including: 1) the test of weak interaction symmetries by trapping radioactive atoms/ions, 2) tests of CVC and the Standard Model (SM) from precise measurements of the intensities for superallowed Fermi $0^+ \rightarrow 0^+$ β-decay, 3)a systematic study of ground state moments for nuclei far from stability using low-temperature nuclear orientation methods, 4) nuclear structure/β-decay studies using an array of Compton suppressed HPGe detectors and 5) condensed matter studies of small structures and interfaces in semiconductors and superconductors by β-NMR with a polarized ^{8}Li beam .

The first low-energy radioactive beams from ISAC (i.e. ^{37}K and ^{38}K) were available in April 1999 for two experiments, namely: 1) a measurement of the β-ν correlation in the $0^+\rightarrow 0^+$ Fermi decay of ^{38m}K using TRINAT (the TRIUMF Neutral Atom Trap), where a 1% deviation of the experimental results from the SM predictions corresponds to a mass of ~250 GeV/c^2 for new scalar-exchange bosons and 2) precision β-decay lifetime measurements.. In August 1999, a Nb foil target was bombarded with a 10μA beam of protons to produce a variety of exotic Rb isotopes including ~4400 ions/s of ^{74}Rb. The half-life for this superallowed β-emitter was determined with a precision of 0.05%. Experiments to search for weak branches in the decay of ^{74}Rb to excited states in ^{74}Kr were carried out in April-May 2000.

The ISAC facility will also produce accelerated radioactive-ion beams with masses A < 30 and energies from 0.15 -1.5 MeV/u, primarily for research in nuclear astrophysics. A state of the art recoil separator (DRAGON) consisting of two magnetic dipoles, two electrostatic dipoles and 10 quadrupoles is being constructed to study radiative proton and alpha capture reactions of importance in the synthesis of elements in explosive astrophysical phenomena such as novae or X-ray bursts. Of particular interest is the radiative alpha capture on ^{15}O which is believed to be the key reaction leading to a break-out from the so-called Hot CNO cycle to the rapid proton capture (rp) process along the proton-rich side of the N=Z line of stability. A general purpose scattering facility, TUDA (TRIUMF-U. K.-Detector Array), has also been built to study reactions where charged particles are emitted in the outgoing channel (e.g. (α,p) reactions on waiting point nuclei in the rp process). This facility consists of a specialized scattering chamber and large arrays of silicon strip detectors instrumented with microelectronics. The intense beams of accelerated radioactive nuclei required for these experiments will be available from ISAC early in 2001.

During the next five-years TRIUMF will upgrade ISAC to 6.5 MeV/u for A $\leq$ 150. ISAC-II will provide the exciting opportunity to pursue new frontiers in nuclear structure physics, nuclear astrophysics and nuclear reactions. The research will address questions of key importance to our understanding of the nucleus as a many-body quantum system. For the first time it will be possible to systematically study the properties of nuclei over a wide range of N/Z (isospin). Of particular interest are the loosely bound nuclei near the limits of nuclear existence which are expected to exhibit new shell structure and new collective modes. Many physics topics will be explored using the full range of nuclear techniques developed for studies with stable beams. New instrumentation will be required to fully exploit these exotic beams.

With the construction of ISAC, Canada is positioning itself in the new millennium as a leader in the next generation of ISOL radioactive beam facilites. This talk will present an overview of the experimental program at ISAC, first physics results with low-energy radioactive beams and the future plans for ISAC-II.