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Physics with radioactive ion beams

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The models of atomic nuclei as we know them today have largely been developed based on results from experiments using stable isotopes as beams and targets, or from beta-decay experiments following fission or spallation. However, such experiments have inherent limitations. Due to the tendency of the heavier elements to have a neutron excess compared to the number of protons, an effect of Coulomb repulsion, stable beam on stable target experiments create fusion products that lie dominantly on the neutron deficient side of stability. Some other possibilities exist, e.g. via particle transfer and deep-inelastic reactions to create residues away from stability, but the neutron rich isotopes remain largely unexplored using reactions. This is an interesting situation since we also know that the neutron drip line should extend far beyond the current limits of known isotopes. There are presumably still thousands of isotopes that could be synthesized and studied in the laboratory that are yet unknown.

For practical reasons it is most reasonable to pursue reactions where radioactive isotopes are involved by creating a beam of the isotope in question. Two techniques, in-flight fragmentation and Isotope Separation OnLine (ISOL) exist today, and are pursued at laboratories in Europe, North America and Japan. I will introduce both methods with some focus on ISOL and discuss a handful of physics cases, stretching from fundamental physics to applications, that can be addressed with radioactive beams.

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