Research at NSCL

To probe the mysteries of an atom's nucleus is to seek fundamental answers about how the elements were formed and what keeps nuclei together. Nuclear scientists pursue these big mysteries by smashing and examining the tiniest of particles. Collisions at half the speed of light create new isotopes in a billionth of a trillionth of one second. To do this, researchers need particle accelerators, state-of-the-art computers, and specially designed equipment.

Creating something new

Research at NSCL concentrates on the study of exotic nuclei, one of the current frontiers in nuclear science. Compared to the more familiar stable nuclei, these exotic nuclei have large excesses of either protons or neutrons and tend to decay quickly, sometimes within fractions of a second. Experimental groups use the world-leading capabilities of cyclotrons at NSCL to produce exotic nuclei through fragmentation of accelerated stable nuclei bombarding a solid target. In less than a microsecond, the exotic fragments are transported to experimental stations where a wide range of experiments can be carried out using state-of-the art equipment.

Dissecting the nucleus

Some experiments are designed to discover a new nucleus, while others capture known nuclei to study their decay or measure their mass. Yet other experiments use the exotic nuclei to bombard another target and study the ensuing nuclear reactions. This can reveal information about the internal structure of the nucleus or the behavior of nuclear matter under the extreme temperatures and densities triggered in a nuclear collision.

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Constructing nuclear theory

Experiments have already revealed many surprising properties of exotic nuclei, such as the formation of a neutron halo around the dense central part of the nucleus. Many more remain to be discovered. NSCL theorists are working closely with experimentalists to interpret these results and to use exotic nuclei to uncover hidden aspects of the nuclear force that holds together all atomic nuclei. Understanding this force and building a theory that can predict the properties of nuclei is one of the ultimate goals in nuclear science.

Probing the stars

Exotic nuclei also play an important role in astrophysics. They are created in stellar explosions such as X-ray bursts and supernovae, and they may exist inside neutron stars. Often the decays of exotic nuclei are intermediate steps in the astrophysical processes that created the elements in nature. Many NSCL groups work at the intersection of nuclear physics and astrophysics to explain astronomical observations concerning the origin of the elements, the nature of stellar explosions, and the properties of neutron stars. This research is the result of combined NSCL experiments, nuclear theories, astrophysical models, and observations.

Learn more about these programs at www.nscl.msu.edu/science or contact visits@nscl.msu.edu

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