Made-to-order isotopes hold promise on science's frontier

Designer labels have a lot of cachet -- a principle that's equally true in fashion and physics. The future of nuclear physics is in designer isotopes -- the relatively new power scientists have to make specific rare isotopes to solve scientific problems and open doors to new technologies, according to Bradley Sherrill, a University Distinguished Professor of physics and associate director for research at the National Superconducting Cyclotron Laboratory at Michigan State University.

"We have developed a remarkable capability over the last 10 or so years that allows us to build a specific isotope to use in research," Sherrill said. "It is a new tool that promises to allow whole new directions in research to move forward. There are tremendous advances that are possible."

Sherrill outlined some of the possibilities -- and what it will take to get there -- in a perspective piece in the May 9 edition of *Science* magazine.

In that article, he writes nanotechnology is getting a lot of attention for the astonishing possibilities of constructing objects with individual atoms and molecules. Sherrill, however, said that nanotechnology hardly is the last word in small.

The chemical changes that brought about the formation of the elements in the bellies of stars are being recreated in laboratories such as MSU's NSCL. Advances in basic nuclear science already have given way to technologies such as PET scans -- medical procedures that use special isotopes to target specific types of tumors.

Isotopes are the different versions of an element. Their nuclei have different numbers of neutrons, and thus give them different properties. Rare isotopes don't always exist in nature – they must be coaxed out with high-energy collisions created by special machines, like those in MSU's Coupled Cyclotron facility. As technology advances, newer equipment is needed.

The next step for the U.S. nuclear science community will be the Facility for Rare Isotope Beams, a world-leading facility for the study of nuclear structure and nuclear astrophysics, expected to be built by the U.S. Department of Energy sometime in the next decade. Through his involvement on various national committees, Sherrill has long been a champion of a next-generation facility to ensure U.S. competitiveness in rare isotope research and nuclear science education.

Sherrill said this type of basic science -- science to examine the core nature of the elements of life -- holds its own gold mine of potential. He offers up PET scans -- short for positron emission tomography -- as an example of the payoff associated with pushing the bounds of accelerator science to study new specific isotopes. To create PET scans, scientists first had to create an isotope with a specific radioactivity that decayed quickly enough and safely enough to inject in the body.

"The rare-isotope research supported by National Science Foundation at the NSCL enables us to push forward our understanding of nuclei at the frontiers of stability, with direct connections to the processes that produce the elements in our world and that underlie the life cycle of stars," said Bradley Keister, a program officer in NSF Physics Division. "Applications to societal areas including medicine and security have traditionally gone hand in hand with these ever-advancing capabilities."

In the Science piece, Sherrill said that aggressively pursuing rare isotope research is a national imperative.

“These are isotopes that are not easy to produce. That’s the frontier we’re working on,” Sherrill writes. “A wider range of available isotopes should benefit the fields of biomedicine (by producing an expanded portfolio of radioisotopes), international security (by providing the technical underpinning to nuclear forensics specialists) and nuclear energy (by leading to better understanding of the sort of nuclear reactions that will power cleaner, next-generation reactors).”

Source: Michigan State University