Physicists Discover an Atomic Oddity

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Working with an international team of scientists, a Florida State University physics professor has taken part in an experiment that resulted in the creation of a silver atom with exotic properties never before observed. The team's observations represent another step forward in science's long journey to understand the nuclear reactions that power stars and produce all matter.

Sam Tabor, a professor of experimental nuclear physics at FSU and

director of the university's Superconducting Accelerator Laboratory, recently performed the experiment at the GSI laboratory in Darmstadt, Germany, in collaboration with the international team. In the experiment, a cigar-shaped atom was created using a particle collider. To the scientists' surprise, this atom demonstrated a novel kind of radioactive decay by spitting out two free protons at the same time.

Radioactive decay normally involves the emission of one of three types of particle: a helium nucleus consisting of two protons and two neutrons, an electron or a photon. Exotic atoms engineered to contain fewer neutrons than in the atom's natural state were expected to break down by emitting protons one at a time. But the correlated two-proton decay hadn't been seen before and represents a new form of radioactivity.

The team's findings were published in the Jan. 19 issue of *Nature*, the world's foremost scientific weekly journal.

"The purpose of this line of research is to expand our knowledge of nuclear physics beyond those nuclei present in nature by exploring nuclei with either fewer or more neutrons," Tabor said. "This will help us to understand even the stable nuclei. Another motivation is the fact that such unstable nuclei play important roles in astrophysics and the production of the elements on Earth. We cannot fully understand the astrophysical processes by which even the atoms in our body were produced until we understand the structure of neutron-rich and neutron-poor nuclei."

At the GSI lab, Tabor and his colleagues bombarded a thin film of nickel foil with a beam of calcium atoms, causing some nickel and calcium ions to coalesce to form silver atoms with fewer neutrons than normal. Most of these silver atoms decayed conventionally, but a few ejected two protons at once.

The deficit of neutrons in the silver had deformed the nuclei from spheres into fat cigar shapes. In some cases the proton pairs jumped out from the same end of the cigar, at other times from opposite ends, but they were always perfectly synchronized, Tabor said.

"It's like there's a captain on board telling them exactly when to dive," he added.

In addition to Tabor, other members of the team were from Germany, Belgium, Russia, Bulgaria, Poland, Italy and Spain.

The collaborators now are discussing future directions for their research. "However," Tabor said, "we are also performing related research at the Superconducting Accelerator Laboratory right here at FSU. Experiments currently under way here are exploring nuclei with neutron excesses, and we have built a facility to directly study reactions and nuclei of importance to astrophysics," Tabor said.

Not all of Tabor's work is on such an elevated plane. At FSU he also serves as coordinator of "The Flying Circus of Physics," an open house and science fair hosted every other year by the physics department to showcase some of the department's cutting-edge research facilities.

"'The Flying Circus of Physics' is a way to help generate interest in the sciences, particularly among youngsters, by showing folks that physics is fun," Tabor said.

The next "Flying Circus of Physics" is tentatively scheduled for the spring of 2007.
For more about FSU's department of physics, please see www.physics.fsu.edu

Source: Florida State University