NUCLEAR PHYSICS

Element 110 Is Created, But Who Spotted It First?

The physics of super-heavy elements is one of those areas of science that push the idea of "finders, keepers" to the limit—and beyond. A high-level international committee has spent the past several years adjudicating disputes over who discovered the elements with atomic numbers from 101 to 106 that were discovered in the 1950s, '60s, and '70s. Now it may have a new case on its hands.

Last month a team of German researchers at the GSI heavy-ion research lab in Darmstadt announced that element 110 had been created for the first time. And while nobody disputes that the German team has achieved a technical tour de force in creating the element, the claim of first discovery may turn out to be far from clear-cut. A joint U.S.–Russian team working at the Joint Institute for Nuclear Research (JINR) at Dubna in Russia began an experiment to create 110 some 2 months before the German group, but they have only just begun to analyze their data. "We could have something ourselves," says team member Ron Lougheed of Lawrence Livermore National Laboratory in California.

And there may be a third "finder" in this search for a keeper. Earlier this year, a team at the Lawrence Berkeley Laboratory (LBL) in California reanalyzed data from an experiment they conducted in 1991 and found one possible candidate atom of element 110. Although the LBL data are far from conclusive and researchers in the field are divided over whether it can be considered a true sighting, it could make the three-cornered debate over the discovery of element 110 a lively one. "I have a gut feeling that it's right," says LBL team leader Albert Ghiorso. As Lougheed puts it delicately, the situation is "potentially muddled."

The GSI team began its experiment on 7 November using the UNILAC linear accelerator, which had just been overhauled and equipped with new detectors to provide a 10-fold increase in sensitivity. Just 2 days later, the refurbished machine produced a result: An atom landed in the detector and less than half a millisecond later decayed, emitting an alpha particle (a helium nucleus, made up of two protons and two neutrons), and hence transformed into element 108. This daughter nucleus soon followed suit, emitting an alpha, as did the two subsequent daughter nuclei. Such a decay chain of four alphas is an unambiguous sign of element 110, because after the first alpha decay, whose energy was predicted by theory, the chain follows the known pattern of element 108. The team detected three more candidate atoms in the days that followed and, as *Science* went to press, was already making atoms of a heavier isotope of 110—with two more neutrons. Says Ghiorso: "It is a beautiful experiment."

Ghiorso's team took a similar tack 3 years ago when it tried to create a different isotope of element 110 by bombarding a bismuth target with cobalt ions. Both experiments attempted to achieve a "cold fusion," which occurs when the projectile ion is given just enough energy to overcome the electrostatic repulsion of the target nucleus, producing a fused super-heavy nucleus with little residual energy. Predictions for the optimum energy to cold fuse element 110 were derived from experiments on lighter nuclei. After a first look at the data, Ghiorso's team thought they had found nothing. But when they reanalyzed the results this year, they spotted a possible candidate for element 110, although it appeared to have been created at an energy lower than the predicted optimum.

To add further uncertainty to their claim to be chief finder, their evidence is marred by a gap in the data. Because of an electronics failure, one part of the decay chain was not recorded, and when the researchers picked up the chain again, they found that it appeared not to have followed the expected straight sequence of alpha decays. Ghiorso believes that one of the nuclei in the chain, element 106, rather than undergoing alpha decay, captured an electron to convert one of its protons into a neutron, becoming element 105. "It's the only explanation we could think of," says Ghiorso.

But that explanation isn't persuading everyone in the field. Ghiorso presented the new analysis of the LBL experiment at a conference in Sicily in May, and many of his colleagues were skeptical: "Most of the community discounted this result," says theorist Rayford Nix of the Los Alamos National Laboratory in New Mexico. That put the LBL researchers in a fix, because in 1992 the laboratory's SuperHILAC accelerator was shut down, and they currently have no way of confirming their own results. "We're in a funny position," says Ghiorso.

Then came the GSI results. Before the German researchers began the search for element 110, they made more atoms of elements 104 and 108 to nail down the properties of those nuclei and get a better estimate of the optimum energy for cold fusing element 110. They found that the optimum energy to fuse 108 "was below the energy in our previous experiments," says Sigurd Hofmann, the detector team leader at GSI—indicating that the energy for 110 would also be lower.

Not only did this new low estimate prove to be just right—the team found an atom of 110 in 2 days when they had expected to take 2 weeks—but it was close to the energy used by the LBL team. "[Their results] are very consistent with ours, but that doesn't prove it," says Ghiorso, a 79-year-old veteran of the field who has been involved in the discovery of 13 elements. "I'm waiting for the judgment of history, and history won't take too long."

For the moment, researchers are waiting anxiously to see what the wild card of the pack—the Russian team—will produce. The JINR experiment is different from the other two: It is a "hot fusion" experiment, which bombards plutonium nuclei with sulfur ions with more than enough energy to fuse—so much so that each new fused nucleus must "cool off" by evaporating off five neutrons. If the JINR team succeeds, the nuclei of their isotope of element 110 will have 163 neutrons, compared to the 159 and 161 claimed by GSI. Says Ghiorso: "I hope they succeed. It would tickle my fancy if three isotopes [of element 110] were found this year."

–Daniel Clery

ELEMENTS AND THEIR FINDERS

Element	Discoverer(s)	Date
99	LBL	1952
100	LBL	1953
101	LBL	1955
102	LBL/JINR	1958/9
103	LBL/JINR	1961
104	LBL/JINR	1969
105	LBL/JINR	1970
106	LBL	1974
107	GSI	1981
108	GSI	1984
109	GSI	1982
110	GSI?	1994

LBL:
Lawrence Berkeley Laboratory, California
JINR:
Joint Institute for Nuclear Research, Dubna, Russia
GSI:
Heavy Ion Research Laboratory, Darmstadt, Germany