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NUCLEAR PHYSICS

Discovery of 'Missing' Element 117 Hints at Stable Isotopes to Come

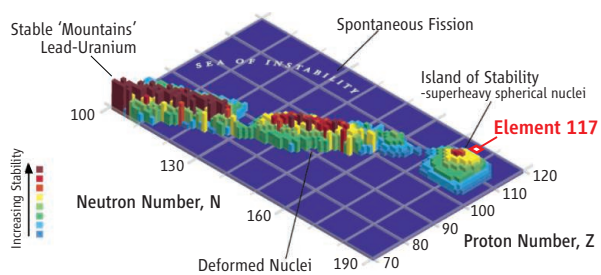
Russia strikes again. In the past decade, the Joint Institute for Nuclear Research in Dubna, Russia, has bagged new elements 113, 114, 115, 116, and 118 by firing up a fantastically intense beam of neutron-heavy calcium-48 isotopes and blasting away at the periodic table's radioactive actinide elements. Last week in *Physical Review Letters*, a multi-institution team there announced that it had filled a gap by making element 117 as well.

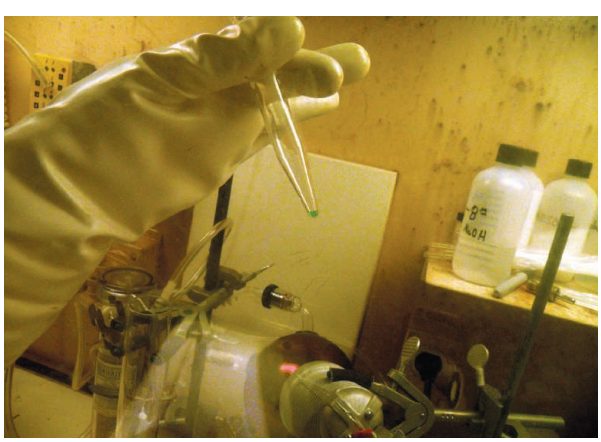
"They devoted very, very long beam times and very hard work," says nuclear chemist Heino Nitsche, who leads the heavy-element group at Lawrence Berkeley National Laboratory in Berkeley, California. At other labs, Nitsche says, heavy-element scientists vie with other experimenters for beam time, but Dubna physicists enjoy a cyclotron largely dedicated to element-hunting. "You won't find that anywhere else in the world," he says.

For decades, the new-element sweepstakes has been a three-way race. Beginning in 1940, the Berkeley lab dominated the field, claiming or sharing credit for all elements except for one from 93 through 106. In 1981, the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, Germany, pulled ahead, planting flags on elements 107 through 112, the recently named copernicum.

Even with stretches of beam time available at Dubna, going after 117 required "experimentally, an enormous tour de force," says nuclear physicist Konrad Gelbke, director of the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University in East Lansing. To get to 117 protons from calcium's 20, Dubna physicists needed the 97 protons in the devilishly-hard-to-synthesize element berkelium. Nuclear chemists at the world's most intense neutron source, the High Flux Isotope Reactor at Oak Ridge National Laboratory in Tennessee, spent 250 days scraping together 22.2 milligrams of the stuff—about the size of a fingernail paring—and another 90 days purifying it to one part in 10 million. Then the clock began to tick: Berkelium's half-life is 320 days.

The hot material's next stop was Russia's Research Institute of Atomic Reactors in Dimitrovgrad, where scientists deposited it on a thin film of titanium. Then it went on to Dubna, where physicists pummeled the target with 7 trillion calcium-48 ions per second, day and night for 5 months. A gas-filled separation chamber diverted atoms blasted off the target into an array of detectors. From thousands of potentially interesting events, the physicists pinned down just six atoms of element 117.





Gotcha. Physicists nabbed element 117 by firing calcium-48 ions at berkelium (*bottom*). The results bolster predictions of an "island of stability" (*top*), a group of long-lived superheavy isotopes.

To do so, they looked at the chains of other elements produced as the radioactive atoms decayed toward stability. An isotope of 117 with 177 neutrons, for example, spits out alpha particles to metamorphose first into daughter nucleus 115 and later into dubnium (105) before fissioning. The elements in this chain—115, 113, 111, and so on—had all been made before. But the new versions had more neutrons than earlier ones did and were strikingly longer-lived—6000 times as long, in the case of one isotope of element 111.

Those results fit with theorists' current picture of heavy-element nuclei, says Witold Nazarewicz, a theoretical physicist at Oak Ridge and the University of Tennessee, Knoxville. The theory predicts that certain so-called magic numbers of protons and neutrons confer extra stability to a nucleus. A magic number at 184 neutrons, for example, ought to anchor an "island of stability," a still-to-be-discovered group of long-lived superheavy isotopes that hold together for days, years, or even millennia. (In contrast, superheavy elements made so far have half-lives of fractions of a second.) The new Dubna results showing that added neutrons increase the stability of heavy elements "suggest that the theory knows what it's doing," Nazarewicz says. "It's encouraging."

Physicists at all three facilities agree that the way to reach the island of stability is by producing heavier isotopes of known elements. That will require superb beams of radioactive elements unlike any now achievable, says Sigurd Hofmann, the head of heavy-element research at Darmstadt. Such beams may become available at labs like NSCL's planned Facility for Rare Isotope Beams, currently in the conceptual design phase, but they are still decades away, Hofmann says.

Meanwhile, Nazarewicz says, efforts to create new elements will help theorists test their models of nuclear structure. But Dubna's spurt of contributions may just have come to an end: Researchers say the lab has run out of useful actinide targets for its calcium beam. To get element 119 would require working with einsteinium, "a very complex task" that Dubna likely won't attempt, says Dubna's director, nuclear physicist Yuri Oganessian. Element 120 is definitely out of range, he says.

That opens the door to other approaches. The Darmstadt group plans to confirm 116

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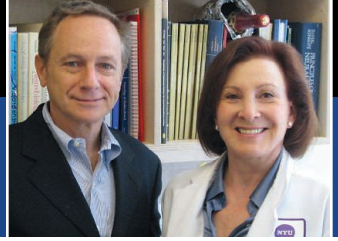

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this summer by training a calcium beam on a radioactive curium target, says Hofmann; the technique could lay the groundwork for creating 120 from curium with a chromium beam. The Berkeley team, which was devastated in 2002 when it had to withdraw its claim on element 118 after critical data turned out to have been fabricated (*Science*, 19 July 2002, p. 313), is back in the game, recently confirming Dubna's element 114 with a calcium beam and plutonium target. And a newcomer—the superheavy element lab at the Institute of Physical and Chemical Research (RIKEN) in Japan—has been instrumental in confirming some of Darmstadt's finds.

Confirmation is key to the discovery process: Under international rules, a lab may not name a new element until a competitor repeats the finding. That could take years for element 117, says Dubna team member Dawn Shaughnessy, a nuclear chemist at Lawrence Livermore National Lab in Livermore, California. "It's hard for someone to go to their management and say, 'I want to do this long experiment just to verify this person's discovery,' " she says. Still, confirmation will come. "There may be rivalry, … but we all have to work together if anyone wants credit."

–LAUREN SCHENKMAN

U.S. SCIENCE POLICY

Obama Picks Pragmatists for New Bioethics Panel

President Barack Obama named the members of his bioethics commission—headed by two university presidents—last week. The 12-member group, selected more for practical advice than for philosophizing, as the last one was prone to, will hold its first meeting in Washington, D.C., in July.

Headed by Amy Gutmann, president of the University of Pennsylvania (Penn), the new Presidential Commission for the Study of Bioethical Issues succeeds the old President's Council on Bioethics, disbanded last June. Gutmann and her vice chair, Emory University President James Wagner, were named in November. Although the label is longer, the group itself is leaner, with a dozen members instead of the 18 under President George W. Bush.

"Previous commissions have been somewhat too philosophically oriented," presidential science adviser John Holdren said last week. Bush's council, headed successively by bioethicists Leon Kass of the University of Chicago and Edmund Pellegrino of Georgetown University, produced lengthy reports on topics such as "Being Human." The new commission, in contrast, is expected to offer concrete policy and legislative advice. Says White House aide Rick Weiss: "The hope is this will be perhaps a little more nimble." He also says the commission is probably "unique historically" for including several federal employees. Because the president wants practical advice, he wanted people "close to the ground" who understand the government's labyrinthine ways, Weiss says.

Gutmann, 60, is a prolific scholar and has an impressive reputation as a philosopher and political scientist. Prior to going to Penn in July 2004, she served as dean and then provost at Princeton University. She'll preside over an eclectic group of physicians (including a Franciscan friar), scientists, philosophers, and lawyers, as well as a patient advocate—the wife of boxing great and Parkinson's victim Muhammad Ali.

BIOETHICS COMMISSION MEMBERS

Amy Gutmann	President	University of Pennsylvania
James Wagner	President	Emory University
Lonnie Ali		Muhammad Ali Enterprises
Anita Allen	Lawyer/bioethicist	University of Pennsylvania
Barbara Atkinson	Vice chancellor	University of Kansas Medical Center
Nita Farahany	Lawyer	Vanderbilt University
Alexander Garza	Chief medical officer	Department of Homeland Security
Christine Grady	Nurse/bioethicist	National Institutes of Health
Stephen Hauser	Neurologist	University of California, San Francisco
Raju Kucherlapati	Geneticist	Harvard Medical School
Nelson Michael	Retrovirologist	Walter Reed Army Institute of Research
Daniel Sulmasy	Bioethicist	University of Chicago

Practical advice. Gutmann and Wagner will chair a streamlined presidential commission.

Gutmann is one of four commission members who are also fellows at the Hastings Center in Garrison, New York. She's "a fascinating choice as chair," says Hastings President Thomas Murray, who calls her "brilliant, … delightful, … a great leader." Her vice chair, Wagner, is an engineer and former medical devices researcher who has "championed the role of ethics" in Emory's mission, according to a White House statement.

"To me, it's a very highly qualified, middle-of-the-road panel," says Penn bioethicist Arthur Caplan. Although some criticized the Bush bioethics council for being stacked with conservatives, conservatives don't seem inclined to attack the Obama selections. "I don't like the politics of most of them, but the records of achievement are great," Bush council member Robert George, a Catholic legal scholar at Princeton, told the Christian news magazine *World*.

It's not known what the commission will tackle first, but as Caplan points out, the newly passed health care legislation offers much food for discussion on matters relating to privacy, limits of coverage, and "the much-despised word 'rationing.' " And that raises a crucial issue in the opinion of bioethicist Norman Fost of the University of Wisconsin, Madison. Fost observes that for all their expertise on cloning, bioterror, underserved groups, or the rights of research subjects, none of the commission members is deeply conversant with the economic issues surrounding health care financing, cost control, or rationing of care. Yet, he says, "the overwhelmingly most serious issue in health … is costs."

–CONSTANCE HOLDEN

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