Albert Ghiorso 1915-2010

Albert Ghiorso, the celebrated nuclear scientist who co-discovered more elements than anyone in history and a prolific inventor of nuclear techniques and machines, passed away from natural causes on 26 December 2010 in Berkeley, California.

Ghiorso was born in Vallejo, California, on 15 July 1915. He became fascinated with airplanes and aeronautics when he moved with his family to Alameda, near the Oakland airport. That exposure triggered his lifelong interest in machines, technology, and electronics. After high school he began experimenting with radio, and soon his projects were exceeding even military capabilities. On a scholarship, he attended the University of California, Berkeley, and in 1937 he received a BS in electrical engineering. His first job, with a firm developing Geiger counters, brought him in contact with the nuclear chemistry group at Berkeley. That led to an invitation from Glenn Seaborg to join him at the University of Chicago's Metallurgical Laboratory, which was responsible for elaborating the chemistry of plutonium as part of the Manhattan Project. Thus began their lifetime collaboration, which eventually resulted in the addition of 12 new elements to the periodic table and numerous innovations in nuclear chemistry, radiation detection, and accelerator science.

Ghiorso's first work in Chicago involved measuring the energies of alpha particles from isotopes produced by irradiation of uranium, neptunium, and plutonium. Ghiorso and colleagues built an electromechanical 48-channel pulse-height analyzer, which they used to spectroscopically resolve the characteristic nuclear radiation, thus providing the first nonchemical means of isotope identification. In 1944–45 the Seaborg group used the reactor at the Clinton Laboratories (later Oak Ridge National Laboratory) and cyclotrons at Washington University in Saint Louis and at Berkeley to irradiate plutonium-239 with neutrons and deuterons. Ghiorso's measurements showed the presence of two new elements, subsequently identified as atomic numbers 95 (americium) and 96 (curium).

In 1946 Ghiorso and Seaborg returned to Berkeley, where they used the 60-inch cyclotron to bombard minute quantities of americium and curium with alpha particles. In concentrating on the chemicals he expected to find based on Seaborg's proposed revision of the periodic table of elements, which introduced an actinide series mirroring the rare-earth lanthanides, Ghiorso showed that the radioactivity was due to two more new elements, 97 (berkelium) and 98 (californium).

In 1952, following the first thermonuclear explosion, the Seaborg–Ghiorso group received samples of radioactive dust collected by an airplane. The group unambiguously identified the characteristic alpha-particle energies in the samples; that work provided the basis for the discoveries of elements 99 (einsteinium) and 100 (fermium). For elements beyond 100, contamination and background radiation made any new nuclides unobservable. Ghiorso solved that problem with a brilliant invention: the recoil technique. A nucleus that undergoes a nuclear reaction will recoil with enough kinetic energy to exit the target—so long as the target is very thin—and be mechanically collected. The technique made possible the discovery of element 101 (mendelevium) based on just 17 individual atoms.

By the mid 1950s it became clear that in order to proceed to heavier nuclei, a new accelerator would be needed, and Berkeley built the Heavy Ion Linear Accelerator (HILAC). With the availability of carbon ions and a curium target, Ghiorso and the HILAC group devised a new technique in which a radioactive element could be identified using its daughter decay products. That enabled the identification of elements 102 (nobelium) and 103 (lawrencium). Subsequently, using targets of californium and berkelium and HILAC ions of nitrogen and oxygen, the group identified elements 104 (rutherfordium), 105 (hahnium, later renamed dubnium), and finally, in 1974, element 106 (seaborgium).

Over approximately 30 years, Ghiorso participated in and led groups that discovered dozens of new isotopes in addition to 12 new elements. That work was central to proving the correctness of Seaborg's revision of the periodic table and to extending the limits of nuclear stability at the top of the chart of nuclides. Ghiorso developed several innovative accelerator concepts for higher-energy heavy-ion beams, including the Omnitron and the Bevalac. The Bevalac opened two new research fields: relativistic heavy-ion collisions and radiation therapy with ion beams. Ghiorso published more than 160 papers in nuclear science, most in *Physical Review.*

Albert Ghiorso became a legend and a metaphor for inspired nuclear research. Physicists and chemists worldwide knew the significance of his work, and those fortunate enough to know him personally were in awe of his brilliance, his hard work and ability to get results when others discounted his chances, and his magical ability to inspire others to devote their careers to the quest. All was done with a quiet, modest personality that belied his power and endeared him to his colleagues. When I remarked to him that nobody gets out of life alive, he replied, with characteristic sagacity, "Well, I don't regard that as proven!"

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