Meitnerium in tribute

Adrian Dingle tells the story of how the name of element 109 represents the lasting recognition that one of the greatest nuclear physicists was in danger of never receiving.

While the furious and well-documented bickering between Cold War adversaries over the discovery priority for many of the transfermium elements was raging in the 1950s and 1960s (mostly involving the Lawrence Berkeley National Laboratory and the Joint Institute for Nuclear Research in Dubna), a new player in super-heavy synthesis was emerging: the GSI Helmholtz Centre for Heavy Ion Research, founded in Darmstadt in the old West Germany in 1969.

It wasn't long before the team there, led by Peter Armbruster and Gottfried Münzenberg, laid claim to the syntheses of new elements, starting with element 107 in 1981, and 109 a year later. In the original experiment that yielded a single atom of what came to be known as meitnerium, a ^{209}Bi target was bombarded with atoms of ^{58}Fe. Analysis led to the detection of an unusual α-decay — determined to have been from an atom of ^{266}109 — which was followed by a second α-decay event from the resulting ^{262}107 daughter nuclide[1].

At the time of element 109's discovery, IUPAC had stepped in to dissuade the premature suggestion of names for new elements, which conspicuously reflected discovery disputes. But the main reason meitnerium managed to avoid the transfermium naming wars was because nobody else had claimed priority for its discovery, which left the GSI group unchallenged in their suggestion, formally accepted by IUPAC in 1997[2]. Peter Armbruster described it in words that clearly allude to two major aspects of the intriguing life of nuclear physicist Lise Meitner (pictured): "to render justice to a victim of German racism and to credit in fairness a scientific life and work"[3].

Meitner's story is one of persecution (she faced discrimination as a woman then as a Jew, and was forced to flee Nazi Germany), and one of a bitter quarrel with her long-time colleague and erstwhile friend, Otto Hahn.

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She played a pivotal role in understanding nuclear fission and giving the first theoretical explanation of the process together with her nephew Otto Frisch, accounting for the puzzling chemical findings of Hahn and Fritz Strassmann that bombarding uranium with neutrons had produced lighter elements. She was largely marginalized, however, notoriously by Hahn, who despite decades of productive collaboration, publicly excluded her from the story of nuclear fission's discovery.

Even though it did not seem like it at the time — with Hahn being solely awarded the 1944 Nobel Prize in Chemistry "for his discovery of the fission of heavy nuclei" — history has perhaps been kinder to Meitner: her Nobel exclusion is now widely regarded as unfair, and those who have an element named after them are part of a far more exclusive club than that of the Nobel laureates. A further fitting tribute would be a significant, real-world application of meitnerium.

For now, any utility clearly remains in the future. The bismuth/iron nuclear fusion that had produced the original, single atom of ^{266}Mt in 1982 was replicated in both 1988[4] and 1997[5], producing two and twelve atoms, respectively. In addition Dubna and Berkeley each confirmed the existence of ^{266}Mt through another reaction, this time between ^{208}Pb and ^{59}Co, with the Americans reporting it in 2009[6]. Current research has identified a number of isotopes ranging in mass from 266 to 278 — almost exclusively α-emitters — with ^{277}Mt undergoing spontaneous fission. Those isotopes have half-lives ranging from just milliseconds to up to a few seconds, the heavier ones being the longest lived.

Thus, it has not been possible to carry out chemical studies on meitnerium (even at the one-atom-at-a-time level), and its chemical and physical properties remain largely those of educated speculation through theoretical calculation and by analogy with other group 9 and period 7 elements. These point to an incredibly dense solid metal element that resembles iridium in terms of its most likely oxidation states, with +3 being the most stable in aqueous solution. A more recent study published in 2016 suggests the existence of a further isotope of meitnerium,^{282}Mt (ref. 7), that may have a more workable half-life (in excess of one minute), providing potential for further research.

At this time, meitnerium's significance thus remains peripheral in terms of efficacy — but it should not be underestimated as it reminds us of an important part of history, scientific and otherwise. ❐

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