
Judging the Discovery of New Elements

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Finding a new element is always exciting, with lots of coverage in the media when announced by the participating investigators. Statistically, a new element has been discovered on the average of every two-and-a-half years dating back well more than two centuries. The competition to "get there first" can be very aggressive because of the prestige associated with the effort and because the discoverers have the traditional right to name the element. Element names are officially endorsed by the IUPAC (the International Union of Pure and Applied Chemistry) Interdivisional Committee on Nomenclature and Symbols following recognition of the discovery. The recognition of discovery, not surprisingly, can be very controversial as IUPAC - and IUPAP, the physics counterpart - experienced in the previous decade-long round of judging the discoveries of the transfermium elements Md-Mt with atomic numbers 101-109.

In 1999 a new Joint Working Group on the discoveries of elements 110-112 was appointed by IUPAP and IUPAC. Four members - two physicists and two chemists - accepted nominations to serve. Two have close connections to JAERI. I served as Chair of the group, Prof. Hiromichi Nakahara, a research advisor of the heavy element nuclear chemistry group of ASRC, from Tokyo Metropolitan University was the other chemist. Prof. Erich Vogt, past Director of the TRIUMF Laboratory in Vancouver, Canada, served as did Dr. Brian Petley from the Centre for Basic, Thermal, and Length Metrology, National Physical Laboratory, Teddington, UK.

Our approach was very significantly influenced by the recent circumstances for elements 107-109, each of those characterized by having a very small number of events. All initial claims pivoted either

on subsequent confirmation and/or included clear observations of known descendents or production of previously unknown intermediates through cross bombardments. The very reasonable criteria for recognition of the discovery of a new chemical element were established by the 1991 IUPAP/IUPAC Transfermium Working Group (TWG). Below are quotes particularly relevant to guiding our deliberations on elements 110-112.

"Discovery of a chemical element is the experimental demonstration, beyond reasonable doubt, of the existence of a nuclide... The TWG realizes that the term 'reasonable doubt' is necessarily somewhat vague... Confirmation demands reproducibility... In the case of the new elements the TWG attaches considerable importance to reproducibility and would indeed like to be able to suggest that no new element should be recognized officially until the data upon which the claim is based have been reproduced, preferably in another laboratory and preferably by a different technique... it would appear unreasonable to apply such a demand of demonstrated reproducibility in all rigidity. We do not believe that recognition of the discovery of a new element should always be held up until the experiment or its equivalent have been repeated, desirable in principle as this may be. However, we would waive this requirement only in cases where the data are of such a nature that no reasonable doubt is possible (for instance for data with a high degree of internal redundancy and of the highest quality), and under circumstances where a repetition of the experiment would imply an unreasonable burden."

The last sentence, squaring a befitting conservative stance with the need for sensible flexibility, generated a lot of introspection and was

especially influential in our deliberations. We also had to take care as to not appear to set a higher standard for "discovery" than applies elsewhere in science. Rather, our operational essence was to conform to a uniform, consistent basis for definitive observation and interpretation.

I can say that all four members of the Joint Working Group could be classified as superheavy element enthusiasts, in that the expectation and hope was that all three elements, 110, 111 and 112, could be established as "discovered" and that our task would be just the possibly difficult assignment of priority or shared priorities, should that prove appropriate. But the standards for "discovery" were severely strained by the experimental results despite the marvelous ingenuity and exceptional care by the investigators. As will be reported by IUPAC and IUPAP, with the exception of the production of element 110 at Gesellschaft für Schwerionenforschung (GSI), there remained reasonable doubt in interpretation of the results.

The reader should recognize that the Joint Working Group's obligation was to be able to say "Yes, Group X discovered element Y". For two elements, we could not legitimately make that statement. This does not imply, though, that "No, Group X did not discover element Y". The difference is subtle yet critical to future recommendations. Although the data under consideration were invariably consistent with discovery, they were not sufficiently compelling to engender confidence that the Criteria for Discovery had been met. Part of the problem in the past, I believe, had been the perceived eagerness to endorse discoveries of new elements through what was arguably premature evidence and political lobbying. In judging the drive to elements 110-112 and beyond, the Joint Working Group believes that the rules of the road are quite clear and that all contenders will proceed with a common understanding of how success is defined. We certainly are looking forward to upcoming developments.

