Historical gathering: International meeting of the discoverers of chemical elements

26.08.2019 |

As part of the International Year of the Periodic Table 2019, the Conference on the Chemistry and Physics of Heavy Elements (TAN) taking place in Wilhelmshaven, Germany from the 25th to the 30th of August, brought together the discoverers of new chemical elements in a unique historical gathering. Researchers from Germany, Russia and Japan, who have added new elements to the periodic table in recent years, met at the international congress. The GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt (GSI), the Johannes Gutenberg University and the Helmholtz Institute Mainz are the organizers of this year's TAN conference.

There are currently 118 elements listed in the periodic table. 92 of them occur naturally on Earth. The search for further new elements is conducted using particle accelerators. To produce elements, researchers collide an ion beam consisting of atomic nuclei of one element with a material sample of another element. In the fusion of the atomic nuclei of both elements a new, heavy element can be produced. The recognition and inclusion of a new element in the periodic table takes place as soon as the discovery has been confirmed. Heavy elements produced in this way are unstable, i.e. they decay within a short time. Unresolved research questions in this field include, for example, how heavy elements are formed, whether heavier elements can have longer lifetimes again due to their special nuclear configuration (known as the island of stability) and which chemical and physical properties the heavy elements have.

Professors Peter Armbruster and Gottfried Münzenberg, who held leading positions in the production of elements 107 to 112 (bohrium, hassium, meitnerium, darmstadtium, roentgenium and copernicium) at the GSI Helmhotzzentrum during their active research careers, are present at the conference. Professor Yuri Oganessian is also on site. He is an element discoverer from Russia and currently the only living person an element is named after: element 118, Oganesson. He was head of the discovery team of Elements 114 to 118 (flerovium, moscovium, livermorium, tennessine and oganesson) at the Flerov Laboratory of the Joint Institute for Nuclear Research, JINR in Dubna, Russia. Dr. Kouji Morimoto from Japan of the RIKEN Nishina Center for Accelerator-Based Science, who was a member of the element 113 discovery team, attends as well. The current heads of GSI, the Flerov Laboratory and the RIKEN Nishina Center, where the respective elements were discovered, also participate in the conference.

“Research on the heavy elements is an incredibly exciting field, there are many unanswered questions,” explained Professor Paolo Giubellino, Scientific Managing Director of GSI, as well as the new international research facility FAIR (Facility for Antiproton and Ion Research) being built in Darmstadt. “Where do the elements come from? How are they produced in explosions of stars and other stellar events? We would like to elicit answers to these questions from the cosmos with the help of our accelerator facilities. The investigation of the heaviest elements will continue to play a very important role in the future of our laboratory. The FAIR facility, which is currently being built at GSI in Darmstadt in international cooperation, offers new opportunities to bring the universe into the laboratory.”

Professor Sergey Dmitriev, Director of the Flerov Laboratory of Nuclear Reactions (FLNR) said at the congress: “Priority experiments on the synthesis of new superheavy elements — flerovium (114), moscovium (115), livermorium (116), tennessine (117), oganesson (118) — were carried out at the FLNR using the U400 accelerator. Further progress required the construction of a superheavy-element factory at FLNR whose key facility is the DC280 cyclotron with the ion beam intensity an order of magnitude higher than that achieved to date. The commissioning of the factory will allow

experiments on the synthesis of the elements 119 and 120 and will significantly expand the work on the study of nuclear and chemical properties of superheavy elements."

In Japan, the search for new elements also continues: “Since December 2018, we run ‘119th element search’ experiment using one of the five cyclotrons in the RIKEN RI Beam Factory. At the end of 2019, our linear accelerator will be equipped with newly-built super conducting cavities and ready to synthesize new elements with higher beam intensity. We will run both experiments in parallel as long as resource permits. We will continue these experiments until somebody, hopefully RIKEN, finds the 119th element,” Hideto En’yo, head of the RIKEN Nishina Center, described the current research goals.

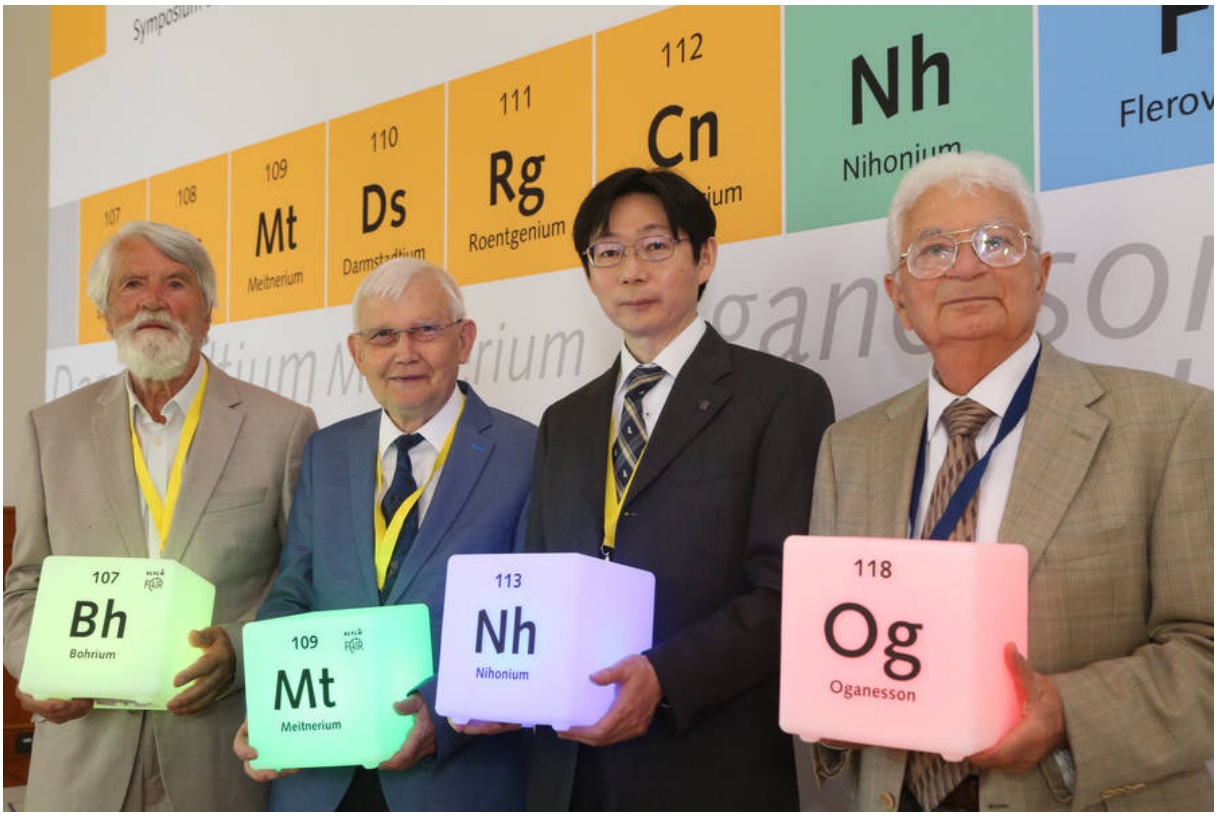
A total of 120 researchers from 19 countries and 4 continents take part in the TAN conference. During the conference week, they discussed the current results and perspectives of research on the so-called transactinides, the namesakes of the TAN conference series. This refers to the elements starting with the atomic number 104 which follow the subgroup of actinides. They are all artificially produced and will be further investigated in the course of research on heavy elements. “We are trying to determine their chemical properties, for example” explained Professor Christoph Düllmann, co-organizer of the TAN, professor at the University of Mainz and head of the GSI and HIM research departments on the chemistry of heavy elements. “The elements are sorted into the groups of the periodic table according to their atomic number. Elements with similar chemical properties stand below each other. In the case of new artificial elements, of course a clarification is needed which properties they have, and whether they also belong to these groups, or whether the high nuclear charge in these exotic atoms causes a disruption of the electron shell and thus leads to unexpected chemical properties.”

“We are also investigating the physical properties of the new elements in the same way,” commented Professor Michael Block, another TAN co-organizer and professor in Mainz, who is also head of the GSI and HIM research department on the physics of heavy elements. “For example, the configuration and the energy levels of the nuclear building blocks can be determined by spectroscopic investigations, or high-precision mass measurements of the nuclei can be carried out in order to understand the behavior of the elements in detail and further improve the current nuclear models.”

The TAN Conference takes place in the International Year of the Periodic Table 2019 (IYPT) proclaimed by UNESCO, which celebrates the 150th anniversary of the Periodic Table. In 1869, the Russian chemist Dmitri Mendeleev introduced a system to the elements, which were previously disordered, and made predictions about missing, then unknown elements. He is thus regarded as the father of the periodic table. The conference has a local connection to the physician and chemist Lothar Meyer, who also proposed a corresponding system for the elements. He came from the neighboring village of Varel, south of Wilhelmshaven.

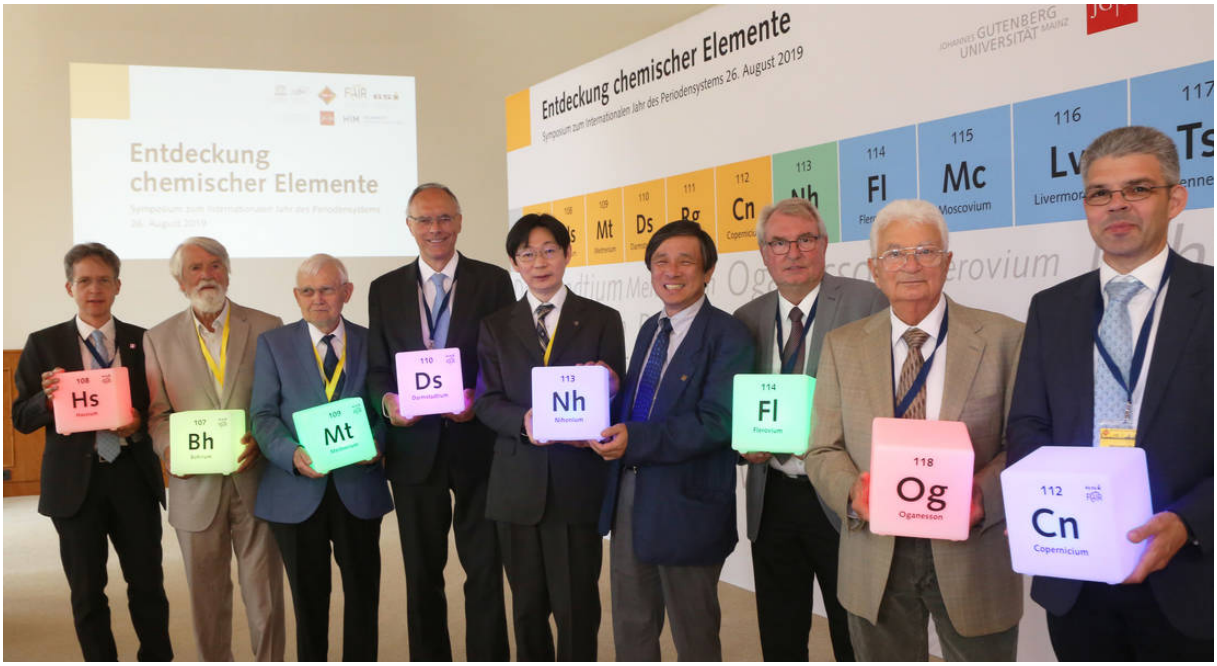
In addition to scientific discourse, a symposium on the occasion of the IYPT with information on the history of the periodic table and the element discoveries, as well as an outlook on the future of research on heavy elements, takes place over the course of the TAN. Representatives of the international organizations IUPAC and IUPAP, responsible for naming the elements, as well as the German Physical Society and the Society of German Chemists are also present. The TAN is one of many examples of successful international cooperation in the world of research.

(CP/JL)



The four element discoverers — from left: Professor Peter Armbruster and Professor Gottfried Münzenberg, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt; Dr. Kouji Morimoto, RIKEN Nishina Center for Accelerator-Based Science, Wako, Japan; Professor Yuri Oganessian, Flerov Laboratory for Nuclear Reactions, Dubna, Russland

Photo: Björn Lübbe, Wilhelmshavener Zeitung

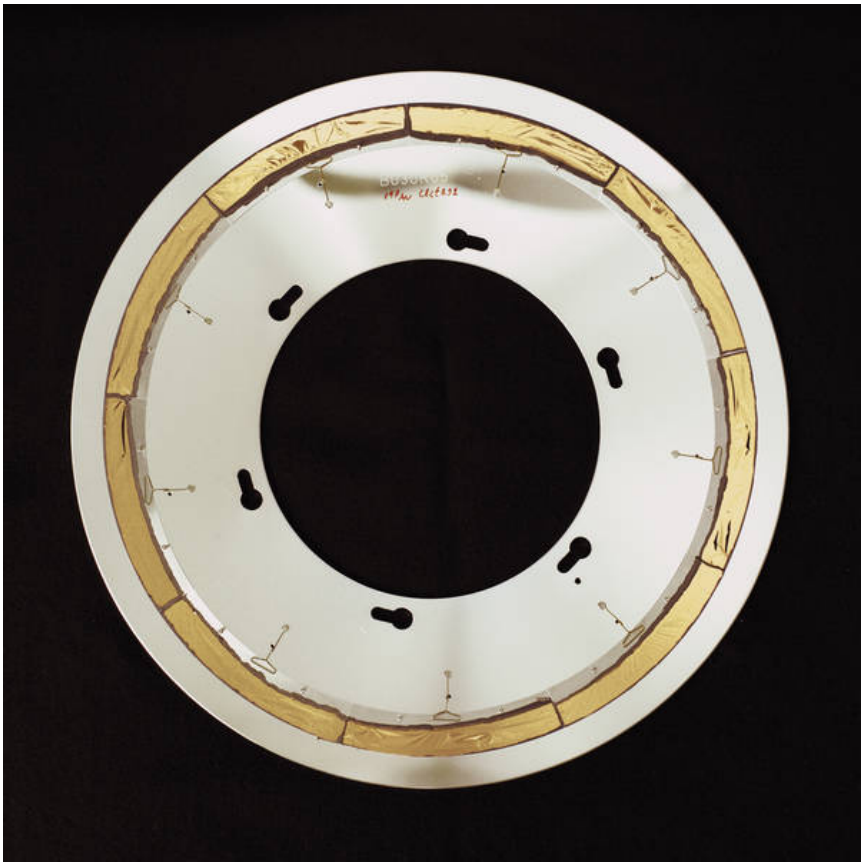


From left: Professor Christoph E. Düllmann; Professor Peter Armbruster, Professor Gottfried Münzenberg, Professor Paolo Giubellino, Dr. Kouji Morimoto, Professor Hideto En'yo, Professor Sergey N. Dmitriev, Professor Yuri Oganessian, Professor Michael Block

Photo: Björn Lübbe, Wilhelmshavener Zeitung

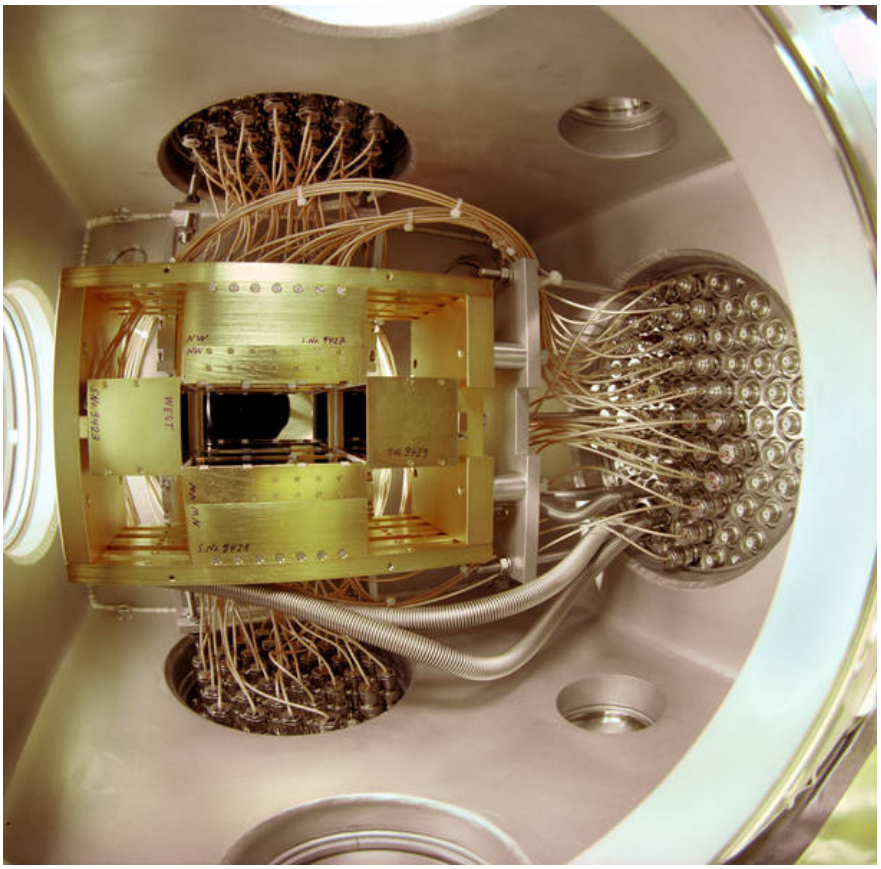
The GSI linear accelerator UNILAC was used to accelerate the ions in the production of elements 107 to 112. They are collided onto a material sample and form a new element by nuclear fusion

Photo: J. Hosan, HA Hessen Agentur



By colliding the ions brought to speed in the accelerator onto a target wheel, a new element can be produced by fusion of the atomic nuclei of both element types. The wheel in the picture is equipped with thin gold foil. When bombarded with ions, atoms of a new element can be formed. Due to the high impact velocity, they leave the foil and can be identified in a separate detector (see below).

Photo: A. Zschau, GSI



Detector for the measurement of the elements 107 and 112 discovered at GSI's SHIP experiment.

Photo: A. Zschau, GSI