The oganesson odyssey

Kit Chapman explores the voyage to the discovery of element 118, the pioneer chemist it is named after, and false claims made along the way.

Having an element named after you is incredibly rare. In fact, to be honoured in this manner during your lifetime has only happened to two scientists — Glenn Seaborg and Yuri Oganessian. Yet, on meeting Oganessian it seems fitting. A colleague of his once told me that when he first arrived in the halls of Oganessian's programme at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia, it was unlike anything he'd ever experienced. Forget the 2,000 ton magnets, the beam lines and the brand new cyclotron being installed designed to hunt for elements 119 and 120, the difference was Oganessian: "When you come to work for Yuri, it's not like a lab," he explained. "It's like a theatre — and he's the director."

For 60 years, with his very own blend of creativity, scientific skill and leadership, Oganessian has pushed the boundaries of the periodic table. Born in Rostov-on-Don of Armenian descent, the young Oganessian wanted to be an architect before he joined the Moscow Engineering Physics Institute. There, he elected to join the USSR's element hunters under Georgy Flerov. He went on to pioneer the 'cold fusion' technique, which would lead to elements 107–113, and the 'hot fusion' reactions with the neutron-rich ^{48}Ca that would give the world flerovium and beyond. A large part of modern science is about partnerships; Oganessian builds and cultivates them with warmth, insight and insatiable scientific curiosity.

The element that bears his name, oganesson, is similarly unique. It was first produced in 2002, firing ^{48}Ca at a ^{249}Cf target, by Oganessian's team from JINR and colleagues at the Lawrence Livermore National Laboratory, US[1]. There is currently only one known isotope, ^{294}Og, made in reactions so rare that it took ten years to obtain four confirmed atoms. The fourth in particular was a lucky discovery: it came from an attempt to make element 117 by bombarding a ^{249}Bk target with a beam of ^{48}Ca, but 28% of the target had decayed into ^{249}Cf, thereby producing element 118 instead[2].

Credit: ITAR-TASS News Agency / Alamy Stock Photo.

An earlier claim[3] for element 118 had come not from Russia, but the Lawrence Berkeley National Laboratory, in 1999. Soon after the death of Glenn Seaborg, who had led or taken part in the discovery of ten elements including plutonium, three decay chains were reported, products of a krypton beam into a lead target. It somewhat seemed too good to be true.

It was. Other groups around the world, along with the Berkeley team itself, were unable to reproduce these decay chains — prompting the Berkeley team to reanalyse the original data. When evidence of the chains couldn't be found, the article was retracted[4] by all authors except for Victor Ninov, the first author, who had been in charge of analysing the raw data. By the time the retraction appeared, in July 2002, Ninov had been dismissed from Berkeley for scientific misconduct in May[5], and had filed a grievance procedure[6].

Today, the discovery of the last element of the periodic table as we know it is undisputed, but its structure and properties remain a mystery. No chemistry has been performed on this radioactive giant: ^{294}Og has a half-life of less than a millisecond before it succumbs to α-decay.

Theoretical models however suggest it may not conform to the periodic trends. As a noble gas, you would expect oganesson to have closed valence shells, ending with a filled $7s^2 7p^6$ configuration. But in 2017, a US–New Zealand collaboration predicted that isn't the case[7]. Instead the relativistic effects — discrepancies between expected and observed behaviours caused by relativity — may result in the loss of shell structure. These effects are seen across the periodic table, increasing as nuclei get larger. Oganesson seems to have reached the point where electrons form an evenly distributed gas of charge. Such changes affect an element's properties: oganesson may well be a solid at room temperature, and more reactive than its noble family as the electrons in its *p* orbitals can be removed more easily.

If the models hold true, it could be the end of periodicity as we know it: a turning point at the join of chemistry and physics. Just like its maverick father, oganesson could be very interesting indeed. ❐

Kit Chapman
Comment Editor at Chemistry World.
Twitter: @ChemistryKit
e-mail: chris.chapman174@gmail.com

Published online: 21 June 2018
https://doi.org/10.1038/s41557-018-0098-4

References

1. Oganessian Y. et al. *JINR Commun.* https://doi.org/10.2172/15007307 (2002).
2. Karol, P. J. et al. *Pure Appl. Chem.* **88**, 155–160 (2015).
3. Ninov, V. et al. *Phys. Rev. Lett.* **83**, 1104–1107 (1999).
4. Ninov, V. et al. *Phys. Rev. Lett.* **89**, 039901 (2002).
5. Johnson, G. At Lawrence Berkeley, physicists say a colleague took them for a ride. *New York Times* (15 October 2002).
6. Schwarzschild, B. *Phys. Today* **55**, 15–17 (2002).
7. Jerabek, P. et al. *Phys. Rev. Lett.* **120**, 053001 (2018).