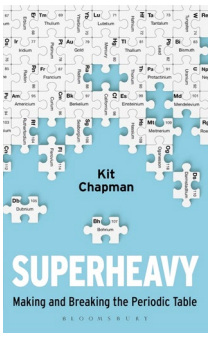
How heavy will we get?



Superheavy: Making and Breaking the Periodic Table

By Kit Chapman

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Considered the 150th anniversary of the discovery of the periodic system, 2019 was proclaimed the International Year of the Periodic Table of Chemical Elements by the United Nations General Assembly and UNESCO. As many of us have been celebrating '#IYPT2019', as it is known on social media, it may be all too easy to lose sight of the arduous and ever-evolving process that populated the chemical chart over the years. It could therefore not be timelier to follow Kit Chapman into the realm of 'making and breaking the periodic table' as it stands today. Not just that dreamed and organized by Dmitri Mendeleev in 1869, but the rather elaborate table now composed of the 118 elements known to humankind. *Superheavy* is a tale of extreme science in the twentieth and twenty-first centuries that guides us through the discovery of the transuranium elements — those beyond element 92 — one nuclear reaction at a time.

From the bombardment of uranium with deuterons to produce elements 93 (neptunium) and 94 (plutonium) at the onset of the Second World War, through to the contemporary challenges of procuring enough plutonium or berkelium to synthesize the much heavier elements 114 (flerovium) or 117 (tennessinne), respectively, Chapman regales us with a crisp and technical account of the creation and characterization of these ephemeral nuclides. The level of scientific detail throughout the book will please nuclear physicists and (trans)actinide chemists alike, but will also not deter the novice. I imagined myself running alongside Enrico Fermi and his students in the dark corridors of an old Roman university building to beat the fast decay of short-lived atoms generated by homemade neutron beams. I held my breath at the exhilarating thought of Al Ghiorso and Greg Choppin, racing through the tortuous hills of Berkeley from the University of California's cyclotron to its chemistry laboratories to analyse the first traces of element 101 (mendelevium). *Superheavy* manages to precisely describe the intricate physical phenomena at play, all the while rendering a deep and mesmerizing sense of excitement at the idea of crafting nature's building blocks.

Equally captivating is the essential role of the geopolitical context that defined how each new tile of the periodic table was filled. In his quest to capture the essence of element creation, Chapman takes us on a worldwide journey, from the first American secrets of the atomic bomb to the fall of the U.S.S.R., and illustrates perfectly how historical events influenced the erecting of the large US National Laboratory network or the ever-growing accelerator facilities in Sweden, Germany, Japan and Russia that have been instrumental in heavy-element research. Beyond that, as the book progresses, we become increasingly enthralled with the social dynamics created between scientists by war and politics — which sometimes came in the way of scientific discovery. This is best exemplified by a quote from Andrey Popeko, from the Joint Institute for Nuclear Research in Russia: "If the Americans discovered something, our first task was to show it couldn't work at all. If we discovered something, the Americans did the same."

The continuous oscillation between competition and comradery that we witness throughout the book still persists today in science and engineering — the competitive aspect sometimes exacerbated by diminished resources, dwindling support from different governments, and the incessant pressure to claim breakthroughs and 'publish' first. And although this was a rather extreme situation, my guess is that many scientists will experience some kind of familiarity when reading about the 'transfermium wars' — a fierce, decades-long controversy centred around the discovery of elements 102–109. Nevertheless, the reciprocal admiration among colleagues experienced by the protagonists of *Superheavy*, and their pride at being part of a group that advances science in such a fundamental manner, are palpable.

As well as the first discovery of all the transuranium elements, the book relates other quirky moments of superheavy synthesis. One such episode is when Glenn Seaborg's team accomplished in the early 1980s the old alchemist's dream of turning bismuth into gold, using carbon and neon beams. What Chapman also achieves particularly well is to convey how elements got their names — increasingly, not only after recognized leaders in the field but also entire communities, for example, through moscovium (115), livermorium (116) or tennessine (117).

It is difficult enough to explain the discovery and implications of each element of the period table to chemistry, physics and engineering students. Chapman accomplished no small feat with this page turner; it provides a fascinating insight into the motivations and challenges of heavy-element science that should appeal to anyone with even a small interest in understanding how scientific innovations shape our world. Discovering new elements is not merely about glory; as Chapman rightly states, "every isotope unlocks a little more of the universe or creates options for saving lives through medical isotopes or cleaner energy."

In brief, Chapman did get it right, and paid a brilliant tribute to all those who have participated in the constant filling and arranging of that part of the periodic table over the years. Despite a few omitted names, the reader will be introduced to a long and accurate list of scientists that have followed in the footsteps of pioneers such as Enrico Fermi, Lise Meitner, Glenn Seaborg, Al Ghiorso, Georgy Flerov and Yuri Oganessian. And I can't help but wonder if the next element will be named after one of the many women who are now among the bearers of the field, Darlene Hoffman, Dawn Shaughnessy, Jacklyn Gates, Julie Ezold, Rose Boll, Clarice Phelps or Nancy Stoyer, to mention a few. Superheavy element research seems to be in good hands, and is the posterchild of successful scientific endeavours that rely on diverse teams, large infrastructure and international collaborations.

Superheavy may well become a staple on everyone's bookshelf; it has certainly found its place on mine, between Paulo Coehlo's *Alchemist* and Primo Levi's *Periodic Table*. I am left longing for the next discovery and maybe, just maybe… the thought that we may reach the island of stability in my lifetime. Who will be leading the race for element 119 and beyond in the twenty-first century? How many more elements will we find? Will we need to wait another 80 years or so to gather enough material for a sequel? ❐

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