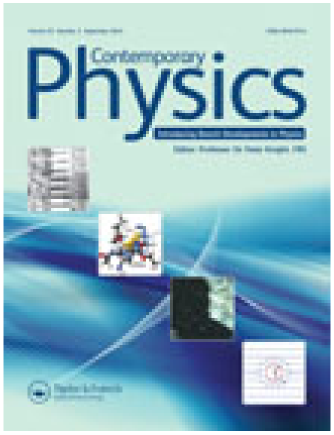

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A Tale of Seven Elements, by Eric Scerri

D.W. Jones[a]
[a] Applied Sciences, University of Bradford, Bradford, UK
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summary of the key themes and a couple of small appendices. A straightforward working through of the small angle formulae from first principles (the formulae was having been introduced in the discussion of planets and planetary motion) and a guide to understanding and using exponential notation for numbers. The ubiquitous reference tables that finish the book are clearly and cleanly laid out and have been well selected.

This is a book that easily achieves its aims of being a fresh and useful source for introducing undergraduates to astronomy by an accomplished and experienced educator. As a textbook, it is engaging and dynamic, and presents its information in a way that is neither patronising nor boring. Some students may already be familiar with the material presented – however even for these students, there is enough material to encourage them to consider, think about and apply that knowledge in fresh ways.

I believe this book, however, goes further. Because of its clarity and accessibility, and focus on building up from first principles the knowledge required I feel it would also be a useful source for those introducing students to astronomy and to thinking about science at any stage. Understanding the Universe is therefore a book I would be happy to also recommend to friends and colleagues who teach science topics at a more introductory level within the school system.

Mark Nicol
Science and Technology Facilities Council, UK
Astronomy Technology Centre, Royal Observatory, Edinburgh, UK
mark.nicol@stfc.ac.uk

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A Tale of Seven Elements, by Eric Scerri, USA, OUP USA, 2013, 200 + 34 pp., GBP £12.99 (hardback), ISBN 978-0-19-539131-2. Scope: accessible monograph. Level: undergraduate, general readership.

The name most closely associated with the periodic table of the chemical elements is, of course, Dimitri Mendeleev, not least because as early as 1871 he recognised the existence of gaps in it, which led to the prediction of undiscovered elements. It was the physicist Henry Moseley, tragically killed in 1917, whose X-ray spectroscopy set up the way of counting the elements by what became known as atomic number, an integer. Curiously, no element has been named in his honour. From the range of natural elements from 1 to 92, seven proved especially difficult to isolate for certain; they were gradually discovered, isolated and accepted over the years 1917–1945. Scerri, accustomed to teaching large classes at UCLA in chemistry and on the philosophy and history of the periodic table within the history of science, has dedicated his comprehensive book to Moseley, even if his name is spelled incorrectly in the Frontispiece.

Many discoveries are made independently by separate researchers in different locations at narrowly separated times; these have ranged from the emergence of oxygen, Darwin and Wallace on evolution, and Euler and Lagrange on the calculation of variations to Bloch and Purcell on NMR. With minute quantities of rare elements difficult to detect and distinguish, some of them radioactive, it is hardly surprising that confirmation of discovery and establishment of priority between rival groups (not unknown among scientists in other fields) should be subject to controversy. For these seven elements, however, there have been protracted and acrimonious disputes over priority, and naming, often vigorously reinforced by followers of the candidates, sometimes tinged with nationalism. This last may be partly, perhaps, because three of these elements were first recognised during World Wars and intellectual property becomes public property. This is in contrast to TS Kuhn's view that predicted (rather than unexpected) discoveries, such as those of missing elements, should precipitate few priority debates! With instrumental detection of miniscule concentrations, there arises the question as to what actually constitutes an acceptable claim to discovery and isolation. Must a minimum amount be prepared (most transuranic elements are formed in what might be regarded as traces only), must it be reported in a recognised journal, and can several competitive groups be honoured equally? Friedrich Paneth, the Austrian-born radiochemist who had to escape from Berlin to the UK (but was not averse to engaging in disparaging arguments over element 85), suggested that naming rights for previously undiscovered elements should go to those workers who had produced the element in a reproducible way. Scerri deals with these questions either in preliminary chapters or *en passant* when describing events preceding each discovery.

The periodic table may be the most important table in chemistry, but physicists (described by Scerri as invaders) and their instruments and theories have been much involved in the detection, verification and recognition of new elements: e.g. Einstein and Perrin, the Cambridge, Manchester and Copenhagen schools, and Stoner and Pauli establishing the four quantum numbers. Scerri deals with these awkward natural elements, roughly in historical sequence of accepted discovery, with accounts for each of the seven in the title. Element 91, initially called UrX by Crookes, then mother of actinium, briefly labelled hahnium and eventually protoactinium, was isolated in Berlin in 1917, largely by Lise Meitner as her collaborator Otto Hahn was on war work. She was later better known for realising with Frisch that Hahn and Strassman had achieved nuclear fission and for not getting the Nobel Prize. Controversies tinged with nationalism were especially evident in the competition to isolate element 72: French, Austrian, Dutch, Danish, Hungarian and British scientists were engaged in the arguments which arose partly because of the similarities between hafnium and zirconium. Long after 1923, the debate has been re-ignited. Element 75, rhenium, the last stable element to be discovered, was laboriously extracted by Walter and Ida Noddack and Otto Berg in Germany in 1925. These analytical chemists also made a strong case for their discovery of the rare unstable element 43, technetium, at the same time but its discovery was ultimately attributed to the Italians Emilio Segre and Carlo Perrier working on the Berkeley cyclotron in 1937. The absence of a ductile-brittle transformation has led to the application of rhenium alloys in turbine blades as well as in semi-conductors, while Tc-99 m has medical applications both in technetium generators (from Mo-99) and in imaging diagnostic tests.

There were many claims and disappointments over the discovery of element 87, eka-caesium, which was ultimately attributed in 1939 to Marguerite Perry who had originally been an assistant to Marie Curie. Thus, three of the seven elements have been isolated by women. This highly radioactive element, named francium, figures in attempts to explore parity violation. Element 85 was the subject of searches in several countries during the 1930s and 1940s and into World War II; but the true discovery of astatine is generally acknowledged to Segre with Dale Corson and Alexander MacKenzie on the Lawrence cyclotron at Berkeley in 1940. It has not been seen with the naked eye and is perhaps the rarest element. Element 61 is one of the rare earths and so would be expected to be very difficult to separate from the others; this was ultimately achieved with ion-exchange chromatography. There have been unsubstantiated claims from Bohemia, Florence and in the USA, but the 1947 discovery was achieved by a group at MIT, following up a finding made during the Manhattan Project. A final chapter is devoted to the synthesis of the 26 missing transuranic elements and a brief consideration of possible relativistic effects; with increasing nuclear charge, the outermost electrons will be more screened which will affect chemical properties.

As Oliver Sachs's Preface hints, Scerri has collected an entertaining and informative collection of stories, well indexed in 20 pages, about the paths to the accepted discoveries of these seven elements; there is a separate author index. The 25 pages of notes do not merely comprise references and misapprehensions, but provide sensitive asides on the scientists and their attitudes to the aim of establishing new elements for certain. There are only a few portraits (though many brief pen portraits in the text) and Scerri inserts frequent diagrams of the emerging table. The few typographical errors are excusable in an accessible monograph containing such a wealth of data. Despite its unassuming title, *A Tale of Seven Elements* is recommended.

D.W. Jones
Applied Sciences, University of Bradford, Bradford, UK
d.jones217@btinternet.com

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Atomic Physics: Precise Measurements and Ultracold Matter, by Massimo Inguscio and Leonardo Fallani, USA, Oxford University Press, 2013, 352 + 16 pp., £49.50 (hardback), ISBN 978-0-19-852584-4. Scope: monograph. Level: postgraduate, advanced undergraduate, early career researcher, researcher.

The invention of the laser in 1960 revolutionised the subject of atomic physics in ways that would not have been expected by the pioneers of laser physics. The first revolution came early on, when it was quickly realised that the frequency stability of the laser and the brightness of its beam could improve the precision of the spectroscopic measurements that lie at the core of atomic physics. However, a second revolution began to emerge in the 1970s, after it was realised that lasers could also be used to apply forces to atoms and hence to cool them to extremely low temperatures. This led to a paradigm shift in the subject, in which the objective was not just to measure the frequency of atomic transitions with ever increasing precision, but also to produce ultracold matter and investigate its properties.

The aim of Inguscio and Fallani's excellent new text is to explain the modern history of atomic physics as it evolved through the development of laser cooling techniques. The book has a particular focus on the experimental methods that are employed, which will be especially useful for starting graduate students and also to established researchers who need to get familiar with the state of the art. One particularly attractive feature of the book is the excellent diagrams that illustrate the experimental methods and help to explain the principles behind them. Another is the comprehensive bibliography that will enable the interested reader to pursue particular subjects in greater depth.

The book is written for advanced undergraduates and graduate students, and assumes knowledge of the principles of atomic physics as would be obtained towards the end of an undergraduate degree. It is organised into seven chapters that focus on the spectroscopy and applications of particular atoms – specifically hydrogen, the alkalis, helium, and the alkaline earths – and on the techniques and applications of ultracold matter, namely Bose-Einstein condensation and optical lattices. The