Book Review

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Modern Isotope Ratio Mass Spectrometry

Wiley, Chichester, 1997. 514 pages, 1134 references.

By an odd coincidence, the call to review this book came only a few minutes after I had finished a discussion with some research associates on the capricious nature of mass spectrometers. My faded photocopy of the 2nd edition of Aston's *Mass Spectra and Isotopes* was still opened to p. 69 on which his famous quotation first appeared. We jokingly attributed the day's anomalous results to 'Aston's curse,' as though some irritated spirit was toying with us for not paying proper attention to our instruments. Platzner and co-authors contend on p. 8 of their book, perhaps with good justification, that modern isotope ratio mass spectrometers have achieved a level of reliability, precision and accuracy that was unimaginable in Aston's day. I agree, but my young associates have yet to be convinced.

This book is Volume 145 in a continuing series of monographs on analytical chemistry and its applications published by Wiley. The three contributing authors offer some valuable insights into high precision isotopic analysis by virtue of their many decades working for commercial instrument manufacturers. The *raison d'être* for *Modern Isotope Ratio Mass Spectrometry* is to provide a contemporary review of the state of the art for high precision isotope ratio measurements of the elements. Most importantly, this book contains a compendium of information on a diverse topic that transcends many intellectual disciplines like few others in the realm of science. Examples of the utility of isotopes can be found in all of the physical and biomedical sciences, ecology, agriculture, commercial product authentication, paleontology and archeometry, some of which are described towards the end of the book.

The first third of the book (Part I, 145 pages) briefly covers the historical work on isotope ratio mass spectrometers, followed by a discussion on the fundamentals of quadrupole and magnetic sector mass analyzers, ionization sources for gas and solid samples and various ion detectors. The treatment of the historical aspects of isotope ratio mass spectrometry is too brief to be of much use, but inquisitive readers can follow up on the citations given, beginning of course with Aston's book.

Most of Chapter 3 is devoted to magnetic sector instruments equipped with multiple Faraday collectors for the analysis of solid samples by thermal ionization or analysis of gas samples by electron ionization. The design considerations necessary to couple multiple Faraday collectors to magnetic sector optics for isotope ratio work are clearly delineated. More advanced multi-sector instruments for special applications are described later in Chapters 4 and 6. Among the major advances in isotope instrumentation is the construction of automated sample processing and inlet systems to improve analytical productivity and reliability. The most notable advance in this area is the continuous flow inlet for gas (CHNOS) samples, but several other specialized preparation devices are also described.

An extended discussion in Chapter 4 is devoted to multi-collector, inductively coupled plasma, magnetic sector (MC–ICP–MS) instruments. It is replete with enough examples to convince any skeptic that the MC–ICP–MS can achieve precision and accuracy comparable to those of a good thermal ionization instrument. The chief barrier to TI/MS and MC–ICP–MS is cost, so some manufacturers have introduced low-cost quadrupole isotope ratio instruments (Chapter 5) for the analysis of gases and solid samples. Although the theory of operation of quadrupole mass spectrometers (QMS) is well known, the authors should have given more depth to the topic. Quadrupole instruments generally cannot compete with sector instruments for high-precision isotope quantitation. However, the QMS may be adequate for isotope dilution measurements or multi-element quantitation by ICP–MS where precision is less demanding than for geochronology or metabolic tracer applications.

Specific ionization processes and element specific applications are covered in Part II (340 pages). Chapter 7 contains a discussion of ion formation processes such as glow discharge ionization and laser-induced resonance ionization, but some of the information presented in earlier chapters on thermal ionization is also repeated here. Chapter 8 introduces the concepts of precision and accuracy in isotope ratio measurements, the statistical treatment of experimental data and the effects of isotope fractionation on precision and accuracy. In fact, this is a substantial issue in isotope ratio mass spectrometry, so I am disappointed the authors did not introduce the topic earlier and with more depth than they have. Chapter 9 contains a detailed compendium of isotope analysis of all naturally occurring elements, such as Aston did more than 70 years ago in the 1st edition of his book. The information in Chapter 9 may be the single best justification to purchase this book. The extent of discussion of various elements is roughly in accord with their importance to a given field. Mononuclidic elements, for which ratiometric measurements are impossible, are dismissed in a few sentences with one or two references, as appropriate. A more thorough treatment is given to isotope ratio measurements of light elements (CHNOS), those of importance for geochronology (Sm/Nd, Rb/Sr, Pb, Th, U) and elements used in nuclear fuel production and monitoring (Xe, U, Pu). Sufficient examples of real-world analytical measurements are given in this section so that readers can gain an appreciation of the precision and accuracy achievable by modern isotope ratio mass spectrometers.

Chapter 10 contains about a dozen selected applications of isotope ratio mass spectrometry in various physical and biological sciences. No more than 3–4 pages are devoted to each topic, so experienced practitioners will be disappointed with the coverage of their specialty. However, the purpose of this monograph is to provide a broad overview of a complex subject matter, and in the process give readers a thorough enough bibliography to pursue as their interests dictate. Chapter 11 contains a compilation of equations for the calculation of isotopic abundances for various elements based on the atomic or molecular species being quantitated. Appendix 1 is a table of the elements and all naturally occurring isotopes, including the relative abundance, atomic mass and ionization energy. Appendix 2 is a table of the standard IUPAC confirmed atomic masses of the elements.

Modern Isotope Ratio Mass Spectrometry is generally well organized and readable, so it will be a worthy addition to the library of everyone who practices the art of isotope ratio mass spectrometry. This book will be especially valuable for scientists first contemplating the use of stable isotopes in their research. Despite the inevitable blemishes that creep into a complex manuscript, I enjoyed reading Platzner's book and took away from the experience a deeper appreciation of my craft.

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