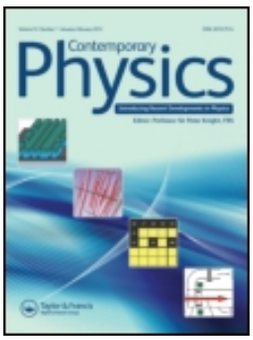

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Astronomical Spectroscopy: An Introduction to the Atomic and Molecular Physics of Astronomical Spectra, 2nd edn., by Jonathan Tennyson Atomic Astrophyiscs and Spectroscopy, by Anil K. Pradhan and Sultana N. Nahar

Stephen H. Ashworth

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multidisciplinary applications, such as the development of intraocular cameras for retinal prostheses.

This book is certainly enjoyable for anyone with an interest in optics, spectroscopy and nanosciences in general. It provides a heterogeneous overview of several fields of optics. The various chapters are very different from each other, going from the very mathematical theoretical description of quasi-normal mode expansion to the narrative account of the history and present perspectives of VLSI photonics. Here and there, there are also some elements that add personal depth to the figure of Professor Richard Kounai Chang, for example, the account of the testing of a single-particle fluorescence spectrometer: 'The system was assembled and tested at Yale. To investigate this sampling particle fluorescence spectrometer's capability to measure particles emanating from non-humans (e.g. allergenes), Richard brought in his dog to the laboratory. The instrument could detect the increase in fluorescent particles when Richard's dog walked around wagging his tail: thus this new sampler was termed the ''Dog Sniffer'''.

Giovanni Volpe
Bilkent University
giovanni.volpe@fen.bilkent.edu.tr

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Stars in Their Eyes

Astronomical Spectroscopy: An Introduction to the Atomic and Molecular Physics of Astronomical Spectra, 2nd edn., by Jonathan Tennyson, Singapore, World Scientific, 2011, 223 pp., £17.84 (paperback) £40.85 (hardback), ISBN 9789814-291965. Scope: textbook. Level: undergraduate.

Atomic Astrophyiscs and Spectroscopy, by Anil K. Pradhan and Sultana N. Nahar, Cambridge, Cambridge University Press, 2011, 376 pp., £45 (hardback), ISBN 978-0-521-82536-8. Scope: textbook. Level: advanced undergraduate/postgraduate.

We already know a great deal about the composition of stars and the dust and gas between them. This knowledge has been built up over time despite the fact that we have not been able to visit a star, or interstellar space for that matter, in order to collect a sample for analysis in a laboratory. All we know about the composition of stars and the interstellar medium is from photons which reach Earth, particularly those which end up in telescopes and spectrometers. A key to teasing out all the particulars is a detailed knowledge of astronomical spectroscopy and astrophysics.

Tennyson's book concentrates on spectroscopy. It is aimed squarely at an undergraduate reader, or perhaps a graduate who is new to the field. He starts by explaining why we feel the need to record astronomical spectra and develops the concepts required to understand later chapters. The later chapters slowly move up through the gears from hydrogen to multi-electron atoms and finally the influence of magnetic fields. Then with an excursion into the additional terminology required he deals with molecular spectra, taking in rotational, vibrational and electronic spectra.

The pace is suitable for a novice, the explanations are clear and the rich level of black and white diagrams (with the occasional greyscale and one colour) are used very well to augment and illustrate the text. The index is helpful and the list of further reading has some classic texts which definitely provide material to underpin and expand the content. Of particular note are the model answers to the questions posed at the end of each chapter. These are concise, but nevertheless explain the method of solution rather than simply giving the numerical answer. In addition there are a number of problems which ask for an estimated value. The model solutions for these come with an appropriate health warning that the model answer might be different from the reader's.

Pradhan and Nahar have written a much weightier tome, and not merely physically heavier. With a smaller font and wider pages they have taken a wise decision and adopted a two column format. Unlike Tennyson's book, which closely follows a single lecture course, Pradhan and Nahar have derived their material from a much wider range of courses. These include Theoretical Spectroscopy, Scattering Theory and Atomic Structure. That these lecture courses are taught at the advanced undergraduate or graduate level is clear from the text as the authors assume a higher level of background knowledge than does Tennyson and the complexity increases quite quickly. After the obligatory introductory material we are already considering the Dirac equation in a central field before the end of chapter two. As did Tennyson, the authors introduce some important tools and concepts first, but rather than build atomic and molecular complexity the chapters focus on physical processes. These build up to considering stellar properties and spectra towards the end of the book. This is not to say, however, that the earlier chapters do not draw on lots of practical examples with spectra and graphs to illustrate the material.

The other big difference between this and *Astronomical Spectroscopy* is fairly obvious from the title. While the latter concentrates on spectroscopy in general the focus of Pradhan and Nahar is atoms,

atomic spectroscopy and the associated astrophysics. The level of detail is entirely appropriate and should the reader wish to know more there is a comprehensive list of references. The index has an appropriate level of detail for the reader to find their way around the book if necessary and the appendices neatly augment the text.

There are a few exercises and they are scattered throughout the text, rather than concentrated at the end of the chapter which makes them hard to locate, should one wish to. These are also given in isolation with no indication of solutions. They might appear on the authors' websites which they undertake to keep up-to-date with the latest atomic data and developments in atomic astrophysics.

One small thing which I would have been grateful to have seen would have been a glossary of abbreviations. If I aim to use this as a text book I would like to be able to find the difference between ISM and a QSO, discover what it means if the AGN is rotating around the SMBH and know what RR and DR are in order to understand their contributions without having to read the relevant chapter right from the start (only to discover that some of these are only revealed in figure captions!). On the other hand it might be that most of the readership will be well versed in these abbreviations – but more than likely there will be those who are not.

I found both books extremely interesting and well put together. They are clearly aimed at different readerships. For undergraduates in astrophysics, physics in general, and even chemistry, Tennyson's book is to be recommended. Even if not used as a primary text it would be useful to augment atomic (and even molecular) spectroscopy courses with applications and examples. On the other hand, Pradhan and Nahar's book is for more advanced undergraduates and graduate students of astrophysics. With a glossary of abbreviations it would also be a useful reference work.

Stephen H. Ashworth
University of East Anglia
s.ashworth@uea.ac.uk

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The Magnesium Civilisation: An Alternative New Source of Energy to Oil, by Takashi Yabe and Tatsuya Yamaji, Singapore, Pan Stanford, 2010, 147 pp., $49.95 (hardback), ISBN 9789814303651. Scope: general interest. Level: general readership and non-specialists.

This book sets out Professor Takahashi Yabe's vision for a sustainable civilisation in which magnesium is used as the main energy source through magnesium-air batteries for transportation – in cars, railways and even ships – and even as fuel for conventional steam-turbine-based power plants. It also tells a personal tale of how he has grappled with the scepticism of the scientific establishment and the problems of funding blue skies research. His co-author is Tatsuya Yamaji.

Three key concepts underpin his vision: the harvesting of solar energy using solar-powered lasers, the smelting of magnesium from oxide using high-powered versions of the solar laser and the development of magnesium-air batteries for power. It relies upon smelting with solar energy resulting in a dramatic reduction in the price of magnesium metal.

It is more than 40 years since John Bockris formulated the idea of a hydrogen economy, as a way of meeting our energy needs, particularly for transportation, when supplies of oil are exhausted. Even then he recognised that this fuel, which could generate electricity in a fuel cell, producing only water, would help to avoid global warming through reducing production of carbon dioxide. Of course there are no natural sources of hydrogen, so in a sustainable world, energy must first be harvested to generate hydrogen by electrolysis, or a chemical route. Yabe rejects hydrogen as the best answer because it can embrittle metals, because of the difficulty of storage and transport, because the fuel cell needs precious metal catalysts, and because of the danger of explosions.

So why would magnesium be a better solution than hydrogen? Hydrogen is a very light fuel, seemingly ideal for powering vehicles or aircraft, but it needs to be transported in a container, typically high-pressure cylinders, or as liquid at very low temperature (as gas the volume is excessive). The weight of the container greatly reduces the quantity of hydrogen that can be conveniently carried and storage as liquid hydrogen results in a steady loss by boil off. Indeed there are active research programmes to create hydrogen stores with hydrogen bound as, for instance, a metal hydride. A store containing 10% hydrogen by weight would be considered a good outcome. This means that in practice light metals such as magnesium or aluminium provide a higher specific energy density than hydrogen.

In a magnesium-fuelled world portable power could be generated in a hybrid semi-fuel cell, with magnesium as the anode – just like a primary battery – but with the cathode reducing oxygen from the atmosphere, as in a hydrogen fuel cell. Unlike the hydrogen fuel cell where fuel is continuously fed to a permeable anode as a gas, metal-air batteries require mechanical replenishment of the anode material. Such batteries have already been tested on vehicles, using zinc-air and aluminium-air. At present the economics