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BOOK REVIEWS

The evaluation of scientific research (A Ciba Foundation Conference), (eds) David Evered and Sara Harnett, John Wiley & Sons, 1989, pp 284, £32.50/$57.95.

The Ciba Foundation normally sponsors gatherings concerned with medical and biological research. By departing from this normal policy and holding this international conference wherein experts in the field of evaluation take stock of the state-of-the-art, the Foundation has done a valuable service to science. The book consists of fourteen brief articles; when one reads these one sees the range of topics covered in this Conference. Various techniques, methodologies and case studies have been used to evaluate: national performance in science and technology; British technological universities; a fifth generation computer programme; links between science and technology; the impact of different modes of funding; the effectiveness of research training; the performance of academic institutes and research groups; the impact of science policy; forecasting; the peer review system; and there is also one paper which evaluates the evaluators! There are serious discussions on *science and surprise, evaluation and uncertainty*, and *beyond bibliometry* – a veritable feast, sometimes a bit indigestible.

For most of the studies, bibliometry and the Science Citation Index (SCI) invented by Eugene Garfield are used. Almost fifty years ago, Lawrence Bragg used statistical methods to assess the number of good scientists that England produces. He concluded that as only one good physicist comes out of each million of population great care has to be exercised in training and using them. It was also Lawrence Bragg who appointed D. J. de Solla Price to the archives of Cambridge (who inspired by Bragg's work) started the field now called Science of Science. Statistical methods have become an important feature of contemporary scientific development. The next step was the enunciation by John Ziman of the premise that science is a corporate activity and so scientists have to communicate with each other and expose their science in scientific journals for critical evaluation by the scientific fraternity. The implication is that while scientific discoveries may be made by individuals or groups their acceptance and assimilation into the body of science rests solely on the scientific community. The present writer feels that Eugene Garfield took off from this point and found that the only method by which one can find out how many scientists read a scientific paper is by counting the number of times it is cited in other papers. He propounded the principle that this citation index is a measure of the influence that the paper has had on science. This started the Science Citation Index (SCI). Scientists were curious to know whether their papers were read at all. The citation index then became a performance indicator for quantity and later of quality. SCI has now taken over science, scientists and scientific administration. Using SCI, the Institute of Scientific Information (ISI), of which Garfield is the Director, made uncanny predictions – of Nobel Prize winners and Fields medallists. One even began to wonder whether citation was also taken as one of the criteria for such awards!

Do the best papers get cited most? The answer is definitely no. For example, one of the well-known citation classics is the review S. Chandrasekhar, Astrophysicist of Chicago, wrote in the *Reviews of Modern Physics* (The stochastic processes in physics and astronomy). This is by no means his greatest or best paper. Yet, it was read by many because it was easier to understand and it suggested the

application of a technique to many fields. There can be no doubt that the paper influenced the development of different fields in a big way. If a paper gets published with an error which is subtle it can become a citation classic (poly water is a case in point)! There are, of course, many pedestrian papers which have become citation classics and one can wonder why.

When scientists came to know that SCI has become Bible for evaluation for jobs, prizes, elections to learned Societies, etc., methods were devised to ensure that their papers do get cited. Concepts like *smallest publishable units, citation rings,* etc., have come into being.

If the scientific community had been a homogeneous one many of the original objectives of SCI would have been fulfilled. That there are problems is indicated in one of the papers in this volume which describes a peculiar case. The earlier studies by ISI presented a pessimistic view of the impact of scientific papers from countries like Germany, Japan, etc., which appeared unrealistic to many (at least in those countries). A new methodology has been evolved — called the relative citation rate (RCR) wherein extra weight is given to the citations made inside the country to normalise the results. The sceptic may feel that processing of the data is being cooked up to get those results which one intuitively wants.

The case of India (and other developing countries) is much more complex for many reasons. (1) The extreme reluctance of western scientists to quote work from foreign countries, especially that from developing countries; (2) The propensity of Indian scientists to quote mostly western sources (to get recognition, citations, fellowships, jobs and for many other reasons); (3) The peculiar attitude not to quote Indian sources. (We shall not discuss the sociological reasons). One of the ablest scientists from India of international stature feels that it is a mugs game and to expect recognition from the west is just a pipe dream. Any assessment through the normal procedures of SCI may therefore be very distorted. How does one arrive at adequate performance markers for India and for developing countries?

Unfortunately, evaluation of scientific research has become extremely important as it affects critically research funding, science policy and the investment that a country has to make in science. The failure of investments in basic reasearch to perform obvious economic miracles is why government and other organisations are seeking evaluators and performance markers. Alvin Weinberg, the pioneer in this field, in his introductory paper "Criteria for evaluation – a generation later" gives two criteria:

1) "The underlying value in the practice of science is *truth* and what achieves truth efficiently is the most valuable".
2) "The underlying value in the administration of science is utility and what is most useful (in addition to it being true) is the most valuable".

One wonders whether the process of evaluation can integrate these two criteria or is the process doomed to failure?

As mentioned before, the only tool that seems to be available to the evaluator is the Garfield SCI. About this Sir David Phillips, the Chairman of this Conference, aptly relates that the old chestnut "Are we looking for the lost wallet under the street lamp which is the only place where there is light"? To be fair to Garfield, when he invented SCI it was done for the convenience of scientists, rather than for the policy analysts. Gene Garfield attended this Conference (as he does most others on this subject) and asked many perceptive questions but one is never too sure whether he agrees with many of the suggestions and deductions.

In spite of the healthy scepticism shown by many we must accept that performance indicators and the evaluation of scientific research based on them are here to stay and we must learn to live with them and find out how they can be used sensibly. It must also remembered that research

evaluation has become an industry with its own academic pundits, contractors seeking contracts and jobs. In this Conference many questions asked were revealing.

"Are we a community of technicians in the business of evaluation or is our role model management consultancy"? Again,

"What is the relationship between evaluator and the customer"?

"Would the professional evaluators have their own ethical and moral codes or will they abandon them and try to satisfy their employers or the powers that be"?

The book is really a debate between various groups mainly between the pragmatist (science policy analyst) and the sociologist of science. Many serious differences amongst the most pragmatic participants about the acceptability of various bibliometric procedures, and techniques have been aired. There are some who feel that if they are honest enough and delve deep enough they may even get answers to the questions as to how science itself works.

This is an important book which scientists, science policy makers, science administrators must read. In India they must be very careful to use it with great discrimination. They should also read the wise summing up by Sir David Phillips.

Raman Research Institute S. RAMASESHAN
Bangalore 560080.

Topics in functional analysis and applications by S. Kesavan. Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110002, 1989, pp 259, Rs. 65.

The theory of partial differential equations is of prime importance in several practical problems which arise in physical, biological, engineering and technological sciences. Functional analysis plays a key role in the study of such equations. It is not only necessary for a theoretical setting for studying existence and uniqueness properties of solutions of these equations but is also an indispensable tool for convergence analysis of approximate solutions.

Any introduction to the modern theory of partial differential equations requires a good exposure to a different set of amalgam of higher level topics in functional analysis than presently available in the standard text books. This amalgam consists of Distribution theory, Sobolev spaces and Semigroup theory.

With this basic functional analysis framework in mind, it is very pertinent to start with Sobolev spaces and their properties. This is what the author does in Chapter 2. The matter covered is sufficient to deal with various types of partial differential equations under investigation—heat equation, wave equation and Schrödinger equation. The prerequisite for the study of Sobolev spaces is Distribution theory which is done in detail in Chapter 1.

Elliptic boundary value problems are introduced in Chapter 3 wherein important concepts like weak solutions of partial differential equations and the notion of regularity of weak solutions are dealt with. This chapter also contains some scattered subtopics like maximum principles, eigenvalue problems, Galerkin method and finite element techniques. An important topic like finite element method (which is actually a subtopic here) is hastily concluded in eight pages. Perhaps it could have been discussed more in detail with Galerkin method as subservient to it.

Semigroup theory is of vital importance for any worthwhile discussion in partial differential

equations. It is given its rightful place in the book. Its application to various initial value problems is neatly described.

The last chapter on nonlinear analysis is rather a conglomeration of several topics like fixed point theory, variational methods and monotone iteration techniques. Galerkin method (for nonlinear equations) reappears in this chapter. It should have been covered in Chapter 3 with a slight modification to suit nonlinearities. Monotone iteration techniques are dispensed within four pages. A bit of general discussion under ordered Banach space structure would have matched well with the modern flavour of the book. Similarly, variational methods go along well with monotone operator theory, a discussion on which is missing in the book. It must be admitted that nonlinear analysis is a vast topic and the choice of subtopics differs from author to author. Nonetheless, this chapter does illustrate the application of some well-known tools of nonlinear analysis, specially fixed point theory. All in all the book is a fine exposition of modern theory of partial differential equations. A book of this kind is missing in the literature, from the Indian environment point of view. It does fill the gap.

It should be of use to both the faculty and students of Indian universities, desiring to pursue research in modern applied mathematics. It could also form a basis for designing new applied functional analysis courses in mathematics curriculum of Indian universities.

Department of Mathematics
Indian Institute of Technology
Bombay 400 076.

M. C. JOSHI

A history of algebraic and differential topology 1900–1969 by Jean Dieudonne. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1989, pp 648, SFR 140. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchasheel Park, New Delhi 110 017.

It is a pleasure to review this book and certainly the job turned out to be quite rewarding by itself. As the title suggests, the book describes the development of algebraic and differential topology from 1900 to 1960. However, one of the main branches, *viz.*, the low-dimensional topology has been completely excluded.

Taking the view that, though topology as such existed even in the nineteenth century, algebraic topology began in its earnest only in 1990, the author rightly justifies the choice of the initial date for his narration. According to him, the choice of the terminal date, *viz.*, 1960 is mainly due to the constraints on the size of the book and the fact that it is rather difficult to take a bird's eye-view of more recent developments. One can hardly differ from him, in choosing to exclude the low-dimensional topology either, the inclusion of which would have made the present book too unwieldy and devoid of its present thematic flavour. The author feels that the topic deserves a separate book on its own and hopes that somebody will soon write one.

Instead of a chronological narration, the author has adopted a thematic description and accordingly has divided the book into three parts. As it turns out, such an arrangement of the material has resulted in a smooth unhindered presentation of the developments of various mathematical concepts.

In the first part, the author describes the fifty-year evolution of the homology theory without reference to its relation with homotopy theory or to its utility. Rightly, he has to begin with the works of Poincaré, the father of algebraic topology. Here, amongst other things, the story of Pontrjagin's duality theorem about the compact abelian groups and how it influenced Alexander and Kolmogoroff to come up with the general definition of cohomology and the correct formulation

of Poincaré's duality theorem makes an interesting reading. Remarks such as how partition of unity enabled one to obtain a simple proof of Stoke's theorem enrich the book.

In Part 2, the author gathers various results linked to homology and which do not use the homotopy theory. One is thrilled to read how Brouwer solves several outstanding problems by employing his single notion of the degree of map. Other important things described here include J. H. C. Whitehead's CW-complexes, applications of the fixed-point theorems to analysis and geometry and the 'Calculus of variations in large' due to Morton Morse.

Part 3 is the largest part of the book being a bit more than half of the book. Having described homology thoroughly, the author now ventures to describe homotopy theory, the central concept of algebraic topology. Here again, though Poincare had studied the fundamental group, way back in 1895, the starting point of homotopy theory as such can be taken to be the pioneering work of H. Hopf, on the self-maps of spheres wherein he proves a conjecture of Brouwer. Then follow the works of Hurewicz, Whitehead, etc., leading up to the suspension theorem of Freudenthal. Side by side, Whitney and others had expounded the theory of fibre spaces and vector bundles leading to the works of Stiefel-Whitney, Pontrjagin and Chern on characteristic classes. In 1946, Leray applied his spectral sequences to determine the cohomology of fibre spaces and homogeneous spaces. It is interesting to note how an innocent looking result due to Hopf about the quotient of $H_2(K)$ by the spherical classes led to the discovery of homology groups of discrete groups, Eilenberg-MacLane spaces and Postnikov's towers, each one of them being a landmark in the development of homotopy theory.

A major breakthrough in homotopy theory was the thesis of Serre in 1951, on the homotopy groups of spheres. Another such important result is Bott's Periodicity theorem. This era in algebraic topology saw new departures, such as Thom's Cobordism theory and Grothendieck's K-theory, opening the floodgate of novel and powerful tools. Both the above ideas are extremely simple but have been proved to be very effective. In his preface itself the author cites what Hadamard once said: *'In mathematics, simple ideas usually come last'.*

The paper, the print and the format of the book are excellent. There is a list of notations, a bibliography of 526 titles, an index of cited names and a subject index. The three elaborate introductions to the three parts have enhanced the utility of the book. The number of misprints is remarkably low. However, there are quite a few irritants such as the choice ($\tilde{C}X$ and CX for the cone and the reduced cone over X, respectively (instead of the other way round)). The following sentence which appears on p. 252 makes a difficult reading: 'In 1932 [310] he pointed out, on simple examples, that the smooth models of the same surface S needed not be homeomorphic, contrary to what (according to him) was believed by many algebraic geometers'. One hopes that, in subsequent editions, these errors will be rectified. A word of caution: if you are looking for any spicy human stories in this book, you will be disappointed.

To sum up, this is one of the most valuable books to the mathematical community that I have come across recently. Both students and experts in algebraic and differential topology can benefit from this. Mathematicians who want to learn about just a particular result or notion in this area find it a very useful reference book. One must at least read the introductions to each of the three parts. This book is a must to every library that has anything to do with higher mathematics.

Department of Mathematics
Indian Institute of Technology
Bombay 400 076.

A. R. SHASTRI

Integrable systems of classical mechanics and Lie algebras by A. M. Perelomov. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1990, pp 307, SFR 138. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchasheel Park, New Delhi 110 017.

V. I. Arnold stated sometime ago that it is beyond the capabilities of present-day science to analyse a general Hamiltonian system with two or more degrees of freedom. In spite of this bleak prospective, remarkable progress has been made during the past two decades or so in the understanding of several nonlinear dynamical systems, leading to the concepts of solitons and chaos. Soliton systems such as the Korteweg–de Vries equation, nonlinear Schrödinger equation, Toda lattice, etc., are completely integrable dynamical systems, while the Henon-Heiles system, Duffing oscillator, etc., are, in general, nonintegrable and often chaotic. It is a challenging task to identify, characterise and analyse nonlinear dynamical systems based on their integrability property. For Hamiltonian systems admitting regular motions, completely integrable systems form a distinct class. By standard definition, completely integrable Hamiltonian systems with N-degrees of freedom admit N-1 additional involutive integrals of motion so that in principle the system could be reduced to quadratures. This book, based on lecture courses given by the author at the Moscow University, is a welcome collection of such completely integrable systems of nonlinear dynamics and Lie algebras. Starting from the simplest examples with one degree of freedom, some very classical but rarely known systems as well as some novel recent examples with two-, three-, and N-degrees of freedom are included in the book, though there are some significiant omissions.

The introductory chapter gives some standard preliminary results on Poisson bracket structure and symplectic manifolds associated with Hamiltonian systems, the connection with the symmetry groups, and the concept of complete integrability. Hamiltonian systems with co-adjoint orbits on Lie groups are also introduced. Several mathematically sophisticated theorems on involutive properties, etc., are given, though their real motivation is not clear as many of these theorems do not find a role in the following chapters.

Chapter 2 deals with several interesting completely integrable systems with two-, three- and N-degrees of freedom along with their explicit involutive integrals of motion. For two degrees of freedom systems, several classes of potentials admitting quadratic, cubic, quartic and transcendental integrals in momenta are explored by a direct method (used originally by Bertrand, Darboux, Whittaker and others). Separability properties of such systems are also analysed. The studies are then extended to higher dimensions.

Chapter 3 deals with integrable systems of N-interacting particles in one dimension of the form $H = 1/2 \sum_{j=1}^{n} p_j^2 + g^2 \sum_{j<k} V(q_j - q_k)$, where g is a constant, through the Lax pair approach. If the equations of motion can be identified with the Lax pair representation $i\dot{L} = [M, L]$, where M, L are Lax pair matrices, then the inverse scattering formalism holds good and involutive integrals are identified as $k^{-1}\mathrm{Tr}(L^k)$. For a specific ansatz of L and M, four classes of potentials are identified with the form of $V(\varepsilon)$ as (1) ε, (2) $a^2 \operatorname{sech}^{-2}(a\varepsilon)$, (3) $a^2 \sin^{-2}(a\varepsilon)$, and (4) $a\mathscr{P}(a\varepsilon)$, where $\mathscr{P}$ is the Weistrass elliptic function. The properties of these four completely integrable classes are discussed and their Lie algebraic generalizations introduced.

Chapter 4 deals with the integrability of the nonperiodic Toda lattice. The Toda lattice is a system of particles on the line with exponential interaction between neighbours. After discussing the Lax pair, involutivity of the integrals of motion, the scattering problem associated with the Lax pair and the association with the group of real upper triangular matrices are discussed. The generalisation related to the root system and simple Lie algebras are developed in a most impressive way.

Chapter 5 contains a miscellanea of integrable systems related principally to soliton systems. The

list of references is quite impressive: rare old literature on integrable systems is cited, which is hardly known to workers in the field, though some relevant recent references are missing.

My main criticism of this book is that no systematic method is presented or advocated for finding completely integrable systems. Some systems are identified by finding the involutive integrals of motion directly, certain others through their symmetry properties and others are analysed through the Lax pair and their Lie algebraic generalisations. The question whether each one of these methods or techniques is applicable to every one of the completely integrable systems is neither addressed nor analysed. Some standard methods such as the generalised Lie symmetry analysis or singularity structure analysis to locate the completely integrable system are not discussed in this book. There are also significant omissions such as integrable generalisations of Heisenberg spin chain, N-coupled quartic oscillators, central-field nonpolynomial oscillators, etc.

In spite of these comments, I find this book to be very enjoyable and a valuable addition to the literature on nonlinear dynamics. I am sure research workers in the area of modern dynamics and Lie groups will love to own a copy of it despite its high cost.

Department of Physics
Bharathidasan University
Tiruchirapalli 620 024.

M. LAKSHMANAN

Hadronic mechanics and non-potential interactions edited by M. Mijatovic. Nova Science Publishers, Inc., 283, Commack Road, Suite 300, Commack, New York 11725–3401, 1989, pp 371, $ 102.

This book is essentially the proceedings of the fourth workshop on 'Hadronic mechanics and non-potential interaction' which was held in Skopje (Yugoslavia) during 22–26 August, 1988. The papers lay special emphasis on mathematical methods which permit quantitative analysis of non-potential interactions using Lie-isotropic and Lie-admissible algebras.

It is somewhat difficult to judge the quality of contributions in such a book. There are over 20 papers discussing a variety of topics. Most of these papers, however, are of rather unconventional nature and do not quite follow the conventional use in the subject. Thus this proceedings can be useful if one is interested in learning about the non-standard approaches to standard subjects.

There are three papers dealing with the mathematical approach to the geometry of space time at microscopic levels; five dealing with the differential geometric approach to some aspects of dynamical systems; five on model building for hadrons; one on coherent and squeezed states for photons; and the rest dealing with applications of Lie algebraic theory to physical problems. All the papers are highly technical and are written for the expert in the field. Though a couple of papers try to give an overview of the subject, by and large, they will not be understandable to non-experts.

Priced at over $ 100, I doubt whether any individual should buy this book. It may be more suitable for libraries with liberal funding in institutes where active research in these areas is being carried out.

Theoretical Astrophysics Group
Tata Institute of Fundamental Research
Bombay 400 005.

T. PADMANABHAN

Analytical instrumentation handbook edited by Galen W. Ewing, Marcel Dekker, Inc., 270, Madison Avenue, New York, NY 10016, 1990, pp xi + 1071, $234.

As a sequel to several editions of instrumental methods of analysis, the book under review covers most of the methods dealt earlier except nuclear methods and simultaneously introduces several new relevant topics for the reader interested in this basic area of chemical science. Professor Ewing deserves appreciation for undertaking this difficult task especially in areas where most of the instruments are assembled by the user and the choice to include or omit a particular technique is open to question. The word 'analytical' implies the use of analytical chemistry for the solution of a problem and 'instrumentation' encompasses several disciplines such as optics, electronics, materials science, computer applications, including hardware and software, etc. However, since this compilation is intended for chemists, too much emphasis on other disciplines may negate the basic purpose of this book. For a researcher, on the other hand, there is a definite need to pinpoint the best method for the solution of a problem and also for evaluation in terms of cost, labour and cross checking the results. The book succeeds in this task as the contributors, in general, have projected the strong and weak points of the techniques under consideration.

The book has been organized in five parts, *viz*., the measurement of mass, spectrochemical instrumentation, electrochemical instrumentation, chromatographic methods and miscellaneous methods. Various techniques under the purview of these broad classifications have been organized in 26 chapters preceded by 'the use of computers in the laboratory'. It seems incongruous and significant that this topic should precede the text which goes only to prove that computers have become part and parcel of analytical chemists' paraphernalia.

The second chapter deals with laboratory balances. No doubt, the measurement of mass is an important laboratory task, but its inclusion in the scope of this book seems definitely out of place. Third chapter on 'Organic elemental analysis' is well written covering the determination of C, H, N, O, S, P, Si, Hg and halogens.

In spectrochemical instrumentation, there are 15 chapters covering spectrophotometry, infrared and Raman spectroscopy, atomic absorption and emission techniques, photoacoustic, X-ray photoelectron, Auger electron spectroscopy, NMR, EPR and two related topics on chiroptical techniques and use of lasers. Ultraviolet and visible spectrophotometers is a lucid presentation of the state of art by Ewing. The chapter on infrared spectroscopy contains an appropriate description of the Fourier Transform technique. Chapters 4, 5 and 6 cover the theoretical and experimental aspects of atomic absorption and emission including flame and graphite furnace techniques. Molecular fluorescence and phosphorescence are discussed in Chapter 8 along with recent developments such as synchronous excitation, total luminiscence spectra, polarization measurements and luminiscence lifetime measurements. Chapters 9 and 10 describe Raman spectroscopy and photoacoustic instrumentation. Despite the emphasis on the potentialities of these techniques, their widespread use is rather limited owing to the prohibitory cost of these equipment. Chiroptical techniques provide information about the molecular activity only and hence their limited uses. Chapter 13 on nuclear magnetic resonance is quite exhaustive as it should be. Theoretical aspects have been well developed but actual instrumentation is rather cursorily dealt with. The same is true of EPR where the use of block diagrams is extensive. X-ray photoelectron and Auger electron spectroscopy have been in the forefront of surface analysis in diverse fields such as catalysis, corrosion, magnetic storage media, biological surfaces and polymers. These are the best contributions in the handbook.

Part III is a presentation of potentiometry, voltammetry, coulometry, conductance and stripping analysis. The subject treatment is mostly theoretical, probably because the instrumentation is user oriented depending upon the information sought. Voltammetry is very informative on the various

types of polarography, including several photographs of commerical instruments. Chapter 18 on stripping analysis fills a vital need, for this important technique is not normally accorded its rightful place in several books on analytical chemistry. The potentiality of this method should be emphasized as a suitable alternative to trace and ultratrace analysis and metal speciation studies. Electrolytic conductance and coulometry have been treated rather prefunctorily.

Part IV is devoted to gas chromatography (GC), high-performance liquid chromatography (HPLC) and supercritical fluid chromatography (SFC). Tremendous advances have been made in these fields regarding the column support materials, sample injection systems, solvent delivery, detectors and data handling. All these techniques share some overlap regarding their applications but it should be borne in mind that each has a unique area of capability. The subject treatment is quite exhaustive and all in all chromatographic instrumentation is well presented.

Miscellaneous methods, *viz.*, mass spectrometry, thermoanalytical techniques, automatic titrations and continuous flow analysers have been presented in Part V. The chapter on mass spectrometry would be quite useful for university students. Thermoanalytical techniques such as TGA, DTA, DSC, EGD, TMA and DMA have been explained well in Chapter 25. Developments in automatic titrations with respect to reagent delivery and end-point detection have been detailed in Chapter 26. Special systems for the determination of water, sulfur and calcium have also been described. The last chapter on continuous flow analysers is a surprise inclusion in that it is an applications-driven technology involving wet chemical methods adapted to automation. These are compared to flow-injection analysis (FIA) with reference to theoretical principles, instrumentation, methods development and computer interfacing. Since this is a low-cost 'try yourself' technology it may motivate the researcher to develop new methods.

In general, the book presents a wide array of analytical techniques presently available to the chemist. The handbook exposes the potentiality of each technique. It can be used as a reference book by practising chemists and students. Considerable variation in presentation format is obvious. However, the text is presented in a simple and systematic manner for easy reading. References are listed at the end of each chapter covering up to 1986 and abbreviations, acronyms and subject index are placed at the end. The printing is very good but the cost is rather high from the Indian point of view. It is a useful book for those interested in the 'state-of-art' analytical instrumentation.

Department of Chemical Engineering
Indian Institute of Science
Bangalore 560012.

J. R. MUDAKAVI

Solid state physics-I, (eds) M. A. K. L. Dissanayake, R. Attele and K. Tennakone. Nova Science Publishers, Inc., 283, Commack Road, Suite 300, Commack, NY 11725–3401, 1990, pp xix + 345, $98.

This book presents the lectures given at a summer school held at Kandy, Sri Lanka. Several leading workers were invited to give talks dealing with exciting new developments in the field of solid-state physics which have led to numerous technological breakthroughs. In particular, the symposium focussed on developments in the areas of semiconductors and solid electrolytes. Recent developments in these areas are likely to revolutionize the life as we know it. In this sense, this book is an important record of the current state of knowledge on these topics.

One of the important developments in the area of semiconductors has been possible due to the availability of technology to achieve two-dimensional structures. Such structures have led to new

physics and applications never thought possible before. Hence, it is proper that several chapters are devoted to quasi-2D structures. Thus, Berggren has contributed a chapter on quantum phenomena in small semiconductor structures. Various topics in the theory of electron transport in 2 and 1D structures have been dealt with by Butcher and Gallagher. Theoretical aspects of heavily doped semiconductors have been ably covered by Sa-yakanit. Zafar Iqbal has given an excellent overview of some current topics especially from an experimentalist's point of view.

The book also describes several interesting structural chemistry aspects. The chapter by Gunawardane dealing with structural chemistry of several framework silicates and the contribution of Tennakone on semiconductor materials for photoelectrochemical cells and photocatalysis provide useful summary. The two chapters by Skaarup describing solid-state lithium ion conductors and solid-state batteries highlight some of the recent developments in this field. The contribution of Liquan deserves special mention. He has surveyed a wide variety of dispersed systems exhibiting ionic conductivity including high T_c superconductivity.

The book also contains short contributions by several workers from Sri Lanka and other countries. Some of these are very interesting and well written. The subject index at the end of the book is very useful.

Solid State Structual Chemistry Unit
Department of Physics
Indian Institute of Science
Bangalore 560012.

J. GOPALAKRISHNAN
VIKRAM KUMAR

A textbook of electronics by S. L. Kakani and K. C. Bhandari. Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110002, 1989, pp viii + 432, Rs. 85.

This book has been written for the students of B.Sc. and B.E. taking electronics as a major subject. It is undoubtedly a very important area of study where a big need for trained manpower exists. Day by day this need is increasing. Several universities in India have introduced B.Sc. in electronics in recent years. This book is meant to serve as a textbook for such courses and, as such, fulfils an important requirement.

The book covers a wide range of subjects. I am glad to note that the emphasis is on semiconductor-based electronic devices though two chapters are devoted to vacuum tube devices. This also reflects a major shortcoming of this book. It has not been able to break away from the past and look into the future. In modern electronics there is little room for vacuum tube amplifiers. Vacuum devices can be considered among special devices such as cathode-ray and microwave tubes. Triodes such as RC-coupled amplifiers, for example, should not have been devoted so much space. On the other hand, it is not understandable why a book published in 1989 should include operational amplifiers only in a short appendix. The op-map has revolutionized the way of life as we know it. Being an over twenty-year-old invention, it should have been a major topic in this book. Likewise, it is a pity that digital electronics is consigned to another appendix.

It is perhaps true that this book reflects the B.Sc. syllabi of some universities. In that case it will be better to change those syllabi.

As it is, this is a good book with very lucid coverage of various topics. There are several worked-out problems and objective-type questions. These will help any student in understanding the material. A large number of figures also helps. I did not come across any errors, typographical or otherwise.

Hence, I will strongly recommend this book to those students who are unfortunate enough to have an outdated syllabus for their electronics course.

Department of Physics
Indian Institute of Science
Bangalore 560012.

VIKRAM KUMAR

Luminescence of wideband semiconductors edited by M. D. Galanin. Nova Science Publishers, Inc., 283, Commack Road, Suite 300, Commack, N.Y. 11725–3401, 1990, pp x + 234, $111.

This book is part of the Proceedings of the Lebedev Physics Institute of the Academy of Sciences of the USSR. It contains review articles and detailed reports of work done at that Institute on the luminescence from ZnS, La_2S_3, La_2O_2S, InP and ZnO. These materials are technologically important due to their potential applications in optoelectronic devices especially as light sources in visible and ultraviolet range.

Luminescence, especially photoluminescence, is a powerful tool for the study of solids and defects in them. Photoluminescence spectrum of a semiconductor includes several emission bands/lines in a wide spectral range below the band gap depending on the temperature, excitation, intensity, impurities and defects. Thus considerable information can be obtained from a detailed analysis of luminescence spectrum particularly if investigated as function of temperature and process parameters. However, there is no simple relationship between an emission line and an impurity in a host and any identification has to be done very carefully.

The articles in this book are indeed reports of such investigations over several years by Georgobiani and his coworkers. A wide range of modifications of experimental systems have been described to suit the requirements of various investigations. Low temperature to liquid helium and wide wavelength range in infrared are used. Luminescence experiments are supported by other methods such as photoconductivity, thermally stimulated current, etc. All results are supported by numerous figures.

The detailed investigations on each of the materials in this book have led to energy-level diagrams, identification of the radiative centre and, in some cases, identification of its origin. Thus this monograph will be very helpful to researchers in relevant area even though the book is somewhat dated as I could not find any reference later than 1985.

Department of Physics
Indian Institute of Science
Bangalore 560012.

VIKRAM KUMAR

Beyond the limits: Flight enters the computer age by Paul E. Ceruzzi. The MIT Press, Cambridge, Massachusetts, 02142, USA, 1989, pp xiv + 270, $17.50.

This book was written to coincide with the opening of a new gallery of the same name at the Smithsonian Institution's National Air and Space Museum in Washington, D. C. The objective of this major new gallery was to update the existing exhibits on flight technology. It was realized by the curators of the museum that computers, more than anything else, have had a profound influence on the developments in flight technology in the later half of this century. What is perhaps not so well known is that it was the aerospace industry which nurtured the early developments in computer

technology. This book talks about this extremely successful interaction between two mammoth industries and how it led to rapid developments in both.

The first chapter presents a brief history of flight and computer technology, setting out the major milestones reached during the decade following the end of the Second World War. During the initial period there was very little interaction between the two communities, though soon the designers of flight vehicles realized the usefulness of computing devices. This initiated the process of bringing the digital computer out of the laboratory and into general commercial use. Though many other agencies and industries, apart from aerospace, purchased or leased the early computers, they could not make full use of them due to their inadequate technical knowledge in handling and maintaining such delicate and complicated machinery. Aerospace, on the other hand, was different as it was used to handling sophisticated machinery and thus was able to make adequate use of the power of these machines. It was also able to suggest possible improvements and, more important, provide funding for future developments in the computing industry.

In the next chapter, the focus of the book shifts to the Northrop Aircraft Company where two of the most significant developments in aeronautics took place. One was the Snark guided missile and the other the Flying Wing manned bomber. Neither craft was a success but they had important and far-reaching effects in both the computer and the aeronautics industry. Their design posed problems whose solution required computing devices of power far beyond those available in the market. For example, the problems of determining the load factor, the factor of safety, flutter, etc., required extensive computational effort. These, in turn, presented a new challenge to the computer industry to develop better machines. One of these projects was to develop a computer called BINAC to guide the Snark missile in its flight. Although BINAC failed to perform satisfactorily, its failure provided the necessary impetus for developing better computers. The money received for this project funded the subsequent development of the UNIVAC computer. The failure of BINAC also motivated some Northrop engineers to design smaller computers which were more successful. Later, some of these engineers left Northrop and formed their own companies for manufacturing small computers.

One of the major problems of the US Air Force was to find a scientific method to manage the logistic problem of operating an air force composed of a large number of different kinds of flight vehicles kept at air bases scattered around the world. The mathematician George Dantzig, then working in the RAND Corporation, modelled this problem in the linear programming framework and proposed the simplex algorithm for its solution. The practical problem which gave rise to this method had an enormous number of variables and equations. Nothing short of a powerful computing machine could go through the steps accurately in the desired short time. The Air Force contracted the National Bureau of Standards and the computer SEAC was built specifically for this purpose, though it was soon replaced by the much larger UNIVAC. The RAND Corporation was engaged in many such theoretical projects which required enormous computational power. In fact, a digital computer was built at RAND in 1953. All this made RAND a centre for fundamental research on computer science, with much of the contracted research being funded by the US Air Force.

With the start of the cold war, the idea of ballistic missiles, which carry bombs to very great distances without danger to human operators, gained favour with the US military strategists. A major problem with such missiles was their flight path planning, tracking, and guidance. For this a computer was absolutely necessary. A computer had to process the data, while the missile was in flight, fast enough to transmit corrective actions before the rocket motors cut off. All these requirements needed new and more powerful computers to be designed.

One of the projects undertaken by the US military was the project Whirlwind which initially had

the goal to simulate the flight characteristic of an airplane before it was built and to use that information to train flight crews to be ready to fly the plane when it entered service. For this a general-purpose simulator had to be built which could be readily reconfigured for several different aircraft. The simulator needed the use of a computer to solve the basic equations of flight and predict and analyse the forces that act on an aircraft. However, Whirlwind, which started out as a flight simulator computer, ultimately became the nerve centre for an air defence system for the United States. As it had to process information from a large number of radar centres, high speed and reliability were important. Among many developments to obtain real-time processing speeds, perhaps the most important was the use of tiny cores of magnetic material which were used as storage devices. The good performance of Whirlwind encouraged the design of the more ambitious SAGE air defence system.

The next chapter focuses on the miniaturization of the computer hardware electronics. The motivation for this came from the need to design on-board guidance computers for flight vehicles. Miniaturization and other developments required for such on-board guidance computers brought down the cost of circuits to such a point where they became cheap enough to go into consumer products. Both the Minuteman missile and the Apollo project of sending a spacecraft to the moon raised new demands on the computer industry. The commercial development of integrated circuits with their wonderful benefits, owes much to the enormous sums of development from NASA.

In the design of aircraft, external factors like runway restriction, environmental factors, etc., dictate design specifications for the aircraft. This, along with other problems like actual placement of aircraft engine, design of wings, etc., led naturally to the development of CAD software. Further demands on computers came from the new area of computational fluid dynamics (CFD) which sought to replace the elaborate measurement set-ups of wind tunnels with mathematical models whose analysis required enormous computing power. This led to new demands on computer technology and Illiac, Cray, and other supercomputers were built mainly to fulfill this need.

Other areas in which digital computers had a significant impact are testing, simulation, and control. In the early days, flight testing of aircraft had to be done by expert pilots who would record the performance of the aircraft on notepads. These, along with data collected from other instruments, would be analysed by other experts later over many days. With computers the analysis could be done almost immediately while the aircraft was still in flight, the advantage being that the pilot could be instructed to execute other useful manoeuvers to determine the performance of the vehicle properly. Computer simulation added a new dimension to this aspect. In most cases it was no longer necessary to actually fly an aircraft to know its performance. Simulation of reasonably accurate mathematical models was sufficient to the task. This opened up the possibility of research on swept-forward wings and ushered in the concept of actively stabilized aircraft. Computers were thereby called upon to perform a stabilizing task which was beyond the capability of any human pilot.

Aerospace also had a unique and important role to play in certain facets of computer software development. The foremost among these were the concepts of real-time programming and of reliability which were of great importance in many critical aerospace applications. The importance given to reliability in aerospace applications led to development of methods by which errors in large segments of codes could be reduced. These methods gave rise to the important discipline of software engineering.

The book, on the whole, is quite well written. It is illustrated with photographs at appropriate places, some of which poignantly capture many historical moments. One of the attractions of this book is the many entertainingly recounted incidents, both minor and major, which enhance its

readability. The book is expected to be useful as a source of reference on the major developments which affected both the computer and the aerospace industry over the past fifty years.

Department of Aerospace Engineering
Indian Institute of Science
Bangalore 560012.

DEBASISH GHOSE

An introduction to Kalman filtering with applications by K. S. Miller and D. M. Leskiw. Robert E. Kreiger, Melbourne, Florida 32902, USA, 1987, pp 128, $16·50.

Kalman filtering has established itself arguably as the most important topic in filtering theory over the last three decades. Its usefulness in many applications, especially in aerospace and electronic systems, has motivated a high volume of research, leading to a large traffic of published literature, both papers/reports as well as textbooks. In such an environment, a fresh book on Kalman filtering has to have something special to be visible. Miller and Leskiw's new book on Kalman filtering is a useful addition to the introductory level teaching and learning material in this very useful area.

One of the most remarkable features of the book is its compactness. The 113-page book has only four chapters. The entire theoretical background leading to the basic equations of Kalman filtering is covered in the first chapter occupying 43 pages. Here the authors follow the well-known path of presenting the Kalman filter problem by first introducing the simpler least-squares theory, progressing through the theory of stochastic differential equations, and then deriving and presenting the complete set of Kalman filter equations. All this is done, as the authors put it, "in an efficient and rigorous manner." Further on in the chapter, the authors present the formulae for the backward filter, and the process of smoothing obtained by combining the estimates obtained from forward and backward filtering. The authors then explicitly bring out the relationship between least squares and Kalman filtering showing that every least-squares problem can be interpreted as a special case of the Kalman filter, *i.e.*, that the least-squares theory is a subset of Kalman filtering.

In the last sections of the chapter on theoretical developments of Kalman filtering, the authors consider the directions of extension of the basic theory, developed for homogeneous linear system equations. The first of these considers the case of nonhomogeneous equations, and derives the corresponding filter equations. The second deals with nonlinear equations, leading to the now-famous Extended Kalman Filter (EKF). The entire first chapter is written in a crisp style. The derivations are logical and rigorous. The authors achieve economy of words, and clarity and continuity of presentation by sticking to the main theme, without diversions.

The remaining three chapters of the book dwell on practical aspects of Kalman theory. Given the historical fact that Kalman filter theory has received its greatest impetus from developments in aerospace systems, the authors have quite naturally chosen an example from this area. They consider a somewhat sophisticated dynamical system, related to the estimation of the trajectory of a ballistic reentry vehicle. In the second chapter, they develop the system model for the problem, and in the third they discuss the associated radar measurement model.

The chapter on development of the system model is a short one in which the reader is taken step by step through progressively higher levels of ballistic system modelling. First, the equations of motion of a point mass are derived, after which a finite-sized rigid body is considered. Finally, aerodynamic effects are included in the model. The authors then discuss briefly the emphasis of the various effects within the general nonlinear system model equations.

The chapter on radar measurement model introduces the concept of coordinate transformation (*e.g.*, from radar coordinates to earth-centered coordinates) and its role in formulating measurement models. The authors then derive the model equations for radar and on-board measurements.

The last chapter of the book is devoted to practical aspects of Kalman estimation. Here the authors consider both filtering and smoothing cases, and derive forms of estimation equations which are suited to numerical computation. The basic Kalman equations of the first chapter are combined with the system and measurement models developed in the next two chapters. A very useful feature of this chapter is an explicit discussion of the difficulties often encountered with the numerical integration of the covariance matrix differential equation. Approximate methods to overcome this difficulty are presented. Another useful section in the chapter is the analysis of the smoother from the standpoint of numerical accuracy, computational efficiency, and data storage requirements. Finally, the chapter provides forward-backward filter and smoother algorithm.

Overall, this is one of the best organized books on the subject. Inevitably, one is drawn to making comparisons with other popular recent books on the subject, notably those by R. G. Brown and P. S. Maybeck. These are no doubt more detailed, but the current book by Miller and Leskiw scores in terms of focus, brevity and simplicity. For all its crispness and range of coverage, the book demands little by way of prerequisites for understanding that is not generally available with most graduate students in engineering and in many disciplines of physical sciences. Priced at $16.50, it is a very affordable introductory book for learners of the subject.

Department of Aerospace Engineering
Indian Institute of Science
Bangalore 560012.

P. R. MAHAPATRA

Reconciliation by Jeremy Griffith. Centre for Humanity's Adulthood, GPO Box 5095, Sydney 2001, Australia, 1989, pp 56, $2.

"There is only one way to achieve happiness on this terrestrial ball. And that is to have either a clear conscience or none at all". Here, the advice is for the former and the brand name of the cleanser is Reconciliation, a richer, a trimmer, a new improved concentrate of the older and fatter *Free: The end of the human condition*, the condition of UPSET, of the eternal enemity of the apple and the appetite, the instincts and the intellect. Instincts are what we inherit through our genes whereas the intellect interrelates the learning acquired by a nerve-based system. It is again the age-old feud between the selfishness of the rational existentialism and the apparent selflessness of the altruism; the individual *vs* the society, the preference of the whole (the holy?) to the parts. Integrate, even if it takes annihilation. Revere the average, and be blessed with order, peace, harmony and stagnation; surrender and sing the positive role of negative entropy and all this towards what purpose? Since the large eddies live longer than the small ones, what does it take to create one Einstein?

The instinct is integrative, the intellect is inquisitive and will the twain ever meet? Yes, according to Jeremy Griffith, in learning to live with ourselves, in being patient while it becomes worse before it becomes better, suffering is good for soul, incomprehension instead of criticism, since our tolerance for truth varies, as for religion too. With a healthy concern for the latter (and for everything else), the reading of this book could provide the much sought-after therapeutic stimulation, a cure (for some, others are incurable) for the anxiety of 'throwing the stick further than the others', the final freedom.

Indian Institute of Astrophysics
Bangalore 560034.

V. KRISHAN