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BOOK REVIEWS

The ancient tradition of geometric problems by Wilbur Richard Knorr. Birkhauser Verlag, P.O. Box 133, CH-4010, Basel, Switzerland, 1986, pp. 420, S. Fr. 128.

For the ancient Greeks, mathematics meant geometry. The problem of cube duplication, angle trisection, and circle quadrature have attracted major interest among scholars of ancient Greek geometry. The search for solutions to these problems profoundly influenced Greek geometry and led to many important discoveries. The literature on ancient Greek geometry is inextricably bound up with these problems and a variety of solutions which the ancients produced from the pre-Euclidean period through the generation of Euclid and Archimedes to the time of Apollonius. No significant progress was made by the ancient geometers after Apollonius except of course by way of producing a few excellent treatises on geometry. The impossibility of solving these famous problems of antiquity with Euclidean tools was not realized until the nineteenth century. Proofs of these facts are essentially algebraic in nature and not amenable to attack by the geometric methods of the ancients.

The admirable book under review written by Wilbur Richard Knorr undertakes a survey of the ancient Greek geometric tradition. It makes a notable contribution to the field of history of ancient Greek mathematics. The basic difference between the many existing books on this subject and the book under review is one of emphasis and general philosophy rather than content. Wilbur Richard Knorr's book has made an attempt to trace the movement of ideas which accompanied the ancient Greek masters and to give a more coherent development of the subject. The book is well motivated and well documented.

The book is divided into eight chapters. Each of these chapters, except the first and the last, is structured around the ideas and techniques developed in solving these three famous problems by Greek geometers and this is accompanied by some sort of a commentary by the author whose purpose seems to place the findings of these geometers in a proper historical perspective.

In chapter one the author formulates the principal objective of this project and explains at length the difficulties that one faces in such an endeavour and makes certain recommendations bearing on the present study to overcome these difficulties.

In chapter two, the author after surveying the various historical sources tries to clarify the way in which the cube duplication and the quadrature of the circle were first articulated as problems. The contributions of Hippocrates of Chios to the study of these geometric problems which lay the foundation for later researches is given.

Chapter three is devoted to the contributions made by the group of geometers affiliated to Plato's Academy in Athens which was the centre for geometric studies during the fourth century B.C. It is learnt that the technical methods in geometry experienced significant advances at the hands of Archytas, Eudoxus, and Menaechmus. The most significant among these are the techniques of limits and the theory of proportions by Eudoxus. It is a view often held that the later theory resolved the first foundational crises. It is of interest to know the author's reaction: "one hypothesized a paralysis of research, a renunciation of the use of proportions in geometry, and so on, until this impasse was finally broken through the efforts of Eudoxus. One seemed not to care that the extant evidence, fragmentary as it is, indicates no signs of such paralysis or renunciation, but rather a remarkable degree of continuity in the development of technical methods".

Chapter four is concerned with the contributions of Euclid an effective teacher and a compiler. His contributions were seminal for the development of problem solving in the third century.

Chapter five is devoted to the work of Archimedes who is considered to be the greatest mathematician of antiquity. Even though he was more or less a contemporary of Euclid, than of Eudoxus, it is the work of the latter that had a profound influence on Archimedes.

The estimation of π, effective rules of estimating square and cube roots, quantitative measurements of geometric figures, for instance, the areas and volumes and the centre of gravity of circular figures dominate the work of Archimedes.

Chapter six is devoted to the work of Eratosthenes, Nicomedes, Hippias and many others in the third century whose research efforts are strongly guided by the Archimedian methods.

Chapter seven is all about the work of Apollonius who is famous for his contributions to the theory of conics. The major concern of Apollonius was to recast, extend, and reorganize the results of his predecessors.

The final chapter is primarily concerned with the mathematical and philosophical reflections of the author on various questions that confront scholars of ancient Greek geometry.

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Quantum theory of finite systems by Jean-Paul Blaizot and Georges Ripka. The MIT Press, 28, Carleton Street, Cambridge, Massachusetts 02142, 1986, pp. 657, $51.75 (Indian orders to Affiliated East-West Press Pvt. Ltd, Madras 600 010).

The volume is an advanced text on the quantum theory of many-body problems. It contains 18 chapters spanning 649 pages. Each chapter beginning with a brief introduction, ends with a set of problems and is complete with its own bibliography. The main emphasis is on finite systems with most topics such as the spontaneous symmetry breaking are treated in some mean-field approximation and as such there is no explicit treatment of the thermodynamic limit. While there already exists a number of very good but highly specialized texts on the quantum many-body theory, what sets the book under review apart from the rest is its somewhat unconventional selection of topics from the current contents that should have a much wider appeal today. Thus, for example, the discussion of the Fermionic coherent states in terms of the Grassmann algebra, and that of the Bosonic coherent states in terms of the Bargmann representation in chapter I, is very apt and welcome. These mathematical objects have shown up unexpectedly in many areas of active research in recent years and a working knowledge of the related mathematical tools is very desirable. Perhaps, this book lays too much emphasis on the coherent state representation in that the entire scheme of semi-classical approximation is based on the path integral representation of the coherent states, Bosonic as well as Fermionic. There is a powerful discussion of the self-consistent Fermion pairing field and of the Hartree-Fock-Bogoliubov equation in chapter 7. Also, there is a very readable account of the spontaneously broken symmetry and the symmetry restoring collective modes in chapter 8. Standard diagrammatic perturbation theory is discussed in chapters 12–14. Chapter 16 deals with renormalization (amplitude and vertex) while chapters 17 and 18 deal with the advanced topics of correlated wave functions.

From the pedagogic point of view, chapters 1 through 15 can form a text for a graduate course in many-body theory. But on the whole, the book is addressed to research workers. Strongly recommended for libraries attached to Physics departments.

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Maxwell on molecules and gases edited by Elizabeth Garber, Stephen G. Brush and C. W. F. Everitt. The MIT Press, Cambridge, Massachusetts, 1986, Hardbound, pp. 565, $62.25.

The volume is about the scientific works and philosophical thoughts of the "leading molecular scientist" of the 19th century—James Clerk Maxwell. More specially, it brings out Maxwell's wide-ranging contributions to the dynamical theory of gases and his ideas on the nature of atoms and molecules. The dynamical theory developed by Maxwell between 1960 and 1975 led to the first successful application of the Laplacean method of probability and statistics to the many-body problem of gases, and provided a kinetic theory of transport properties of gases—viscosity diffusion and thermal conductivity. Through 92 original documents reproduced without change and one comprehensive introduction to Maxwell's kinetic theory and numerous annotated cross-references, the authors have presented a perspective on Maxwell the physicist in the context of the 19th century science, which should be of great interest both to a student of history of science as well as to an active researcher in the field of statistical mechanics. Several fundamental ideas, *e.g.*, that of pressure as being due to molecular impacts rather than intermolecular repulsion, the idea of meanfree path and finally the idea of equipartition of energy are seen to evolve as a discursive formation of thought. This is seen clearly in his frank correspondence with and reference to his great contemporaries — Tait, Stokes, Spencer, Clausius and Boltzmann. The authors also bring out very clearly the main preoccupation of Maxwell namely, the atomic structure of matter and not a theory of heat. The book is more than a collected works or an original sourcebook on Maxwell meant for an archive. It *analyses* Maxwell the physicist and the philosopher who is very much relevant to-day. The book, of course, has no prosopographical details but has adequate bibliography on this aspect. Also, the later more mature contributions of Maxwell on 'Statistical Mechanics' have been reserved for a separate companion volume. (The two will have to be read together for completeness). The book is highly recommended for libraries attracting physicists, philosophers and scholars of history of science.

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Polymer science by V. R. Gowariker, N. V. Viswanathan and Jayadeva Sreedhar. Wiley Eastern Limited, New Delhi 110 002, 1986, pp. 505, Rs. 50.

Synthetic polymers which started out as a discovery from Baekeland's laboratory in 1909 soon became, in the following decades, a focal point of study in the various disciplines of science and engineering. Polymers as we know today have come out of these long and perserving studies. Today the overall insight into polymer science and technology is so deep that a material scientist can create an almost limitless range of new materials—materials which can be used to bear loads, bond objects, seal joints, fill cavities—in fact, anything from clothing the body to powering a space vehicle to even replacing a worn-out human organ! The annual production of plastics has increased several fold in recent years having surpassed, on a volume basis, even the production of steel in some of the advanced countries.

One consequence of this widening use of polymers is that a large fraction of chemists and chemical engineers, to say nothing of those in other disciplines, is employed in jobs related in some way to polymers. In fact, a science student entering a science-based industry has today a better than 30 per cent chance of being involved with work relating to polymers in one form or another. No wonder, very often we encounter people who have no formal training in polymers, but now due to their job requirement want to learn about polymers in a short time. Education in polymer science, it appears, has not kept pace with the growth of polymer industry.

The need for polymer education has to be filled, however, by teaching at several levels in several disciplines. At the post-graduate level, polymers are now taught under various titles like polymer chemistry, polymer science, polymer technology, polymer processing, and industrial polymers. In addition, more specialised polymer courses are offered in curricula leading to degrees in polymer disciplines. Polymer science, as a discipline is no longer confined to post-graduate curricula and has expanded to the levels of graduation and diverse industrial courses, creating need for simpler polymer texts for beginners. While many specialised books have been published over the last 30 years on each of the various facets of polymers, their science and technology, there are only very few introductory level books on polymer science. The only three such books, to this reviewer's knowledge, are Billmeyer's *Textbook of polymer science*, Rudin's *The elements of polymer science and engineering* and Cowie's *Polymers: Chemistry and physics of modern materials*. Viewed against this background, *Polymer science* by Gowariker, Viswanathan and Sreedhar is a welcome addition.

The book features separate chapters dealing with the chemistry of polymerisation, molecular weight and size, kinetics of polymerisation, chemical and geometrical structure of polymer molecules, glass-transition temperature, crystallinity of polymers, and copolymerisation. The authors have done well to devote one full chapter to glass-transition temperature and another to polymer crystallinity alone as these are very important factors influencing polymer behavior and properties. Polymer rheology and polymer solution properties are also presented in two separate chapters. Most of the commercially important polymers are described individually in one chapter giving, though very briefly, their properties, uses and method of production. The functional groups present in polymer molecules can, depending on their chemical nature, undergo a variety of chemical reactions leading to polymer structures with interesting new properties. Polymers have thus been put to many novel uses and new applications are continually being developed. It is to the credit of the authors that they have recognised their importance and devoted one whole chapter to polymer reactions. Other distinctive features of the book are the special treatment given to polymer degradation and experimental techniques for polymers.

None of the chapters, however, has been provided with problems or exercises at the end. This would be a drawback if the book is to serve as a text for polymer science courses.

The book, written in a very lucid style, uses simple analogies and illustrations to explain some of the most abstract concepts in polymer science. The text is eminently suitable for self-study. The authors and publishers should be complimented for producing this fine volume.

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Structural stability of columns and plates by N. G. R. Iyengar. Affiliated East-West Press Pvt. Ltd., 104, Nirmal Tower, 26, Barakhamba Road, New Delhi 110 001, 1986, pp. 316, Rs. 75.

This book contains a lucid presentation of elastic and inelastic buckling behaviour of columns and plates, buckling of frames, torsional and torsional-flexural buckling of open sections, and postbuckling behaviour of plates. Buckling of laminated composite columns is briefly introduced. A chapter is devoted to buckling of composite plates covering author's contributions in this area. The text is supplemented by an Appendix on constitutive equations for anisotropic materials and, in particular, orthotropic laminates.

Chapter 1 deals with elastic buckling of columns, in which stability criteria from four different approaches, *viz.*, equilibrium approach, energy approach, imperfection approach, and dynamic (vibration) approach are clearly presented. Applications of Timoshenko's method, Rayleigh-Ritz method, Galerkin method, finite difference techniques, and finite element techniques are given in great detail through several illustrative examples. Columns with open cross-sections, pinjointed triangulated frames, rigid jointed frames, and multi-storeyed multibay frames are dealt in chapters 3 and 4.

In chapter 2, inelastic buckling of columns is treated through double modulus theory and tangent modulus theory. Eccentrically loaded columns are also considered. Various empirical relations for evaluation of critical stresses for short columns are included in this chapter. Inelastic buckling of plates dealt in chapter 7 covers Stowell's theory and Bleich's theory. Both approaches are illustrated through application to rectangular plates subjected to uniaxial as well as biaxial loads.

Chapters 5 and 6 deal with elastic buckling of isotropic rectangular and circular plates, tapered plates, stiffened plates, polar orthotropic circular plates, thick rectangular plates and composite plates.

Postbuckling behaviour of plates is treated in chapter 8. Derivation of von Karaman's large deflection equations is presented in great detail. This final chapter ends up with two useful sections, one on ultimate compressive strength and the other on ultimate shear strength of flat sheets.

The text is well-organised and is designed for the undergraduate/graduate in aeronautical, civil, and mechanical engineering. It contains numerous worked-out examples and results are presented in non-dimensional form so as to be useful to the practising engineer. Several problems and references are included at the end of each chapter.

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Computer environments for children by Cynthia Solomon. The MIT Press, Cambridge, Massachusetts 02142, 1986, pp. 183, $25.88

It is not the title *Computer environments for children* but the subtitle *Reflections on theories of learning and education* that more accurately reflects the contents of this book. There are no recipes for setting up ideal computer environments for children (to prepare them for the twenty-first century). There are instead some thought-provoking questions about computers in education, especially for children; questions which sometimes reach beyond the computer issue and force us to examine the very policies about education.

It was in the early sixties, with the advent of time-sharing computers, that it became possible to think about introducing children to computers. Within a short span of two decades, due to the spectacular technological advances in the field of microelectronics, one finds millions of children interacting with computers today. That the computer can be a powerful and exciting educational aid has been widely recognised. How best can we use it?

The author, Dr. Cynthia Solomon, describes four different approaches in as many chapters. In fact, she discusses "an individual or a team, in each case considering the intellectual origins, the approach to using the computer and the extent to which this approach has penetrated school practice and has been evaluated". These four approaches have been further divided into two broader catagories: Computer as an interactive textbook and Computer as an expressive medium.

In the first category, Patrick Suppes' work with the Computer Curriculum Corporation deals with the use of computers for drill, practice and rote learning. The author gives a detailed description of the project (the way mathematics curriculum was divided into blocks, the way the exercises were presented, etc.), its successes (increased scores of the students who underwent the course) and its shortcomings (only the students whose performance had earlier been below average were seen to have been benefitted the most). Though methodically prepared and extensively tested, one is left with a feeling that such a package of programs seems to put the computer to a most pedestrian use—simulating a very patient, untiring but unimaginative teacher. On the other hand, the approach adopted by R. B. Davis for the Madison Project (described as "Socratic Interactions and Discovery Learning" by the author) draws on the reality and uses the computer to bring the children's everyday experiences into the classroom. For example, while teaching about fractions, the child is asked to divide a handful of beans equally amongst their friends—except that the beans as well as the friends are present only on the computer screen! Undoubtedly the children would find this more fun than rote learning and because of that, they may learn the fractions much faster. The author gives examples of several attractive games (torpedo, car race, darts, etc.) to illustrate other concepts in mathematics (arithmetic operations, the number line, etc.). The goals of the project, as outlined, go far deeper than creation of pretty programs, however. The potential of the computer as a "flexible medium to create sets of materials for children to do mathematics in a creative manner" is to be exploited to help the student to acquire a wide range of abilities—from "discovering patterns in abstract situations" to "appreciating pure mathematics for its own sake". The students of education should find this part fascinating.

In the second category, Tom Dwyer ("Eclectism and Heuristic Learning"!) teaches the children about the computers, about programming and leaves them to carry out their own explorations. The metaphor of flying an aeroplane is very apt—the child should be instructed in the use of computers and programming till he can "fly solo". The language of choice has been BASIC, due to reasons mainly of availability and ease of learning. The children did seem to pick up the language quite fast and seemed to enjoy the programming projects. The author's criticism of this approach is on philosophical grounds. It is generally agreed that BASIC is not the best of the programming languages, since it is not structured. As the author convincingly demonstrates, the program for a decision tree, written in BASIC, works perfectly, but the source code gives no clue whatsoever about the inherent hierarchical organization of such a tree. Should one, then, go all out to teach BASIC to the young children?

Perhaps the most radical of all is the approach by Seymour Papert. It is so broad in outlook and calls for so fundamental a change that it is impossible to capture its essence in this short review. To quote, "Papert ... sees most of present day school mathematics as denatured and alienating and outside of child's concerns. He sees the computer as a way to create new learning conditions and new things to learn. He envisions the computer as a 'mathland', in which the computer becomes an instrument for children to talk in mathematics about their everyday life experiences and in which children learn mathematics as naturally as they learn to speak". The author has brought out the important aspects of Papert's work-LOGO, importance of debugging, use of the powerful ideas like procedures and recursions, etc—very clearly. Dr. Solomon's constant comparisons of the four approaches, though repetitious, helps the reader to understand the fundamental similarities as well as the differences from a proper perspective.

The last two chapters—Trends in practise and Computer educators—deal with more concrete matters. Based as they are on the author's detailed research as well as on the two decades of experience in teaching children about computers, they provide a very realistic picture of the way things are. One of the points which comes out very strongly is the inadequacy of the infrastructure—even in the United States, the average amount of computer time available per student is about 15–20 minutes per week! Such information will be crucial for a realistic planning of computer education in the Indian context. The perceptiveness and sensitivity shown by the author when describing the way children react to computers and programming is truly remarkable. Even the brief description of her experiences gives valuable hints for computer educators.

This book grew out of Dr. Solomon's doctoral thesis. This is quite evident from the style, especially of the first five chapters. These are written by an academician for academicians and the balance is more in favour of the terse and the esoteric rather than the simple. The last two chapters, on the other hand, have a more human touch and are considerably easier to understand, and yet as informative.

This is not a book for light reading. Only those seriously interested in the deeper issues of computer education for children would find it worthwhile to read through this thesis. For others who would like to give some thought to this topic, the last two chapters give a lucid account of how things are and what could be done to integrate the computer into the children's everyday learning environment. It is interesting to note that the excerpts from several reviews of the book (printed on the jacket) by scientists with impressive credentials are unanimous in their praise of the author for raising the deeper issues in this otherwise fashionable and trendy subject. Perhaps the most important contribution of the book is that it clearly outlines the areas of research in the field of computer education for children, and emphatically brings out the need for such research for exploiting the full potential of the computer.

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