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BOOK REVIEWS

Mathematics in Berlin edited by H. G. W. Begehr *et al.*, Birkhauser Verlag AG, Klösterberg 23, CH-4010, Basel, Switzerland, 1998, pp. 204, sFr. 28.

This book was conceived as an information booklet about the development of mathematics in Berlin and various events connected with it to the participants attending the International Congress of Mathematicians (ICM) 1998 at Berlin. History shows that Berlin has always been one of the main centres of the world in cultural, political, intellectual and scientific activities. This booklet gives a vivid account of how these activities shaped the life of mathematics and mathematicians of Berlin. It ends with a presentation of mathematics scene of today at Berlin. The book contains a collection of 24 articles written by various authors; each one being devoted to the description of a particular aspect, period, the role of mathematicians or university.

As one goes through the book, one gets a feeling of witnessing a drama enacted by many towering mathematicians/personalities of the period. The scene is set mainly in Germany. The opening scene describes the start of the Berlin Academy in 1700 and its initial presidents Leibniz, Maupertuis, Euler and Lagrange.

The next important point of history occurs in 1810 with the establishment of the University of Berlin (which was then under French occupation). The important mathematicians of its initial period were Dirichlet, Jacobi and Steiner. Then came the 'Golden Age' of the University during the years 1850–1891 with the contributions from the towering personalities Weirstrass, Kummer and Kronecker. The famous controversy between Weirstrass and Kronecker regarding existence and constructive procedures in analysis broke out during this period.

Since the initial period, several turning points have occurred in the evolution of the university. Some of them are as follows: outbreak of the World War I, the Nazi period (1933–1945) and World War II, the partition of Berlin and Germany and finally reunification. During these long years, Berlin mathematics has seen its ascent and decline a few times. A noteworthy point is its rivalry and differences with the University of Gottingen which under Klein and Hilbert emerged as the leading centre of mathematics. These differences existed on several fronts. In contrast to purism promoted in Berlin by mathematicians like Frobenius, Klein in Gottingen wanted mathematical community to climb down from its ivory tower and address the needs of scientists and engineers. One can also contrast the pure algebraic approach pursued in Berlin with a more intuitive geometric approach of Gottingen. Another instance of their rivalry was when Hilbert of Gottingen led a German delegation to 1928 ICM at Bologna, none of the Berliners went along. It must be recalled that this was the first ICM to which German mathematicians were invited ending the post-World War I anti-German boycott.

The Nazi years are marked by the appearance of the concept called 'Deutsche Mathematik' and the anti-Jewish feelings. The act of its exponents among mathematicians (Bieberbach, Teichemuller Vahlen) against fellow mathematicians remains one of the controversial chapters in mathematics history. It resulted in the exodus of several mathematicians from Germany including Schur, von Mises, von Neumann, Einstein, etc.

Another notable event of this era is the birth and the development of relativity theory and quantum mechanics (QM) in physics and their impact on mathematics. This little book gives an account of Berlin years of Einstein and his visit to Gottingen. Some light is thrown on the somewhat controversial act of plagiarism on the part of Hilbert which amounted to challenge Einstein's priority with respect to his field equations of relativity.

All these important points make the reading of this book very interesting. Apart from containing material for historians, this book also offers good lessons for mathematicians and the managers of mathematics all over the world to learn. Another important aspect of the book is that it contains nice photographs of several Berlin mathematicians which is a delight to anyone who may be interested in making an album.

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Stability and oscillations of nonlinear pulse-modulated systems by A. K. Gelig and A. N. Churilov, Birkhauser Verlag AG, Klösterberg 23, CH-4010 Basel, Switzerland, 1998, pp. 360, sFr. 128.

Let us consider a control system written in the following form:

$$\dot{x}(t) = Ax(t) + bf(t), \qquad f(t) = M\sigma(t). \tag{3}$$

Here $x(t)$ is a ν-dimensional vector which describes the state of the system, A a constant real $\nu \times \nu$ matrix and b a constant ν-dimensional vector. Here $f = f(t)$ is an input function into the system. It is given in terms of a control function $\sigma(t)$ and an operator M (which may be linear or nonlinear). The output of the system is given by $-c^* x(t)$ where c is a constant ν-dimensional vector. The aim of the control problem is to choose a control $\sigma(t)$ such that the output has a desired behaviour (e.g. stability). The idea of closed-loop control is to make the control to depend on the state of the system

$$\sigma(t) = c^* x(t) + \psi(t), \tag{2}$$

where $\psi(t)$ is an external action which is assumed to be given. Let us observe that eqns (1) and (2) form a closed system.

Some of the classical issues of control theory are to find conditions under which one is guaranteed the existence of stationary and periodic solutions and how one can stabilize such solutions. This is a practical question which is of interest to engineers. Because of the importance of the above question, many books and monographs have been written presenting a variety of methods of stabilization. Majority of them are devoted to the case when M is a smooth operator.

The orginality of the present book is to consider cases where M is a nonlinear and nonsmooth operator which is of interest to engineers. The authors who are mathematicians say

that they have a very rich experience of several years collaborating with practicing engineers. The examples of M treated in this volume come from their discussions with engineers.

Two basic models of M (called pulse modulators) are considered in this book. The first one defines f on $[t_n, t_{n+1}]$ by the following rule:

$$f(t) = \begin{cases} \lambda_n & \text{if} \quad t \in [t_n', t_n' + \tau_n], \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

where $t_n \le t_n' < t_n' + \tau_n \le t_{n+1}$ are instants of time. While (3) defines pulses of nonzero duration, the next model one defines instant pulses:

$$f(t) = \sum_{n=0}^{\infty} \lambda_n \delta(t - t_n). \tag{4}$$

In both the cases, the parameters λ_n, t_n', τ_n are chosen to depend on $\sigma(t)$. We realise at once that this choice make models (1) and (2) somewhat unconventional. It defines a control problem with a pulse-modulated feedback control. Its special features are the lack of continuitity of solutions on initial values and discontinuity of solutions themselves. If we introduce randomness into the system as a smoothener then it is known that certain of its aspects can be reduced to the study of variational and quasi-variational inequalities. However, the authors deal with deterministic systems with the above features that make the study both interesting and challenging. As far as my knowledge goes there are not many books devoted to such models.

Let us quickly go through some of the contents of the book. The opening chapter presents various classes of pulse operators:

Pulse amplitude modulation	(PAM) (here λ_n depends on $\sigma(t)$),
Pulse width modulation	(PWM) (here τ_n depends on $\sigma(t)$),
Pulse phase modulation	(PPM) (here t_n' depends on $\sigma(t)$),
Pulse frequency modulation	(PFM) (here t_n depends on $\sigma(t)$).

This book presents results of stabilization in all the above cases except the first one. (The authors remark that there are enough number of books on PAM but they do not cite any). Even though a whole of variety of methods is presented, the main emphasis is on Averaging method which is applied to analyze the stability of equilibria and arbitrary solutions. The idea behind the method is to replace the operator $M\sigma$ in (1) by a nonlinear function $\phi(\sigma)$ and obtain, in some sense, an equivalent system. We can throw light on the asymptotic behaviour of (1) and (2) from that of the new system for which numerous methods are already available. The stability condition obtained is in the form of frequency-domain inequalities.

The book also addresses the important problem of existence of periodic solutions and their stability. Fixed-point method is employed to probe the existence question. Being a topological method, it requires the continuity of the operator in question, a property which need not be valid on the entire state space for the model under consideration. However, it is possible to construct an ellipsoid in the state space in which the operator is continuous. This again gives rise to frequency-domain inequalities.

The above description gives, hopefully, an idea of the contents and methods followed in this book. Having in mind potential readers from engineering departments also, the authors have pushed complicated proofs to separate sections and this facilitates reading. They have also pushed all preliminary results in control theory to Appendix and I am not sure whether this makes the life of the reader easy. The reader is assumed to be familiar with many results in deterministic control theory. Finally, as in many books authored by Russians, the bibliography does not seem to be well balanced and more concentrated on Russian literature.

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Mathematical essays in honor of Gian-Carlo Rota edited by Brude E. Sagan and Richard P. Stanley, Birkhauser Verlag AG, Klösterberg 23, CH-4010, Basel, Switzerland, 1998, pp. 480, sFr. 148.

The volume brought out in honor of Gian-Carlo Rota under the series 'Progress in Mathematics' has been a good consolidation of an array of mathematicians and their contributions on specific topics which include very fascinating articles addressing the areas such as the MacMahon's partition analysis, the cd-index of zonotopes and arrangements, letter place methods and homotopy, natural exponential families and umbral calculus, umbral calculus in Hilbert space, umbral shifts and symmetric functions, orthogonal polynomials, and geometric homology. There is also a wonderful piece by J. S. Yang entitled 'Apologies to T. S. Eliot: The Rota nerds'.

The book fills gaps in the literature in certain specialised areas which include well-known trivectors, higher geometric series, umbral calculus and orthogonal polynomials, and the different areas of mathematics by networking and tries to answer some of the logistics in straightening out the algorithms that are continuously being used. It is also gratifying to note that a book like this focusing on the algebra of polynomial and algebric structures with indepth analysis has appeared. It is fascinating to see that the scrutiny of orthogonal polynomials and hypergeometric series certainly brings in a high level of synergy of these areas. It is pleasant to note that in spite of several matrices, differential polynomial calculus, differential calculus and many other mathematical variables, one hardly finds any typographical mistakes in the articles *per se*. This is highly commendable looking at the intricacies of the mathematical equations and the number of polynomials that are described in the book. Each chapter also has a lot of references for further reading and suggests some innovative ideas for probing into different models which the reader can visualize and derive some of the models for furthering in the area of one's interest. The book describes not only elementary methods in calculus but also has a higher level of understanding from the point of view of application in several fields.

I strongly recommend the volume to any scientific library which would like to enthuse the reader with modern writings in the methods of mathematics and its application. The admiration with which Rota is held by the mathematics community is aptly stated by J. S. Yang in the

words: 'Those who have crossed With direct eyes, to Gian-Carlo's office, Remember us-if at all not as lost, Absent-minded souls, but only, As the math nerds, The Rota nerds".

My congratulations to the editors for bringing out this excellent volume. It will be a milestone in the saga of modern mathematical books.

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Singularities by V. I. Arnold *et al.*, Birkhauser Verlag AG, Klösterberg 23, CH-4010, Basel, Switzerland, 1998, pp. 486, sFr. 88.

This volume contains a collection of papers on singularity theory, most of them being extended versions of the talks given at a conference at Oberwolfach in honour of Brieskorn on the occasion of his 60th birthday in 1996. Prof. Brieskorn is well known for his contributions in this field. Very appropriately, this book starts with a brief presentation of mathematical works of Brieskorn.

The reader may be aware that the theory of singularities is a classical topic in mathematics having interaction with analysis, geometry and topology. The subject has enormous applications in dynamical systems, geometrical optics, asymptotics of integrals, hydrodynamics, quantum mechanics, crystallography, chemistry, wave propagation, algebraic geometry, biology, economics and many others. This diversity of application explains why the literature on this subject is very vast: there are many books, monographs and surveys. The present book is an addition to this enormous literature giving some of the recent developments on the subject.

The theory of singularities of smooth maps is a far-reaching generalization of the theory of maxima and minima of real-valued functions. Singularities dealt with in this theory are therefore not connected with discontinuities and poles but with the vanishing of certain derivatives. Simplest examples include critical points of functions and their importance lies in the fact that they describe stationary behaviour of gradient dynamical systems. In general, physical systems depend on several parameters. There are regions in the space of parameters where a small change of parameters produces smooth changes in the systems. In certain other regions (called critical regions), small changes in the parameter values yield abrupt effects on the qualitative properties of the system (e.g. bifurcation of stationary states). The former situation is modelled, for instance, by a parametrized family of functions admitting only non-degenerate critical points whereas the latter is modelled by a family which includes a black sheep, i.e. a function admitting a degenerate critical point. Analysis of singularities will be useful for the control of dynamical systems, for their optimization and for understanding changes in their behaviour.

In view of applications, one is motivated to consider not only individual functions but also parametrized family of functions and maps between manifolds. Due to several approximations and imprecisions in the modelling process, notion of singularities which are stable under small perturbations for both individual and family of maps is very important. A singularity which can

be made to disappear under perturbation for each individual member of a family may not disappear simultaneously for all members of the family.

Some basic issues of the subject are as follows: genericity of stable singularities, canonical forms of maps around them, classification of singularities in terms of invariants, their topological and geometrical structures, their regularization, i.e. how to approach them by means of smooth structures and so on. Big names have been associated with this huge programme: Poincaré, Morse, Whitney, Thom, Arnold, etc. Contributions from Arnold school in Russia are very significant to the overall development of the subject and this volume contains a good number of them.

Twenty-one articles included in this volume are divided into four chapters: 1. Classification and invariants, 2. Deformation theory, 3. Resolution, and 4. Applications.

There are contributions on algebraic and topological aspects of singularities, differential invariants, discriminants, monodromy properties, Brieskorn lattices, Brieskorn–Pham singularities, Kleinian singularities, critical points at infinity, etc. Articles are written at an advanced and abstract level with specialists in mind. They are not easily accessible for other interested readers. Given the diversity of the topics discussed here, it is felt that some survey articles which will somewhat ease the life of non-experts could have been included. In the chapter on Applications, one would expect to see connections with the subjects mentioned above; on the contrary, it contains papers on diverse topics such as hypersurfaces, trigonometric functions, Ferminon loops and knot theory. In summary, this book may be useful for pure mathematicians interested in various aspects of singularities.

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Parabolic boundary value problems by S. D. Eidelman and N. V. Zhitarashu, Birkhauser Verlag AG, Klösterberg 23, CH-4010 Basel, Switzerland, 1998, pp. 312, sFr. 198.

This monograph is devoted to the study of linear systems of partial differential equations of parabolic type. The prototype of such equations is of course the heat equation. It is well known that this classical model represents physical processes such as heat conduction or diffusion of particles in a medium. In probability theory, Brownian motion provides a micro-model of the above physical phenomenon. Cauchy, initial- and boundary-value problems associated with this type of equations are considered in this book. In addition, the authors also consider what they call conjugation problems. These are generally known as transmission problems in the literature. These arise when the medium is heterogeneous and consists of multiple homogeneous media. There are plenty of books, monographs and articles devoted to these types of problems. However, there is another type of problem considered in this book on which not many books are found. This is called Tikhonov's problem and its characteristic is that the order of the boundary operator can be higher than that of the equation in the interior. Various aspects of these problems are also investigated in the volume. Apart from existence and uniqueness of solutions in appropriate function spaces, deriving estimates on the solution and its asymptotic

behaviour for large times are some of the points of concern of this volume. It is clear that concrete physical examples are behind the mathematical theory presented here. However, we do not see any specific application of the theory and the results developed.

Let us quickly go through the contents of the book. In total, there are seven chapters. Various concepts of parabolicity for partial differential equations are introduced in the first chapter. General initial and boundary operators are considered and the classical complementary conditions are imposed on them. The first chapter also contains several examples of the initial and boundary operators to be treated in the sequel. Chapter II begins with some elements of distribution theory. Various algebraic and calculus operations performed on them are described. The reminder of Chapters II and III in its entirety is devoted to the introduction of Sobolev-type spaces (denoted H) and their properties. The significance of these spaces is that they contain all finite energy solutions of physical models. They incorporate the singularities exhibited by such solutions. Since space and time are both involved in the problem, we need isotropic and anisotropic spaces to distinguish them. Because of the consideration of Laplace transform techniques with respect to time variable, Sobolev spaces with weights are also naturally motivated.

Convolution and multiplication operators by smooth and nonsmooth functions and their boundedness in these spaces are investigated. Trace properties of these spaces play an essential role in the sequel. Indeed, the regularity of solutions depends on that of their traces on initial and boundary surfaces and the compatibility between them. Spaces (denoted by $\tilde{H}^s$) incorporating these features are introduced.

The purpose of Chapters IV and V is to show the solvability of the initial boundary-value problems in the spaces indicated above. To this end, the authors follow a well-known classical procedure and consider, to start with, operators with constant coefficients. One is naturally led to solving the corresponding problems in the classes of functions supported in certain cones K: the half-space $K = \{t \geq 0\}$ corresponds to the initial value problem and the quadrant $K = \{t \geq 0, x_n \geq 0\}$ corresponds to initial-boundary value problem. It is well known that Paley–Wiener Theorems establish a one-to-one correspondence between such functions and a sub-class of holomorphic functions of several complex variables in tube domains via Fourier–Laplace transform. Resolution of the problem is then essentially reduced to division by a polynomial. The roots of the polynomial give rise to what is classically known as zero-divisor problem. The whole theory presented here is to show the reader how one can overcome the above difficulty and obtain the solution supported in K. In particular, it is shown how the structural hypotheses (parabolicity of the equation and complementarity of the boundary operators) are used to achieve the goal.

Chapter VI gives a survey on a variety of miscellaneous topics: fundamental solutions to Cauchy problems, Schauder theory to solve problems in Hölder spaces, Green's functions, integral representations of solutions to Cauchy problems, etc.

Chapter VII is devoted to certain qualitative aspects of solutions, especially their behaviour for large times. In particular, necessary and sufficient conditions for stabilizability of the system by acting through the boundary are given.

Thus this volume makes a systematic presentation of what is known as L_2-theory of parabolic systems. The reader is assumed to be familiar with elementary theory and techniques of partial differential equations. It is a mathematics book giving definitions, lemmas, theorems and their rigourous proofs. It is not a book where one can find applications and motivations even though concrete physical models are behind the mathematical theory developed here. The reader may feel lost because of the lack of motivation for various definitions, notions and objects introduced in the first few chapters. This is further compounded by the complicated analysis. This is in contrast to the style of presentation in the last two chapters where some explanations are offered. Given the amount of notations used, one feels that a separate list of notations would have been very useful but this is sadly lacking. I must caution the reader that objects familiar to them may be called by different names in the text (e.g. transmission problems are called conjugate problems, adjugate matrix is called adjoint matrix). This may be due to the fact that the book has been translated from Russian. It is not clear what criterion has been adapted to order the list of references at the end: it is neither alphabetical nor according to the order of appearance in the text.

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Stereochemistry: Conformation and mechanism edited by P. S. Kalsi, New Age International (P) Limited, Publishers, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1997, pp. 555, Rs 185.

The first edition of this text was published in 1990, followed by three subsequent editions in 1993, 1995 and 1997, respectively. Although the author says in the preface to this edition that "...a text book must be revised periodically to keep pace with the rapidly changing aspects in a discipline", we find it hard to understand since this book, published in 1997, has only 10% references from the post-1980 period (with the most recent reference being of 1984). The print quality is not great, and the structures and drawings are rather poorly reproduced. The use of different fonts, drawings which vary in size from one scheme to another, and the numbering of compound in Roman numerals make the reading rather difficult.

It seems that the author has tried to pack too much information in this book meant for the under- and postgraduate students specializing in organic chemistry. There are several sections which are really irrelevant to the theme of the text, and it is not clear why the author chose to include these in stereochemistry textbook. The ninth chapter (Mechanism of common organic reactions, type reactions and reagents in organic synthesis) is one in which very little stereochemistry is discussed. Similarly, in Section 3.4–3.6, the discussion on the effect of nucleophile, leaving group and solvent on S_N1 and S_N2 reactions is also not relevant.

There are problems of other kinds too. For example, it is unclear why stereospecificity is discussed before stereoselectivity (p. 85); why cyclic systems are shown (p. 189) before the chapter on 'Conformation of acyclic and cyclic systems'? This kind of misarrangement can only confuse a beginner.

There are many places in which corrections are needed: Section 3.6, aprotic solvents should be replaced by dipolar aprotic solvents; the angle 109.5 degree should be clearly indicated on p. 220; on p. 223 the X-axis label should show *n*-butane and not ethane; Lindlar's catalyst should be correctly described (Pb-modified palladium on $CaCO_3$); the axes in Fig. 7.1 should be labeled; the isocyanate and diazo species (shown on pp. 426 and 486, respectively) should be shown as linear species (specially in a stereochemistry text!); cyclochloropropane (p. 406, problem 4) should be written as chlorocyclopropane. There are many typographical errors too, like Fisher (p. 65), loose (p. 178), untill (p. 198), Hofmann (p. 465), etc. It is unfortunate that these errors were not corrected at the proof stage.

There are certain statements which are obviously incorrect: "sulfonium salts are identical with quaternary ammonium salts (p. 135), "..they (organic sulfides) are easily oxidized to sulfoxides as sulfones" (p. 135).

Notwithstanding the difficulties described above, the text has some useful information and it is indeed affordable. Some students and teachers might be able to extract these from this book.

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European Congress of Mathematics, Budapest, July 22–26, 1996, edited by A. Balog *et al.*, Birkhauser Verlag AG, PO Box 133, CH-4010, Basel, Switzerland, 1998, Vol. I, pp. 334 and Vol. II, pp. 402, sFr. 158 each.

There are 40 articles in this collection distributed over two volumes. Volume one contains 22 articles and the rest are in volume two. There are two kinds of articles in these volumes. First, survey-type articles which deal with various main directions in mathematics. Many of these articles give a reasonably up-to-date account of the current state of affairs in their chosen area. The second kind contains more detailed concrete problems, results and techniques. They are aimed at a smaller group of readers and require more background expertise. All the articles contain a list of references by means of which more detailed and more material on the topic can be found. Some of the articles of the first kind contain many open problems.

Brief reviews of select papers presented at the Congress are given below:

Volume I

1. Luigi Ambrosio, Free discontinuity problems and special functions with bounded variation (pp. 15–35).

The article surveys the current research in the field of free discontinuity problems, focussing on the existence of weak solutions, regularity of solutions and computation of (approximate) solutions.

2. F. Bethuel, Some recent results for the Ginzburg–Landau equation (pp. 92–99)

The author presents some recent results obtained in the study of Ginzburg–Landau functionals. These functionals were first introduced by Ginzburg and Landau in 1950 in the context of superconductivity and were aimed to model the energy state of superconducting sample in the presence of exterior magnetic field.

3. J. Bricmont and A. Kupiainen, Renormalization group for fronts and patterns (pp. 121–130)

This review article contains recent results on the stability of stationary solutions and of moving fronts in several nonlinear parabolic partial differential equations: The Ginzburg–Landau, Swift–Hohenberg and Cahn–Hillard equations, and chemical reaction–diffusion equations. Some of these results are obtained using the Renormalization Group method.

4. Ulrich Dierkes, Minimal surfaces in singular spaces (pp. 150–161)

The problem discussed here is the higher-dimensional analogue of the famous catenary problem.

5. L. H. Eliasson, One-dimensional quasi-periodic Schrödinger operators. Dynamical systems and spectral theory (pp. 178–190)

From author's abstract: "We shall describe two types of results that have been obtained for the one dimensional quasi-periodic Schrödinger operator, both continuous and discrete. The technique is perturbation theory of KAM-type and the results connect in a fruitful way ideas from dynamical systems and from spectral theory. Both results are developments of original works of Dinaburg, Sinai, Frohlich, Spencer, Wittver from the middle 70s and late 80s."

6. Roswitha Marz, Extra-ordinary differential equations: Attempts to an analysis of differential-algebraic systems (pp. 313–334)

Differential-algebraic equations (DAEs) have been an intensively discussed field of applied mathematics. They arise in models that couple dynamical parts with constraints and invariants. The most popular fields of application are simulation of electrical circuits, chemical reactions and vehicle system dynamics.

Volume II

1. Stefan Muller, Microstructures, phase transitions and geometry (pp. 92–115)

From the introduction: "The attempt to mathematically describe and analyse the formation, interaction and the macroscopic effects of microstructures yields new, easily stated but deep mathematical problems. Their resolution is in its very beginning and involves the interaction of a variety of branches of mathematics including calculus of variations, differential geometry, geometric measure theory, dynamical systems and nonlinear partial differential equations... describe some of the basic questions and how different branches of mathematics are involved in their resolution."

2. Jurgen Poschel, Nonlinear partial differential equations, Birkhoff normal forms and KAM theory (pp. 167–186)

From the introduction: "The purpose... is two fold. First, I want to give another example of how tools and techniques which are well proven in the world of finite dimensional dynamical systems may be applied in the world of infinite dimensional evolution equations. In this case, the tool is so-called Birkhoff normal form of Hamiltonian mechanics. Second, such normal forms enable one to aply, in rather effortless way, an infinite dimensional extension of classical KAM theory and thus establish the existence of large families of time-quasi-periodic solutions which are linearly stable.

3. Nandor Simanyi, Studying dynamical systems with algebraic tools (pp. 200–210)

The aim of the present survey is to give the reader a sketchy review of the newly developed algebraic methods that have been successfully used in the proof of a weak version of the ergodic hypothesis for hard ball systems which is often referred to as the weak version of the Boltzmann–Sinai ergodic hypothesis. One can find a list of open problems in the last section of the article.

4. J. P. Solovej, Mathematical results on the structure of large atoms (pp. 211–220)

From the introduction: "In this lecture it is my intention to give a very elementary presentation of some of the mathematics used in studying the structure of atoms. I shall mainly be concerned with the energy and size of the atom".

5. A. P. Veselov, Huygens' Principle and integrability (pp. 259–275)

From the introduction: "Over recent years some new evidence for the close realation between Huygens' Principle and Integrability has been found. We are going to discuss here these new examples to Huygensian hyperbolic equations and the related theory of algebraically integrable Schrödinger operators, in particular, quantum Calogero–Moser system and its generalizations. Our approach has its origin in the beautiful theory of "finite-gap" Schrödinger operators in one dimension developed in 1974–76 in connection with the periodic problem of KdV equation".

6. Enrique Zuazua, Some problems and results on the controllability of partial differential equations (pp. 276–311)

From the author's abstract: "We present some recent results on the controllability of partial differential equations. We discuss the different notions of controllability and comment on how feasible they are depending on the nature of the system under consideration. We discuss both the wave and heat equations as model examples of conservative and irreversible systems respectively and we describe the different tools that have been developed to address these problems. We also present some recent results on the controllability of the linear system of thermoplasticity which is the simplest one coupling both the hyporbolic and the parabolic nature of the wave and heat equation respectively".

Finally, Volume II also presents reports on some of the Round Table discussions on the following topics.

1. Electronic publishing and electronic publications in mathematics.

2. Mathematical games
3. Women and mathematics
4. Education: Challenges in mathematics

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A history of modern computing by Paul E. Ceruzzi, The MIT Press, 55 Hayward Street, Cambridge, Mass. 02142, USA, 1998, pp. 398, $35.00.

This is an excellent history of computers, especially stressing the hardware aspect of computer systems. There is a wealth of information, especially those that are not usually known. A case in point is the way Minneapolis became part of high-technology developments and the role of Seymour Cray.

There is a very nice description also of companies like Digital that took roots in academic places like MIT and the different culture of work that they represented. The origins of the PC are also discussed well. Burroughs & Honeywell, however, get the short shrift as do some small/later trendsetters such as Tandem, Sequent, etc. in specific niches such as highly available systems.

Atanasoff is relegated to a footnote but that may not be inappropriate as the book concerns itself with "computing systems that were sold & installed in large numbers" (preface, 2nd para). However, this reviewer believes that the seminal impact of Atanasoff in many later computers (esp. ENIAC/UNIVAC) could have been explored (see Burks and Burks[1]).

The one shortcoming of this book is the relative neglect of the software aspect of computer systems. For a book that has been published in '98, there is almost no mention of Knuth/TeX/Metafont, Stallman/FSF, Linus Torvalds/Linux, and the intellectual foundations of this movement. Similarly, such major events as the design of language like Lisp, Pascal, Ada, Java do not get registered. There is mention of C/C++ but is too sketchy compared to their importance.

There are some dubious statements such as "Sun's success" with licensing SPARC architecture (p. 290) but on the whole the book is highly recommended to those who like to understand the history of the development of computer hardware.

Reference

1 BURKS, A. R. AND BURKS, A. W. *The first electronic computer: The Atanasoff story*, Univ. of Michigan Press, 1989.

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Elements of physics, Vols I and II, by D. Chattopadhyay and P. C. Rakshit, New Age International (P) Ltd, New Delhi 110 002, Second edition, 1997, Vol. I . pp xiv + 506, Rs. 165, Vol. II. pp xiv + 440, Rs. 155.

It is a pleasure to come across a good textbook, this time for classes XI and XII students, who are at an impressionable age and hence need proper foundation. The West Bengal Council for Higher Secondary Education decided some years ago to restrict the number of pages of the textbooks for classes XI and XII, so that the students are not burdened literally and figuratively with the enormous volumes of their books. The present books were written according to these guidelines, covering the syllabus in a limited number of pages. The West Bengal Council's decision and the attempt by the authors to meet the challenge are both to be commended.

The two authors are indeed highly qualified researchers and teachers working at the Institute of Radio Physics and Electronics, University of Calcutta, a very renowned institution. Both have PhDs, have more than two decades of research experience, have published several research papers and are currently at the level of professors. On looking at the credentials of the authors, the reviewer had initially a serious worry that the story would be repeated of the unfortunate episode of the NCERT's effort some years ago to revise the physics textbook at roughly the same level. The authors of that episode were all very distinguished researchers. They assumed the students to be at their research level and wrote a book which presented the elementary concepts in physics from the most advanced top-down point of view. For example, the laws of mechanics were deduced from the general principles of invariance and conservation, temperature from the zeroth law of thermodynamics, electrical and magnetic fields from gauge invariance and so on. Such a book might be useful for advanced researchers to get an axiomatic and unified view, but resulted in a virtual revolt by the students and the teachers of classes XI and XII. At that level, physics is to best taught with all its links with day-to-day life. The historical evolution of the ideas, including the successive refinements of these ideas, gets accepted immediately. This is indeed the time-tested traditional way of teaching the subject at the school level. The scholarship of the authors should reveal itself in the precision and clarity of presentation, with occasional flashes of insight or peep into the current thinking on the older subjects. The great mathematician Felix Klein, who titled his famous treatise *Elementary geometry from an advanced point of view*, cautioned the readers that the book is meant for advanced students to look at the basis and foundations of geometry, from angles like Euclidean geometry, Cartesian geometry, projective geometry, affine geometry, non-Euclidean geometry and so on. The students have to be advanced students and the subject material is the foundation of the topic of geometry. The title of the book should not mislead anyone to assume that the book is meant for the general student learning the rudiments of the subject.

The present textbook set is written in a more traditional, acceptable way avoiding the pitfalls of overzealous attempts to exhibit the superiority of the authors. Volume I covers four topics — mechanics, general properties of matter, heat, vibrations and waves. Volume II deals with optics, magnetism, electrostatics, current electricity and modern physics. The text covers the syllabus in a uniform way. The topics are treated in a simple language with a number of diagrams and illustrations, some of the traditional type and some from the modern advanced

world. The idea is to make the subject intelligible and interesting to the students. Numerous problems have been worked out to train the students into the applications of the principles and the formulae developed in the text. Short-answer questions, long-answer exercises, analytical problems and numerical problems are given. It appears from the references given that many of the questions and problems have been chosen from the recent examination papers. Thus the requirements of both the average and the meritorious students have been kept in mind. For the more intelligent students, several harder problems, sometimes marked with asterisks, are included, which will help the students prepare for the more demanding competitive examinations. The use of fine print for worked examples, questions and problems adds to the visual clarity of presentation. It is therefore not surprising that the two volumes have been well received and have gone to the second edition.

The occasion of the second edition has obviously been used to eliminate slips or errors, which might have remained undetected in the first edition. Very few typographical slips remain. Indeed with some effort one could notice a few in Volume I, like 'radio' for 'ratio' on p. 153, 'density of specific gravity' instead of 'density and specific gravity' on p. 204 or 'oule' instead of 'Joule' on p. 342. It was not Arago who was the first to measure the velocity of sound in air in 1829 (p. 482). The 'guinea' should be mentioned as a coin in the Guinea and the feather experiment on p. 148 to avoid the word being mistaken for the bird and its feather. The publishers have indicated on page ii of Volume II that the first edition was printed in 1992 and the second edition in October 1997, but this information is missing in Volume I. Perhaps better care was taken of the second volume. This is reinforced by the fact that Volume I has the question paper of 1991 Physics First Paper of the West Bengal Higher Secondary Examination. Volume II has the question papers of the Physics Second Paper of the examinations for the years 1991, 1992, 1993 and 1994.

A few more improvements could have been considered while revising Volume I. Scalar and vector products of two vectors are mentioned on p.14 and the example of work as a scalar product of two vectors, force and displacement is mentioned on p. 101. The representation of angular motions as (axial) vectors is mentioned on p.126 and the torque is called a vector on p. 82 without citing them as examples of vector products. The authors have felt the need to retain for the benefit of the students the older CGS, FPS and MKS systems of units besides the introduction of the SI System of Units (p. 4). In this spirit they could have added a note on the units for measuring sound intensity in Chapter 4, especially on p. 486 of vibrations and waves part. Similarly, in the spirit of adding bits of advanced thinking, they could have added a paragraph on safety siphons on p. 222, but then there are limitations to the material which can be covered within a fixed number of pages.

The authors have closely followed the syllabus prescribed by the West Bengal Council for Higher Secondary Education. However, repeating the numbering of the chapters 1, 2, 3... for each topic like mechanics, properties of matter and heat is somewhat clumsy. Each topic could have been given a Part number I, II, III, etc. Then an improved method of numbering of the chapters could have been easily considered. The policy of exactly following the syllabus has also the disadvantage that a short account of 'transformers' is not given. It would have greatly widened the knowledge of the students in connection with alternating currents. If something is to be deleted, the reference to 'cold fusion' could be removed.

The authors have also given short accounts of the pioneers associated with the subject. This bit of history adds spice to the book and is welcome. However these are not uniformly given for every chapter or with photographic sketches in every case. Short accounts with the pictures of the savants could have been provided for each chapter. A suggested pattern could be Galileo, Newton (mechanics and work in optics), Aristotle, Leonardo da Vinci (mechanics and painting), Watt, Coriolis (rotational forces), Kepler (also geometrical optics), Hooke, Pascal, Archimedes, Toricelli, Kelvin, Harrison (chronometer), Hope, Boyle, Rumford (calorimetry), Black, van der Waals, Joule, Boltzman, Fourier, Rayleigh, Huygens, Young (optics and elasticity), Helmholtz and C. V. Raman for the various chapters of Volume I. For Volume II, the pattern could be Roemer (eclipse and velocity of light), Fermat (least time principle and mathematics), Foucault (velocity of light and Foucault pendulam), Snell, Gauss (lenses, magnetism and mathematics), M. N. Saha, Bunsen, Abbe (microscopes), P. Curie, Maxwell (electromagnetism and kinetic theory of gases), P. Weiss, Gilbert, B. Franklin, Poisson, Coulomb, van de Graaf, Volta, Ampere, Ohm, Faraday (numerous areas), Oersted, Henry, Tesla, J. J. Thomson & Roentgen, O. W. Richardson, Einstein, N. Bohr, M. Curie and H. Becquerel, O. Hahn and W. Schockley.

The authors have used the conventional older examples and the recent developments to illustrate the principles. The Magdeburg Hemisphere experiment and the Tantulus' cup are given as well as the zero-gravity situations in orbiting satellites. The background of the authors in research and teaching is stamped at numerous places. A few examples of these are the discussions when they explain why a goods train is moved back a little before moving forward, why it is easier to pull a roller than to push it, how a roll of carpet unrolls on the floor, why there is more dew on the ground than on the leaves in winter, what happens to a candle light in an orbiting artificial satellite, why distant sounds are heard more distinctly in night than during daytime, why air bubbles are put in glass paper weights, why metallic lead is chosen as the reference for thermo-power measurements and so on. These linkages between the general principles and the practical observations give charm to the study of a subject like physics.

On the whole, the authors have written a fine textbook at the XI–XII standard level. Their labor of love has not gone in vain.

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Strengthening cooperation in the 21st Centuary, Vol. 91, edited by Peter M. Bainum *et al.*, published for the American Astronautical Society by Univelt Inc., P.O. Box 28130, San Diego, California 92198, USA, 1996, pp. 1154, $145.

The volume reports the proceedings of the Sixth International Space Conference of Pacific-basin Societies (Sixth ISCOPS) held at Marina Del Rey, California, USA, during December 6 –8, 1995. The conference series is biennial, and was formerly known as Pacific-basin Interna-

tional Symposium on Advances in Space Technology and its Application (PISSTA). The sponsorship of the series is international, with the American Astronautical Society (AAS), the Japanese Rocket Society (JRS), and the Chinese Society of Astronautics (CSA) participating. Given such a sponsorship, and the timing of the conference at the threshold of the millennium, the Sixth ISCOPS has an apt theme of "Strengthening cooperation in the 21st century".

Because of its sponsorship by national-level professional bodies, the conference has senior-level representation from the governments and industry from the three sponsoring countries. Their presentations, many covering broad plans and policy issues, constitute the opening and international session of the conference. Wesley Huntress, NASA's Associate Administrator for Space Science, makes a lucid presentation of the future plans of his country, which can safely be said to be the prime mover of the global space exploration effort in modern times. However, mighty as it is, even the US economy cannot all by itself sustain megaprojects in the space arena in all directions of interest. Even the kind of high-profile projects of yesteryears such as the Apollo program, conducted in the heydays of cold war to garner technological as well as psychopolitical advantage, appear unsustainable in the current milieu. Two strategic directions have evolved to meet this challenge. One is the new NASA mantra of "faster, better, and cheaper" missions. The emphasis has shifted from conducting a small number of heavy and expensive manned missions to launching a larger number of small but 'smart' spacecraft. These 'microspacecraft' use high technology to achieve extreme miniaturisation, requiring small booster rockets. Also, these unmanned missions do not have a lot of resources to support human voyagers over long periods, and can have somewhat less stringent requirements regarding reliability, thereby greatly reducing the mission cost. Yet, through highly focused experimental objectives, these spacecraft can return very high grades of scientific data.

One advantage of such a strategy is readily apparent from the managerial and budgetary point of view. Megaprojects, which must necessarily be few and far between, make the financial flow spiky. In contrast, a multiplicity of small and frequently executed projects result in smoother and more predictable budgetary process. Further, the loss (financial as well as scientific) due to an occasional mission failure is not catastrophic.

The result of this thinking is the now-famous Discovery series of NASA missions, of which a highly visible member has been the Mars Pathfinder, the microwave-oven-sized Mars mobile that caught the world's imagination for over a month in 1997. The Near-Earth Asteroid Rendezvous (NEAR) spacecraft is another exciting Discovery mission. Indeed, the recently launched X-ray-observing satellite Chandra may well be the last of big space projects for quite a while. The 'faster, better, cheaper' idea seems so logical and straightforward that one wonders why it took so long to hit upon it!

Huntress dramatically illustrates the effectiveness of the new philosophy by comparing two Mars-mapping missions: the current Mars Surveyor series with the Viking spacecraft of the 1970s. At $180 mn (vs $1100 mn for Viking), 2–3 years developmental time (vs 5–6 years), performance enhancements of 4 to 100 times in coverage and resolution, and added features such as mobility and seismic monitoring (absent in Viking), the relative cost-effectiveness of the new missions is striking.

The second strategic direction of making space programs more tractable is through international cooperation. The protective, inward-looking space exploration philosophy of the early decades is being supplanted by a more open and cooperative environment where costs and efforts are shared, as are scientific results. Canada, the European nations (individually and through the European Space Agency) and Japan have been the major cooperators with the US in a number of programs, and the success of the process will see more of the same as we make the transition into the new millennium.

On the scientific front, the space program of the coming decades has four clear thematic directions: the Sun–Earth connection, solar system exploration, structure and evolution of the universe, and origin and distribution of life in the universe. This last area is one of relatively recent origin, following exciting discoveries including extra-solar planets, presence of organic compounds in heavenly bodies, and the chances of presence of water on many bodies, including the Earth's Moon.

If the US space program for the next millennium (rather its early decades!) looks exciting, other nations that can afford it do not want to miss this excitement, and the volume contains the Chinese and Japanese plans in this direction. The Japanese space programs are deliberated, planned, and supervised by the Space Activities Commission (SAC), and executed by the Institute of Space and Astronautical Sciences (ISAS) and the Japanese National Space Development Agency (NASDA) as the main agencies. Starting somewhat tentatively, the Japanese space proram is now on an even course, with very ambitious science goals. The M-, J-, and H-series of booster rockets will give Japan a wide range of space-launching capabilities. Even a winged reusable unmanned reentry vehicle is planned. The H-II Orbital plane is designed to transport material to and from the Space Station, perform on-orbit satellite servicing and Earth observations.

Japan is a major partner in the international Space Station program and the Tropical Rainfall Measuring Mission (TRMM). Advanced Earth-observing satellites, a Moon penetrator, a Mars orbiter, an X-ray astronomy mission, and even a mission for returning samples from a near-Earth asteroid are included in the Japanese space program.

The Chinese space program has the primary goal of serving its national economic development. To that end, the country plans to establish in the coming decades several stable operational satellite systems for communication and broadcasting, environment and earth resource exploration, disaster mitigation, and microgravity resource. It plans to give priority to the development of payload and satellite bus, expand international cooperation and scientific exchanges.

The remaining sessions of the conference are focused on individual technological themes, from control to communication and propulsion. Interesting ideas are presented on the control of large flexible space platforms, optical inter-satellite communication, broadband aeronautical communication, and tripropellent combustion.

Microgravity, or the near-weightless state within orbiting craft, has emerged as a conducive environment not only for science experiments, but for economic exploitation, starting from the growth of fault-free crystals, high-purity materials, and perfect shapes such as spheres. Not

surprisingly, an entire session is devoted to this topic. Experiments on gallium arsenide, crystal growth of electronic and nonlinear optical materials and proteins, combustion, magnetorheological fluid flows are indicators of the high level of research activity in this area.

Remote sensing has been an original driving force of the development of Earth-orbiting satellite technology, and the volume covers new developments in this area. A global disaster observation satellite system and wind pattern determination by cloud correlation are important topics in this section.

Space exploration has hitherto been utilitarian, whether for science or economic gain. A very interesting recent development is the promotion of space as a pleasure destination. Space tourism is an idea whose time seems to have come, and an entire session deliberates on this issue. The key elements in this venture are development of efficient and reliable reusable space vehicles, spaceports, and support systems and logistics. A discussion on a proposed California Spaceport provides a peep into the shape of things to come.

Major international cooperative programs like the Space Station, and associated research on manned flight find pride of place in the volume. Utilitarian aspects such as agricultural use, land surveying and remote sensing are also covered. This forum is always a rich source of tracking new developments in guidance and control theories and technologies, and the current volume is no exception. Other major areas covered are large space structures, space debris and environment, and space life sciences.

The volume has maintained its high standard of technical exchange over the years, and, dwelling on the theme of international cooperation and the future plans of space research, this volume is a rich source of top-rung information and ideas on current and projected space ventures.

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