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Book Reviews

Stress: Neurobiology and neuroendocrinology edited by Marvin R. Brown, George F. Koob and Catherine Rivier. Marcel Dekker, Inc., 270, Madison Avenue, New York, NY 10016, 1991, pp 720, $198.

There is no question that self-preservation is the most important biological instinct. Any living organism and that includes the human beings, has built-in mechanisms which come into play when self-preservation is threatened, inducing the fight–flight reaction which helps the individual face the threat or run away from it.

The mechanisms work something like this. Our system is constantly in a state of dynamic balance, both within ourselves and also with the environment in which we live Any change in this balance is registered. The body produces an appropriate response, so that the integrity of the system is not threatened. The response leads to a new state of balance. The information that a new state of balance has been gained is fed back so that the response generated earlier does not continue indefinitely.

Much of this goes on unconsciously. However, major changes in the environment enter into our consciousness, are interpreted by the brain as threatening or otherwise and the individual makes the necessary adjustment including the fight or flight to deal with the threat. This perception of threat is the experience of stress and produces a chain reaction which may be called the stress-response.

Over centuries of existense and with the development of language and civilisation, the meaning of self and self-preservation has become more elaborate as well as more complex, acquiring a symbolic significance which goes beyond the body. Self is not only our body but also our property, our relationships, our jobs, our sense of power, our status and our name

Along with this enlargement of self there is also an increase in the variety and quantity of environmental stimulation which we refer to as the 'increased pace of life'. Much of this environmental stimulation is not life threatening but appears to be threatening to this enlarged self. There is thus an increased stress in the day-to-day existence of the modern man. This increased stress cannot but take a toll of our body in a variety of ways.

It was in 1936 that Hans Selye first described the General Adaptation Syndrome—the body's in response to stress. He divided the Syndrome into three stages, the first stage consisting of an increased discharge of epinephrine and norepinephrine from the nerve endings as well as from the adrenal medulla, the second stage consisting of increased secretion of corticosteroids and the last stage of exhaustion. In the first stage there are body responses like increased heart rate, increased respiration, increased muscle tone and a state of arousal which improves our preparedness to meet the threat. In the second stage, there is an extra release of glucose in the system, so that the body is sustained and strengthened to meet the continuous challenge and in the third stage, there is a breakdown of the bodily responses resulting in death. This description was based on animal experiments. In the real-life situation, long-term stress produces diseases like hypertension, diabetes, myocardial insufficiency, rheumatoid arthritis, asthma and ulcer, which have been called the diseases of adaptation. Since these diseases often occur after a long-drawn psychological stress, these are also called psychosomatic diseases.

More recently, it has been demonstrated that a prolonged stress also suppresses our immune system making us more prone to repeated infections as well as dreaded conditions like cancer.

It is a cliche that stress is not 'out-there' but in our minds. This means that what is important is not the

actual strength of the environmental stimuli but our perception of how threatening these stimuli are. A number of factors determine this perception. These include the state of physiological arousal, of the personality of the individual and the social support available to that person. These further depend on our genetic equipment, the way we are brought up and the environment we live in, respectively

The book under review deals with the current state of research and knowledge related to those biological responses which come into operation in face of stress and those which increase our stress tolerance. The psychosocial factors are also considered but only in relation to the bodily responses these generate—a detailed examination of the psychology and sociology of stress is out of the scope of this book.

This is an edited book, containing contributions from 29 different authors or groups of authors all of whom are currently engaged in work in this area. The purpose of the book according to the editors is to ". . assemble the research and opinions of selected investigators who have explored and characterised the mechanisms of stress diseases. The four broad areas of discussion include historical perspectives on the study of stress, the regulation and integration of homeostatic processes, the role of regulatory processes in the development of stress or induced pathophysiology and a description of stress management".

The first section on Perspective of stress makes the now well-accepted point that one does not think of anymore in terms of a few psychosomatic diseases but rather of the role of stress in all kinds of disease response. For example, even in diseases like tuberculosis where the infecting organism *Mycobacterium tuberculosis* has been isolated, there are various different factors determining whether a person will actually have the disease tuberculosis once the body is infected with this organism. These include the age of the host, his nutritional status, the immunological status and the bodily responses which denote controllability of the disease. Controllability means .... "... in part .... the cognitive emotional response to such a threat". "A chronic background of distress, irritation and frustration is conducive to demoralisation, a chronic depressed mood and a variety of diseases (Chapter 2).

The section on Regulation and integration of homeostatic responses describes the neuro-physiological and neuro-hormonal pathways which regulate the stress response. It deals with the mechanisms involved in corticotrophin secretion, the neurotransmitters active in the limbic pathways, the receptors in the brain and pituitary which respond to these neuro transmitters, the role of the newly discovered cortisteroid–releasing hormone (CRF), and the manner in which pituitary and hypothalamus regulate the peripheral release of hormones from the adrenal glands. There is a detailed description of the newly discovered neuropeptides regulating the autonomic nervous and neuroendocrine functions, as well as of chemicals like chromoorganims which are involved in the pathways releasing well-known catecholamines. The description range from classical knowledge in the area to the discovery of new mechanisms and directions in which the research is moving as well as possible models which might explain as yet not fully understood phenomenon.

The third section deals with pathophysiology. In this, stress-related diseases like cardiovascular abnormalities, diabetes, gastric ulcers and gastric hypermotility have been discussed. There is exciting new information about the role of glucocorticoids in neuronal degeneration and possibly in the ageing process and the role of stress in psychiatric diseases. There is an excellent chapter on the effect of stress on immune dysfunction.

The last section on Stress management describes the research program in progress regarding the role of exercise and certain yogic techniques in reducing stress. It is interesting to learn that the usefulness of regular exercise in controlling stress has still not been unequivocally established, especially the psychological stress. It is also exciting to learn about the role of techniques like Pranayama stimulating the right or left brain *via* the contralateral affectory pathways (hence the alternate breathing in Pranayama!).

It would not be overzealous on the part of the reviewer to say that this book published in 1991 contains an exhaustive summary of available information, examines most new hypotheses and critically evaluates major research currently under way. Besides the 29 exhaustive chapters, there are more than four thousand references which an avid reader may pursue to increase his understanding.

However, the book suffers from defects usually associated with edited collections. There is a considerable

overlap in descriptions, showing that the contributors are not aware of what others have written. The editors' evaluation of the different contributions does not appear anywhere; hence, the writers get away with their respective bias. This extends to giving a scientific status to one's pet but untested theories some of which are still in the realm of mythology. For example, while I have the greatest respect for Yoga and have considerable positive experience of Yoga techniques in reducing stress, I know that we are still far from understanding their role in clinical conditions. The writer David Shannahof Khalsa describes with tremendous faith (and impunity?) the effectiveness of different kinds of Kundalini Yoga not only in relieving anxiety, removing fatigue but also in curing obsessive compulsive neurosis, expanding and integrating the mind (whatever it means), stimulating the immune system and regenerating (sic) the central nervous system, giving even the precise time duration required for each therapeutic activity. This he does without giving the slightest research evidence in favour of his statements. Surely the editors could have made some comments on this poetic exposition.

It is also not clear whom this book is addressed to. Some chapters will be enjoyed by enlightened laypersons, others will be gratefully read by graduate students in various neurobiology disciplines but many will be interesting only to those themselves involved in research in the specific areas. I suspect that the last group would rather read fresh articles in journals rather than obtain (to them) stale knowledge in an edited book. The reviewer is a psychiatrist and would confidently recommend the book to teachers and academicians in the field but not to psychiatrists involved in bread-and-butter clinical practice. Would someone working in broad area of life sciences enjoy the book? Perhaps, in parts, but in others he may find himself out of depth. What about those in natural sciences? No, this book is not for them. This is indeed a pity because most chapters are excellent and written with great intensity and affection for the subject. Perhaps someone will paraphrase this book for the intelligent layman, for there is much written in between the unpronounceable names of the brain parts and chemical entities which describes how wise and wonderful is the human body and what exciting work is in progress to understand how this body withstands the onslaughts of environment and the so-called civilisation.

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Space: The next renaissance edited by Jill Steele Mayer. Univelt, Inc., P.O. Box 28130, San Diego, California 92198, 1991, pp 518, $ 35.

This book represents the proceedings of the Seventh Annual International Space Development Conference, Denver, Colorado, USA, May 27–30, 1988.

Frank White talks about the Overview effect–when we see the Earth from space we get transformed. Gordon Woodcock says that space technology cannot be done only by the private sector. Robert Forward describes some options in interplanetary propulsion.

Tom Rogers speaks about human settlements in space. Thomas Becker reviews the basic philosophy of space technology education and then the processes for a teaching unit or series of modules for comparing Earth to Mars.

Kerry Kimble speaks about the viewpoints on space of the 1988 presidential candidates. Spencer MacCallum says that entrusting responsibility for complex life-support systems in space to conventional, tax-supported, political bodies is an impractical proposition. Ivan Dryer speaks about games in space. Frank White speaks again, about the spiritual dimension of space exploration. In another talk, he introduces new phrases indicative of human evolution in space. Scott Pace speaks about the role of the National Space Society in enhancing American budgets for space. Nathan Goldman puts forth the claim that Houston would be the space city of the 21st century. Summarizing the Soviet space programme, Art Bozlee and Charles Vick conclude that in order for the US programme to catch up with the Soviet programme, NASA must realign its activities from operations back to research and development and restrictions must

be reduced on the commercialisation of space by private industry. A 'Declaration of first principles for the governance of outer space societies' is discussed by Nathan Goldman. Mark Sirkin talks about an integrated university as a key element for spacefaring civilizations. William MacDaniel describes the sociocultural implications of space habitation. Sally Morem says that space treaties should be carefully worded so that smaller space bodies can be inhabited by space settlers (from America). Andrew Hall Cutler and James Bowery call for privatization of the space programme.

Robert Bruner lists the basic job skills. Jerry Emanuelson introduces high-temperature superconductivity in ceramic oxides. Eric Drexler speaks about nanotechnology and the challenge of space development. Tihamer Toth-Fejel speaks about artificial intelligence applied to space research. Mark Sirkin talks about a human systems laboratory to test human subjects in simulated space environment. Chek Twang talks about readaptation to prevent the space adaptation syndrome. There are four papers on a lunar base. Three papers describe the use of space shuttle external tanks, which are currently discarded, in orbital operations. Gennaro Avvento describes a space freighter. Seitz *et al* describe in detail a manned Mars mission. Aureo Andino picturises four space 'arks' to the star Beta Pictoris with a terraformed planet. Tom Taylor and Bob Citron speak about entrepreneurship development and Steven Wolf *et al* discuss space policy issues.

All in all the book presents a crosssection of interesting articles on space exploration and is worth retaining for reference.

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Space safety and rescue, 1990 (Vol. 79 in Science and Technology Series) edited by Gloria W. Heath. An American Astronautical Society Publication, Orders to Univelt Incorporated, P.O. Box 28130, San Diego, CA 92198, 1991, pp 222, $50.

A total of 13 papers presented at the 23rd Symposium on Space Safety and Rescue are compiled in this volume. The Symposium was held in conjunction with the 41st IAF Congress during October 6–12, 1990, at Dresden, Germany. Two related papers on effective communication system at the time of disaster and other emergencies are included in the appendix. Unlike the previous proceedings wherein broader topics were discussed, the present one dwells at length on two important themes, *viz.*, Safety and rescue in space and Space activity impact on environment.

The section on Safety and rescue in space contains four papers on aspects of safety while the rest of the two deal with rescue systems. For the coming generation of spacecraft which have a life expectancy of around 30 years or so, fire represents one of the most serious hazards. The prevention and/or quelling of fire onboard requires in-depth understanding of sources of fire, dynamics of spreading of fire under near-zero gravity environment, and mechanisms for fire prevention and protection as well as consequence of such actions on bio-environment inside the closed spacecraft. Generally speaking, the disaster and incidents can be caused by engineering system failures, environment effects or unforeseen external circumstances, crew's and operator's errors. Depending on the nature of failures, safety assurance measures have to be implemented to overcome critical and controlled emergencies and also to avoid catastrophic disasters. Many a time, Murphy's law (*i.e.*, if anything can go wrong, it will) comes into operation without any hint as sufficient thought process and preventive mechanism are not built into the system or due to overbearing attitude in design of systems (one may recall the infamous space shuttle failure). It may be possible to alleviate many of engineering system failures by proper identification and development of safety-critical software residing in the intelligent computers of the complex space systems. Apart from this, one has to build appropriate devices to combat the emergencies. However, in the event of catastrophe, rescue operations have to be taken up. Two such schemes for crew return are presented at a conceptual

level. It is not possible to say whether any of these schemes is practical as the accompanying details are too scanty. All papers of this section are descriptive in nature and make easy reading.

For over a decade, a lot of attention is drawn to the study of debris environment and its impact on safe operation of earth satellites. The problem is expected to worsen with time due to increase in both number and size of the spacecraft. This proceedings addresses only a small fraction of the larger issues involved with modeling, tracking and management of debris. Among all the papers presented in this volume, the paper on 'Dispersion of debris clouds from on-orbit fragmentation events' treats the subject matter in a competent and rigorous manner. Three papers are devoted to the removal of debris from Earth orbits and it is anybody's guess whether any of these methods can see the light of the day in the foreseeable future. To the reviewer, the paper on the removal of orbital debris by laser radiation is the most interesting concept realization, which, however, depends largely on the breakthrough in laser technology.

The contents are easy to understand. The greatest strength of this volume is that it contains many good references which are useful to researchers. However, by itself, insufficient technical details are given in most of the papers with the exception of one or two.

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Space: A call for action edited by Robert C. Blackledge, Carol Luckhardt Redfield and Steven B. Seida. Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198, 1991, pp 385, $35.

Questions like "What is out there?" "Where did it come from?" drove mankind to explore the outer space, and were primarily responsible for landing on our nearest planet—the moon. After man conquered the moon, the space activities in general slowed down not because the spirit of adventure itself declined, but largely because of economic compulsions. Space programs being extremely expensive, only the most relevant and cost-effective projects could be supported. The US plans for the future include a permanently inhabited space station, an inhabited lunar colony and a joint mission to Mars with USSR (which is now unlikely). Although these are mighty involved programs, a general disinterest, and decline in space activities is prevailing in recent years, and their priorities in relation to more urgent economic and developmental activities is questioned time and again. It is in this regard that a call for action is needed to establish a continuous drive supporting man's aspiration towards space.

The volume presents the proceedings of the 10th Annual International Space Development Conference held at San Antonio, Texas, in May 1991. The theme of the Conference points to the excitement of the new knowledge which space exploration offers in order to strengthen interest in these activities, and list out actions to further create a spacefaring civilization. The envisaged objectives involve not only the exploration of the feasibility of various activities in outer space but also promoting their significance, and creating an environment for acceptance by the public, especially by the young minds at primary school level.

The volume lists many interesting ideas and experiments. Fairly detailed conceptual descriptions of a lunar hostel, a lunar-based chemical analysis laboratory, a low-cost space transportation system, Earth-Mars missions, and even a starship design for manned flights to Alpha Centauri is contemplated! Outer space has been advocated to be an ideal place to manufacture microchips. Several abstracts are devoted to space medicine. Physiological and psychological problems arising out of long living in the near-zero gravity are listed. Besides technology-related topics, efforts that could be made to popularize space science have been suggested. Amongst these, participation of astronauts in school programs, introduction of space related courses in early education, bringing telemetry into the class rooms, etc., have been mentioned

Experiences of the schools involved in space-related programs have been reviewed. Experiments on tomato seeds flown in space shuttle by elementary school students are described. A session each on cultural/ethical, and business/economics aspects in space are also included. Problems of habitat living on moon where basic life support is provided by technology, such as who can bear arms in a community where possession of life-support controls can hold everyone a hostage are envisaged. On the business side, reasons for not exploiting the almost limitless opportunity offered by space ventures, and the role of NASA *vs* private enterprise has been discussed. One of the papers looks into the need of establishing a world space agency since with the technology presently available, interplanetary exploration is too costly for any individual nation.

It is apparent that a wide variety of topics have been covered in the proceedings. An important aspect in furthering the cause of space activities is the long-term commitment and planning which is difficult to come by in the prevailing chaos and instability in the world scenario. The space programs have a tendency to take a back seat in preference to other urgent world problems. It is in this sense that the objectives of the seminar to sustain interest and push for action in furthering the spacefaring activities has been rightly emphasized. It is unfortunate that out of the 85 talk titles listed, the full texts of only about 20 are given. The remaining titles are presented only as brief abstracts, which provide no information on the technical content of the papers. However, the volume does provide some newer information in non-technical language, of the kind often carried in the daily newspapers. The volume is recommended to space scientists, educationists and general readers.

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Introduction to the Galois correspondence by Maureen H. Fenrick. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 220, SFr 78. Indian orders to Springer Books (India) Pvt Ltd, 67, Community Centre, Panchsheel Park, New Delhi 110 017.

When one writes a textbook, the number of choices one has to make must be so overwhelming as to dissuade most people. The diverse backgrounds of students, the direction in which the subject is moving, whether it is presently active or not, whether there is a sense of completenesss or is it still in its formative stages, one's own personal biases—the list could go on. It is then surprising that textbooks do get written at all. Even more surprising, when it is on a subject like Galois theory where some excellent textbooks are easily available. Given all this, I was surprised to find yet another textbook on Galois theory published by Birkhäuser. The book under review gives no new insights into the field, but I am not the typical reader the author has in mind. It could be quite useful to a new and enthusiastic student.

This book deals with the theory of Galois correspondences, a major triumph of conceptual thinking which enabled the mathematicians to settle very many ancient questions in a unique and very satisfactory way. The author describes these techniques lucidly and concludes with some of its applications to old questions. The book assumes only some basic algebra and develops the rest with numerous examples and exercises thrown in—as any textbook should. This book is not aimed at the bright, inquisitive and intuitive, but more towards the plodder. The pace of development is slow and comfortable.

Following major results are proved:

1. Fundamental theorems of Galois theory.
2. Fundamental theorem of algebra.
3. Various results on constructibility—subjects like constructing cubes with a specified volume, squaring the circle, trisection of angles, construction of regular polygons.
4. Wedderburn's theorem on finite division rings.

5. A special case of Dirichlet's theorem—there are infinitely many primes which are congruent to 1 mod n, for a given n.

For some mysterious reason, the author avoids some well-known facts from elementary arithmetic which could have made certain proofs considerably shorter and transparent. For example, this is true of the proof of Proposition 1·9 on page 7 if one uses the fact

$$\gcd(m,n) \cdot \text{lcm}(m,n) = mn.$$

There are errors too of such number theoretic nature, *e.g.*, on page 104 in the proof of lemma 3·16, it is asserted that m divides $\binom{m}{r}$ for $1 < r < m$. I am sure that any undergraduate student in India (and hopefully elsewhere) will notice the error. One gets the feeling that proofs are somewhat carelessly written *e.g.*, by interchanging the two steps in the proof of Cauchy's theorem (2·21), the proof would have been pleasanter. Yet another example of carelessness is on page 38 — "*. . . if a finite group G is solvable, then we may build up G via a finite, abelian quotient groups, each of which is completely classifiable. Hence the word solvable is indeed appropriate.*" Indeed! Yet another misleading, though technically correct statement appears on page 164 — "*. . . given any line L and a point P on L, we can* construct *through P both a line parallel to L and a line perpendicular to L.*" (emphasis mine).

These are not serious criticisms. Only serious criticism one can have of this book is that it adds, at least in the theoretical aspects, nothing new to the existing textbooks; not even the perspective is very original. The positive aspects of this book are its examples and exercises–neither very spectacular. May be the pace is an attractive feature for a lazy instructor.

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Reflections on Kurt Godel by Hao Wang. The MIT Press, 55, Hayward Street, Cambridge, MA 02142, USA, 1987, pp 336, $25. Indian orders to: Affiliated East-West Press Pvt Ltd, 25, Dr. Muniappa Road, Kilpauk, Madras 600 010.

Kurt Godel is acknowledged to be one of the greatest mathematicians of this century. His most well-known work is the famous Incompleteness Theorem which has given rise to many speculations (some of them highly thought-provoking such as Hoffstader's book *Godel, Escher, Bach—The eternal golden braid*) on logic, mathematics and mechanical procedures. Godel has made many other fundamental contributions to mathematics and philosophy. Though rated very highly as a scientist, very little is known about his life and his views. The main reason for this appears to be that, unlike Einstein who was a close friend of his, Godel was very much a private person. This biography of Godel brings together rich information both about his life and his scientific work.

The first part of the book concerns itself with the life of Godel. While Chapters 3 and 4 give a dry chronology of important events, Chapters 1 and 2 present a more readable account of various aspects of Godel's life. Chapter 1 presents some important documents from which facts about Godel's life can be culled. Chapter 2 discusses Godel's relation with the Vienna school of logic and also gives an account of Hilbert's famous problems regarding consistency and completeness of logic and how Godel had, in a burst of superlative work, settled the question.

Part II of the book concentrates on the scientific work of Godel in different areas such as mathematical logic, general relativity, philosophy, etc. Within each area the author explains the background and significance of Godel's work. At the end, the author tries, with a good measure of success, to piece together all the work to find some characteristic of Godel's choice of problems and his approaches to solution.

The last and final part of the book contains two chapters on important papers of Godel. This part of the book is meant only for professional philosophers and mathematicians.

The biography gives a wealth of information about Godel's life. However, it is written in a dry style and is not very well able to hold the reader's attention. Another problem is the manner in which the work of Godel is discussed. The author does not seem to have attempted to make the material accessible to the general public. I feel such an approach should have been adopted at least for his famous work in logic. Chapter 6 which discusses Godel's work in logic is too formal and cannot be appreciated by people without any background. The account in Chapter 2 of his work on consistency and completeness is too brief and here also the author does not provide sufficient background material for nonspecialists to appreciate the result.

On the whole, I think this book will be of interest to scientists and philosophers who know some aspects of Godel's work and are interested in him. For people with no formal background in mathematics, logic or philosophy, the book will be formidable to read.

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Effective methods in algebraic geometry edited by Teo Mora and Carlo Traverso (Progress in Mathematics No. 94). Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 501, SFr 98. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

The volume under review is the outgrowth of a symposium on Effective Methods in Algebraic Geometry held in Castiglioncello, Livorno, Italy, in April 1990. The themes (to quote from the foreword) were the following:

1. Effective methods and complexity issues in commutative algebra, projective geometry, real geometry, algebraic number theory.
2. Algebraic geometric methods in algebraic computing.
3. Contributions in related fields, like computational aspects of group theory, differential algebra and geometry, algebraic and differential topology, etc.

Of the papers submitted, the editors chose 31 papers for inclusion in the volume, after having them refereed. The result is an interesting book, which will be of some value both to the specialist in computational algebra, and to others interested in algebraic geometry, singularities, real geometry (geometry over ordered fields like the field of real numbers), etc.

Algebraic geometry is basically concerned with the study of *varieties*, which are (at least to start with) solution sets of finite systems of polynomial equations. More precisely, such a solution set is called an *affine variety;* a 'general' variety is a 'space' which 'locally' has the structure of the set of solutions of a system of polynomial equations. Similarly, one may speak of *analytic varieties,* where the local model consists of the set of common zeroes of a collection of analytic functions of several complex variables.

From an algebraic point of view, an affine variety X, determined as the common zero set of a finite collection of polynomials

$$f_1(X_1, \ldots, X_n), \ldots f_r(X_1, \ldots, X_n)$$

with coefficients in a given field k, determines a finitely generated algebra over k, namely, the quotient of the algebra $k[X_1,\ldots,X_n]$ of polynomials in the variables X_i modulo the *ideal* $I = (f_1,\ldots,f_r)$ consisting of all polynomials g which are expressible in the form

$$g = \sum_{i=1}^{r} g_i f_i$$

for some polynomials g_i. One may also replace I by its radical, which consists of all polynomials g such that g^N is in I for some $N > 0$. This is because any polynomial g with g^N in I clearly also vanishes on X, the set of solutions of $f_1 = \ldots = f_r = 0$.

Just given the collection $f_1, \ldots, f_r$ (so that X has, in principle, been specified), an interesting problem in computational algebra is the following: given a polynomial g, give an algorithm to determine if g lies in I, the ideal generated by f_i. This is called the *membership problem*; a related problem is the *representation problem*, namely, that of giving an algorithm to find an explicit representation of g as a linear combination of f_i with polynomial coefficients. For example, these sorts of issues come up in writing a program like *Macaulay*, which is used by many people for symbolic computations in algebra and algebraic geometry. There are several articles in this volume dealing with various aspects of these problems.

A theme which runs through several of the articles is the 'effective Hilbert Nullstellensatz'. The Nullstellensatz, proved by David Hilbert in the course of his work on invariant theory, states that if $f_1, \ldots, f_r$ are polynomials over an algebraically closed field, whose set of common zeroes is the affine variety X, and if g is any polynomial which vanishes on X, then g is contained in the radical of the ideal I generated by f_i, *i.e.*, some positive power of g lies in I. Recently, the number theorist Brownawell published a proof of an effective version of this theorem (see *Ann. Math.*, 1987), which was followed up by a sharpening due to Kollár. These theorems have the following form: given polynomials $f_1, \ldots, f_r$ of degree $\leq d$, and a polynomial g of degree $\leq \delta$, then g lies in the radical of $I = (f_1, \ldots, f_r)$ if and only if there is an identity between polynomials

$$g^N = \sum_{i=1}^{r} g_i f_i$$

where N and the degrees of the g_i are bounded by an explicit function of d, δ and the number of variables. Obviously, this sort of result is closely related to the membership problem mentioned above. In another direction, this seems to have applications to Wu–Ritt sets, used in constructing theorem proving programs for plane geometry.

On looking at the table of contents, one of the titles immediately commands the attention of an algebraic geometer—A simple constructive proof of canonical resolution of singularities by E. Bierstone and P. Millman. A quick look shows that this is an introduction to their new 'computational' proof of the theorem of resolution of singularities for analytic varieties, and for algebraic varieties over fields of characteristic 0. 'Resolution of singularities' refers to a process of 'modifying' a given (algebraic or analytic) variety X, which may have singularities (points where the variety does not have the structure of a manifold, *i.e.*, where one cannot find a set of 'independent local coordinates'). The modified variety $\tilde{X}$ maps on to the original one X, in such a way that

(i) the mapping $\pi: \tilde{X} \to X$ is proper (equivalently, the inverse image of a compact subset is compact, if one works over the complex field C);
(ii) there is a dense open subset U of X consisting of non-singular points, such that $\pi^{-1}(U) \to U$ is an isomorphism (one expresses this by saying that π is birational);
(iii) $\tilde{X}$ is non-singular.

The existence of such a resolution of singularities is a fundamental result in algebraic geometry, on which several important later results and constructions depend (to name one, Delinge's theory of mixed Hodge structures); it was first proved in the deep and difficult work of Hironaka, whose proof appeared in a paper in the *Annals of Mathematics* (1964) which was 218 pages long! As a result, most working algebraic geometers tend to assume Hironaka's results, almost like a new axiom. The article cited above, as I stated earlier, gives an introduction to a new proof of the theorem; the article itself gives self-contained proof, in less than 20 pages, of the theorem for hypersurfaces, starting from the definition of 'blowing

up', which is the basic 'modification' used repeatedly in the resolution process. Hironaka's proof proceeds by contradiction, at a crucial step — one makes certain types of 'allowed' modifications, which are known not to further worsen the singularities, and (he proves) must actually 'improve' them after an unspecified finite number of steps (if not, he derives a contradiction). Thus, the search for a 'constructive' or 'canonical' proof has actually greatly simplified the proof of the theorem, to the point when (presumably) any graduate student will be able to read the proof. From a computational point of view, this is the first major step towards obtaining a 'workable' algorithm for resolution of singularities.

The reader should have already received an impression that the book under review contains several interesting articles; to finish, let me briefly mention some other topics which are dealt with. There is a quick introduction to coding theory, with a discussion relating Reed–Muller codes to supersingular elliptic curves over finite fields; a computational study of the moduli space of curves of genus 2 over a field k, including a criterion for when a k-rational point corresponds to a hyperelliptic curve defined over k; a study of points in 'uniform general position'; relations between the membership problem and the theory of residues and duality; algorithms for computing the Chow ring of a homogeneous space for a semisimple algebraic group, and for finding equivalent compactifications of adjoint groups.

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Renormalization and asymptotic expansions by V.A. Smirnov. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 380, SFr. 98. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

In high-energy physics, a large number of phenomena can be theoretically understood by perturbatively calculating various correlation functions of field operators. The perturbative expansion parameter is usually a coupling constant, and the expansion converges rapidly if the coupling is small as in quantum electrodynamics where its value is about 1/137. In the 40s, Feynman introduced a convenient method of writing down the successive terms in such an expansion, and this has been followed ever since. A major problem which immediately arose and was eventually solved was that the Feynman amplitudes, as the correlation functions are sometimes called, are usually ill-defined because they are defined by multi-dimensional integrals which happen to diverge. Two procedures, called regularization and renormalization, were invented to tackle this problem. Regularization manipulates the integrals to make them converge, while renormalization is a way of extracting finite values for physically observable quantities from the regularized integrals.

In the 70s, it was discovered that renormalization has a deep physical significance. For instance, quantum chromodynamics, which is now the accepted theory of the strong nuclear forces, was shown to have the property that its coupling 'constant' becomes smaller as we go to higher energies or, equivalently, to shorter distances. This implies that the quarks and gluons, which are the elementary constituents of protons and neutrons, interact strongly at nuclear distances (typically, 1 fermi or 10^{-13} cm) but become asymptotically free at much shorter distances. This was a dramatic discovery. It means that perturbative calculations become increasingly accurate for processes involving quarks and gluons at higher energies although they are hopelessly bad at 1 fermi or more. Thus there is a qualitative difference between ultra-short distances (where perturbative methods are useful) and long distances where one requires non-perturbative methods which are more difficult to apply and are relatively less developed.

The book under review contains a detailed and mathematically careful exposition of the perturbative calculation of Feynman amplitudes. The first part uses the popular technique of dimensional regularization to perform the integrals mentioned above. Several examples are presented to illustrate the various methods used by the practitioners to simplify the calculations. In the second part, Smirnov discusses the BPHZ renormalization procedure developed mainly by four physicists in the 50s and 60s. A novel feature of this

book is that both ultraviolet (short distance) and infrared (long distance) divergences are considered in detail. Most books in this subject concentrate on the ultraviolet divergences which were tackled by BPHZ. A similar way of dealing with the infrared divergences was perfected in the 80s and it is discussed here.

In the third part, the author derives asymptotic expansions for various Feynman amplitudes in the limit in which some of the particle energies or masses become large. These expansions have several applications some of which are presented in this book. They can be used to obtain the short distance properties of a theory (for example, to prove the renormalization group equation which shows that quantum chromodynamics is asymptotically free whereas quantum electrodynamics is not), to derive the decoupling theorem (which tells us what effects remain at low energies when the masses of some of the elementary particles are increased to very high values), and to perform operator product expansions. The latter expansions express a product of several operators as the sum of a number of composite operators each multipled with a certain coefficient. The Feynman amplitudes of the composite operators cannot be calculated perturbatively and are beyond the scope of this book (they need non-perturbative or experimental inputs). However, the coefficients depend only on the short-distance properties of the theory and can therefore be perturbatively obtained in quantum chromodynamics. This factorisation of a physical quantity into perturbative and non-perturbative pieces is phenomenologically very useful.

The author provides interesting historical and bibliographical notes at the end of each part, and a detailed bibliography at the end of the book. The overall presentation is clear enough that a Ph.D. student can work through it without great difficulty. A necessary prerequisite for reading the book is an exposure to relativistic quantum field theory and to one- and two-loop Feynman graphs.

An important limitation to note is that explicit calculations are done only for scalar field theory models. (Further, the rules for deriving the Feynman amplitudes from the field theory model are not discussed). While all the difficulties with divergences and graph combinatorics already arise in such simple models, there are additional subtleties present in the current theories of strong, weak and electromagnetic interactions because they contain fermions and gauge bosons also. These are not considered here at all although the author gives the necessary references.

The book is clearly meant for specialists for whom renormalization and asymptotic expansions are a necessary computational tool. Such people will find a satisfying combination of mathematical rigour and calculational expertise here. However, as mentioned above, the reader who wants to confront the current high-energy experiments will have to consult the papers listed at the end to learn how the methods presented in this book are applied in theories with fermions and gauge bosons.

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Numerical methods for scientists and engineers by H.M. Antia. Tata McGraw-Hill Publishing Company Ltd, 4/12, Asaf Ali Road, New Delhi 110 001, 1991, pp 957, Rs. 360.

Scientific computation today is an important research activity. With the rapid development of computer hardware, software and peripherals, numerical techniques are evolving very fast. We need to adapt our methods to the changing computer architecture. With a vast array of methods available for solving different kinds of problems, the numerical analyst is faced with the problem of choosing the right method suited to his needs. A handbook describing the various methods and their limitations is hence a necessity in the library of any one aspiring to do serious computation.

The book under review fills such a need. Though it is indeed a textbook on numerical methods, it is an important work of reference. Almost all the topics covered in a standard numerical analysis course are treated here, though emphasis differs from topic to topic. The book may not be very suitable for a

mathematical course on numerical analysis, as the mathematical background behind the methods has not been treated. However, as per stated aims of the author, it has been deliberately designed so as to be of use to practising scientists in general. The book is written for users of modern computers.

The book starts with an introduction to error analysis and programming. Linear algebraic equations are treated next. Classical topics like interpolations and numerical differentiation are dealt with very briefly except perhaps for splines. On the other hand, numerical integration is given its rightful place and is treated rather exhaustively. Topics like the Cauchy principal value, improper integrals and automatic integration are discussed. There is also a section devoted to multiple integrals. Numerical methods for nonlinear algebraic equations and the algebraic eigenvalue problem are presented. For the applied scientists, the chapters on numerical methods for optimization, differential equations (ordinary as well as partial) and integral equations are bound to be of interest.

The book has several important features like techniques for error estimation, the comparative study of different algorithms and explicit mention of the limitations of each and detailed discussions of difficult and pathological problems.

To teachers of numerical analysis, there is a wealth of exercises (together with hints for their solution). To the practising scientists, there is an appendix containing FORTRAN programs. There are sections devoted to parallel processing.

All in all, the book should be an extremely useful work of reference for students and research workers engaged in scientific computation. Teachers of courses could use portions of the book, provided they are not interested in mathematical derivations. However, the exercises will be useful for any teacher.

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Analytical, numerical and computational methods for science and engineering by G. H. Hostetter *et al.* Prentice-Hall, Simon & Schuster International Group, 66, Wood Lane End, Hemel Hempstead, Hertfordshire, HP2 4RG, England, 1991, pp 488, $ 17.95.

Engineering and scientific computation is a major scientific activity today. Very large-scale computations are now possible thanks to the development of powerful computers. However, the appeal of analytical methods, wherever they can be used, is undeniable. Today, a practising engineer or scientist must have a background of both types of methods in solving equations of various kinds.

The aim of the book under review is to present a collection of methods, analytical as well as numerical, for the use of scientific computation. It is however also designed to meet the needs of an elementary course on that subject and so is written with the view of being useful to students, assuming minimal mathematical background.

Let us briefly describe the contents of the book.

The book starts with a chapter summarizing the main features of the programming languages FORTRAN 77 and BASIC. The next chapter deals with linear algebraic equations. The main numerical technique discussed is the Gauss–Jordan pivoting method. This is followed by a chapter on the location of zeroes (or finding the extrema) of a function of a single variable. The case of multivariate functions follows in the next chapter. Polynomials are discussed next. The emphasis is on finding roots of polynomials and on factoring of polynomials. Interpolation is not discussed.

Then follow chapters on elementary matrix algebra, eigenvalue problems and quadratic forms and the method of least squares.

Finally, there is a chapter on analytical, numerical and computational aspects of slutions of (ordinary) differential equations.

The book contains several worked examples. The mathematical ideas are plentifully illustrated *via* figures. Every method is derived or explained using an example, the algorithm is then given, followed by computer programs in BASIC and FORTRAN. Thus, it can be used as a book of ready reference. However, the methods are not compared. There is not much stress on the limitations of the methods. No attention is given to special problems arising from large-scale computations.

Several important topics find just passing mention or none at all. For instance, several of the standard methods for finding the eigenvalues of matrices are not even mentioned. In the same way the Runge–Cutta methods are not explained at all. Numerical integration is not given sufficient importance. The conjugate gradient method, an important method in optimization, is not discussed.

The attractive features of this book are the nice practical examples at the conclusion of each chapter. Teachers of numerical analysis will find the wealth of problems at the end of each chapter useful. Answers are also provided.

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Stable processes and related topics edited by S. Cambanis, G. Samorodnitsky and M.S. Taqqu. Birkhauser Verlag AG, Klosterberg 23, CH-4010 Basel, Switzerland, 1991, pp 329, SFr 79.

The book under review consists of 16 papers presented at the workshop on Stable Processes and Related Topics held in January 1990 at the Cornell University. The papers deal with the theory of stable processes with special emphasis on their dependence structure, the theory of infinitely divisible processes, and their applications. We now give a brief description of the papers.

In the first paper 'Gaussian measures of large balls in $\mathbb{R}^n$', W. Linde studies the asymptotics of the distribution of various norms of Gaussian random vectors in finite-dimensional Euclidean spaces, using a generalization of Laplace's method (for determining the asymptotic behaviour of a function defined by an integral). In the next paper 'On a class of infinitely divisible processes represented as mixtures of Gaussian processes' by J. Rosinski, variance mixtures of the normal distribution with infinitely divisible mixing measures, their relationship with the so-called type G distribution and the class of self-decomposable laws are studied; and a series representation for a related class of processes considered. G.L. O'Brien and W. Vervaat, in their paper 'Capacities, large deviations and loglog laws', study large deviations and the laws of the iterated logarithm for a Poisson random measure, using spaces of capacities where large deviation principles arise as a class of limit relations.

Necessary and sufficient conditions for the existence of conditional variance in a symmetric stable distribution in $\mathbb{R}^2$, and an explicit form of this conditional variance are given in 'Conditional variance of symmetric stable variables' by W. Wu and S. Cambanis. In the next paper 'Bounded stationary stable processes and entrophy', J.P. Nolan shows that a bounded stationary stable process has a finite metric entropy integral and proves that the classical necessary condition for sample path continuity of stationary Gaussian processes extends to their stable counterparts. 'Alternative multivariate stable distributions and their applications to financial modeling' by S. Mittnik and S.T. Rachev considers the geometric summation model to study portfolios of financial assets.

'Construction of multiple stable measures and integrals using Lepage representation', by G. Samorodnitsky and M.S. Taqqu considers the stable analogues of the multiple Wiener integrals, *viz.*, multiple stochastic integrals (for Banach-valued deterministic functions) with respect to certain symmetric stable

random measures. In the next paper 'Numerical computation of nonlinear stable regression functions', C.D. Hardin *et al* provide a self-contained exposition, an algorithm and a computer program to evaluate regressions of skewed stable distributions; the program is also useful in computing the probability density function of a stable random variable. Stationary stable processes for which the covariance is not defined are considered in 'A characterization of the asymptotic behaviour of stationary stable processes' by J.B. Levy and M.S. Taqqu; they take the difference, $r(t)$, between the joint characteristic function of $(X(t),X(0))$ and the product of the characteristic functions of $X(t)$ and $X(0)$ as a measure of asymptotic dependence; they analyze the asymptotic behaviour of $r(t)$ for stationary moving average processes (in particular, the Ornstein–Uhlenbeck processes and linear fractional Levy motions), real stationary harmonizable processes and sub-Gaussian processes.

The paper 'An extremal problem in H^p of the upper half plane with application to prediction of stochastic processes' by B.S. Rajput *et al* has two parts. In the first, they study a best approximation problem in the Hardy space of the upper half plane; and in the second part, using the results of the first part, they provide explicit formula for the best linear predictor for a complex continuous parameter 'L^p-representable' harmonizable and regular process; and this class of processes is shown to be fairly broad. In the next paper 'On multiple Markov S α S processes', V. Mandrekar and B. Thelen discuss symmetric α stable processes which are nth order Markov and give conditions under which the solutions of nth order stochastic differential equations driven by symmetric stable noise are themselves nth order Markov. The paper 'On shot noise processes attracted to fractional Levy motion' by L. Giraitis and O. Surgailis concerns the convergence in distribution of an integrated shot noise to α-stable fractional Levy motion.

Examples of self-similar stable processes, their sample path properties (including local time and nowhere differentiability), and a series representation for such processes are discussed in the paper 'Self-similar stable processes with stationary increments' by N. Kono and M. Maejima. Bootstrapping problem for distribution in the domain of attraction of a stable law is considered in the paper 'A stochastic integral representation for the bootstrap of the sample mean' by J. Kinateder. In the paper 'Multiple stable integrals appearing in weak limits', J. Szulga shows that the distributions of multiple stochastic integrals arise as natural limits of suitably normalized multi-dimensional empirical measures resampled by using random variables from the domain of normal attraction of a symmetric stable distribution. The contents of the last paper in the collection, 'Characterizations of ergodic stationary stable processes *via* the dynamic functional' by K. Podgorski and A. Weron are self-explanatory from the title.

The reader will find the short description of contents given in the beginning of the book very helpful. There is no doubt that anyone interested in stable processes will find this book quite absorbing.

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Dynamic programming: A practical introduction by David K. Smith. Ellis Horwood Ltd, Market Cross House, Cooper Street, Chichester, West Sussex, P019 IEB, England, 1991, pp 164, $29.25.

This book is a part of the Ellis Horwood Series in Mathematics and its Applications and is intended as a text for an advanced undergraduate or beginning graduate course in dynamic programming for students of operations research or management science.

Dynamic programming as a general methodological principle for sequential decision-making was first formalised and promoted largely by the late Richard Bellman, though its spirit can be traced as far back as the Hamilton–Jacobi formalism of classical mechanics. It is now a cornerstone of operations research and in its mathematically more abstract variants, of optimal control theory as well. Crudely put, the principle can be described as follows: A sequential decision problem involves taking decisions sequentially over several (possibly infinitely many) stages of the problem strung out over the time axis. At each stage,

there are several possible states the system may find itself in The decision-maker has to make a decision at each stage given the stage he observes, with an aim to minimize some associated cost of the overall process (or maximize reward). The dynamic programming principle states that if the decision maker is following an optimal trajectory, then any part of it, in particular the remaining portion of it when he finds himself at some stage and state, must also be optimal. Suppose he is in state s' at stage i and his decision takes him to state s' in stage $i+1$. If he is following an optimal trajectory, the remaining cost at $(s', i+1)$ must be the minimum over all possible values thereof and moreover, the same holds true for (s, i). Thus, if we assign to each pair (s, i) a 'minimum cost to go' from stage i and state s, then it must satisfy: minimum cost to go at (s, i) = minimum over all s' reachable from s at stage $(i+1)$ of [the cost of going from (s, i) to $(s', i+1)$ plus the minimum cost to go from $(s', i+1)$]. Furthermore, the optimal choice of s' is the one for which this minimum is attained. The former statement implies a backward recursion for the minimum cost to go, usually expressible as a recursive equation amenable to analysis and explicit solution. The latter in turn gives a recipe for finding the optimal strategy in terms of this solution.

The book opens with a descriptive chapter containing some preamble on sequential decision-making in general and motivating the principle of dynamic programming. Chapters 2–5 contain applications of dynamic programming to deterministic (or non-random) sequential decision problems. Chapter 2 describes the 'shortest route' problem, the most basic and perhaps the most popular classroom example of dynamic programming. Chapter 3 is devoted to the knapsack problem (how to optimally pack several items in a knapsack), one of the prototypical problems in operations research. Chapter 4 is devoted to production and inventory planning problems. Chapter 5 poses the static optimization problem of minimizing a function of several variables as a dynamic programming problem. Transportation problem is discussed as an example of the same. This chapter, as also Chapter 2, shows in particular that the 'stages' described above need not correspond to an actual time order, but may be a purely artificial construct that allows the tools of sequential decision-making to be applied to nonsequential problems

The next three chapters describe stochastic dynamic programming problems. Here the next state is random due to external 'noise', but the probabilities of transition from a given state and stage to another depend on the decision taken. This so-called 'Markov decision theory' is a popular paradigm for decision-making under uncertainty and has found far-reaching applications that include optimization of data flow in computer networks. Chapter 6 describes the basic ideas of Markov decision theory with illustrative examples. The next two chapters include more serious applications such as production planning and search under uncertainty and problems with infinite time horizon.

Chapter 9, titled 'Dynamic programming for fun', is what it claims to be, being devoted to recreational applications of dynamic programming. An appendix gives information regarding computer programs for dynamic programming and a bibliography suggests further reading material.

The book is lucidly written, with a sizeable descriptive component motivating and elaborating upon the ideas and with lots of worked-out examples. The strong points of the book are: a wide range of applications, attention to approximation and computational issues, and sensitivity analysis of the problems considered. The level of mathematics is kept minimal. To borrow from a famous quote, the author thereby makes things 'as simple as possible, but not simpler'. This, of course, entails the omission of some details, as in case of the Howard algorithm of Markov decision theory which is described without any rigorous derivation. The book is thus an excellent text for a beginning course in the subject for the uninitiated and the mathematically unsophisticated, but someone with reasonable mathematical maturity would do well to jump directly to a more advanced text like *Dynamic programming—deterministic and stochastic models* by D. Bertsekas (Prentice Hall, 1987).

I also feel that the author should have included a smattering of dynamic programming in continuous time (as in optimal control) to give the students a glimpse of what lies beyond.

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