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BOOK REVIEWS

Imagining tomorrow edited by Joseph J. Corn. The MIT Press, 55, Hayward Street, Cambridge, Massachusetts, 02142, USA, 1986, pp. 233, $9.95. Indian orders to Affiliated East-West Press, 25, Dr. Muniappa Road, Kilpauk, Madras 600010.

Imagining tomorrow is a collection of essays on utopias unattained; for the future is not ours to know, for machines do not the men make, for tomorrow is not an extension of today, for materials cannot be moulded into morality (and swallowed). The utopia hunters envisioned a world of values, a world of brotherhood, a world free of want for the X-rays, the radio, the nuclear energy, the plastics, the skyscrapers, the home machines, computers and the electric light will transcend all social, cultural and economic differences and make one creamy batter of humanity licking ecstacy, the extravagant extrapolations striving to be reality.

X-rays, medicine's machines, a tunnel to the human interior, a gateway to God's territory, the second sight, the miracle healer would eradicate disease and death from the face of the earth and fulfill Marie Curie's dream of 'looking 21 at 210'.

The world improvement programme through radio broadcast was conceived with communication between seas and sea-shores, weather warning, rescuing, news gathering; all this to the making of better human beings since 'there will be no rivalry and suspicion often caused by isolation', and the human race will be related through the 'wireless' like beads through an invisible string. Radio, a calling for the willing, a silence for the indifferent, stimulated youngsters to see a condenser in a discarded photographic plate, tuning coils in curtain rods. This kept them from trouble, and made everyone one up the newspapers. The necessity of spectrum economy led to the biggest breakthrough in radio, the shortwave broadcasting pioneered by amateurs. Once again technology was believed to be a 'tremendous teacher' with powers to 'unify thoughts, purposes, cultures' of terrestrials and extraterrestrials.

'Future is not what it used to be'. Where is the utopia expected through nuclear energy? The nuclear energy, 'too cheap to meter', that would liberate man of all material needs and levitate his soul in the leisure so earned; split the atom and bind humanity. Then what was amiss? The exaggerated expectations born of desire to get something for nothing and what is to become of the nuclear waste?

Predictions went off the mark in relation to computers too. According to Hartree, the physicist, 'one in Cambridge, one in Manchester, one at NPL, we need one more in Scotland and that's all'. In America, at present 'there are half a million large computers, 7 or 8 million personal computers, 5 million programmable calculators and millions of dedicated microprocessors built into other machines', estimates Paul Ceruzzi. The computers were seen as fragile, unreliable, meant only for scientific calculations, to be dismantled after the job. Since they did their job fast, they would remain idle. The low expectations were the result of the ignorance of its working. Use of computers in business, word processing and graphic designing was beyond the comprehension of the pioneers. The innovations have transformed computers into such push-button videogames that users need know no mathematics and this has brought the boom.

Then, there was light, the electric light that informed, that decorated, that advertised, that flashed messages on to the Moon, that could illuminate the Great Pyramid and all the rest of them, that would 'unify home and work place and lower the divorce rate', that could attract extraterrestrials, if arranged in the pattern of the Big Dipper-Bid Diddler!

What happens when you join Phenol and Formaldehyde? Bakelite is born, 'a child of depression', a born loser, told not to be itself, not to look itself. The plastic, the fake, the false, the imitation, the immortal made of the 'very stuff of death', used in automobiles to home furnishings ushered in a 'damp cloth utopia'. The skyscraper, the Grand Canyon of future, the glass houses of tomorrow furnished with everything that 'middle class respectability' could wish for were the other utopias envisioned by inventors and sociologists. But a scientist would never rest until he 'fabricates a loaf of bread or a beefsteak from a lump of coal, a glass of water and a whiff of atmosphere'.

March on!

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VINOD KRISHAN

Managing S and T — conceptual design of management tasks edited by C. R. Mitra and P. Mandke. Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110002, 1989, pp. 175, $90.

The authors have set out on an ambitious project in their attempt to write a text on science and technology management addressing undergraduates and graduate students, working scientists and engineers. The text addresses itself to the management of S & T and R & D institutions based on the authors' teaching and training experience with CSIR scientists and others.

The book is divided into 11 chapters. Let me hasten to add that the typical chapter is only three or four pages in length Chapter 1 is too brief and is presented as the abstract of the book. Chapters 2 and 3 are concerned with management, and science and technology. They attempt to redefine the traditional tasks of management and they consider discovery, invention, innovation, diffusion, replication; order restoring, stability, crisis and 'do-nothing' as nine fundamental management tasks (p. 39). Their attempt represents a vague overstructured exercise. Chapters 4, 5 and 6 cover managing S and T input, management of innovations and new perceptions in management. Chapter 6 includes some good arguments and examples to illustrate key points.

Chapter 7 is about management of S and T institutions (4 pages). Chapter 8 deals with several aspects of R and D management (about 45 pages). R and D organisation, management, types of activity, functions, structures, etc., are described as points without much details. I think the authors should have expanded or deleted this chapter to provide a clear focus for this book. Chapters 9 and 10 are about management of selected institutions (4 pages) and education of engineer-manager (2 pages). Chapter 11 provides ten case studies. Even though the authors appreciate case method in management, their presentation of the case studies and commentaries lacks coherence, focus and utility. There is an interesting glossary of terms. The book should have included a set of references or bibliography. Regardless of authors' frequent references to their credentials and experience, I cannot recommend this book as a text for R and D management and believe would be useful as a supplementary reading.

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Nonlinear methods in Riemannian and Kahlerian geometry by Jurgen Jost. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1988, pp. 153, SFR 38. Indian orders to Springer Book (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110017.

From the time of Riemann it has been noticed that there is a close connection between the understanding of the topological and geometrical aspects of manifolds and solutions of linear differential equations. One such early example is the Riemann mapping theorem, which states that 'Every connected and simply connected Riemann surface is either the sphere, the disc or the complex plane'. The method adopted in proving this involves in finding a harmonic function on an open set Ω of the Riemann surface with prescribed boundary data. Another important example is in calculating the singular cohomology of a compact C^∞-manifold. It has been shown by De-Rhan and Hodge that, in this case, the singular cohomology is isomorphic with the space of harmonic forms. Many more examples occur in calculating the topological invariants *via* the solutions of linear differential equations.

It has also been observed that the existence of solutions of nonlinear partial differential equations help in understanding the geometric aspects of manifolds. One such example is Yamabes problem which states as follows. Let $(M_{(n)}, g)$ be a C^∞-compact Riemannian manifold of dimension $n \geqslant 3$, R its scalar curvature. The problems then: 'does there exists a metric $\tilde{g}$ conformal to g, such that the scalar curvature $\tilde{R}$ of the metrix $\tilde{g}$ is constant?' It is easy to see that if $\tilde{g} = u^{4/n-2}g$, then u satisfies

$$\frac{4(n-1)}{n2}\Delta u = \tilde{R}u^{(n+2)/(n-2)} - R(x)u \qquad (1)$$

$$u > \theta$$

where Δ is the Laplace-Beltrami operator on $(M_{(n)}, g)$ Recently (1) has been solved by T. Aubin and R. Schoen to settle the Yamabes problem.

The book under review, as the title suggests, deals with the interplay between the solutions of nonlinear partial differential equations and the geometric aspects of manifolds. It mainly deals with the study of Yang-Mills equations and the harmonic maps between the Riemannian manifolds. The book is expositary in nature and is very well written.

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Nonlinear functional analysis and its applications: Applications to mathematical physics (Vol. IV) by E. Zeidler. Springer for Science, Kanaalstraat 2, 1975 BE IJmuiden, Netherlands, 1988, pp. 975, DM 298.

The importance of mathematics in applications is by now a well-accepted fact and cannot be overemphasised. However, the levels of mathematical rigour adopted by different users can vary a lot. Often an unorthodox and sloppy approach used in applications can lead to profound developments in mathematics. The theory of distributions is a typical example. Towards the end of the last century and in the early part of this century, engineers and physicists used some ingenious symbolic calculus to solve certain problems and their methods were totally unacceptable to mathematicians. An attempt to make sense out of these led to important developments culminating with the discovery of the theory of distributions by Schwartz, which today plays a central role in the study of partial differential equations.

On the other hand, a mathematician must also need to know something of the physics lying behind the problem he is working on. A physical problem has to be converted into a mathematical model which can be studied using mathematical techniques. The results obtained must then be interpreted physically. For instance a simple model for shock waves is given by Burger's equation (without viscosity). For some initial data, there can be an infinite number of solutions. The mathematician is unable to single out a physically acceptable solution without further conditions. One such meaningful condition comes from the physicists and is called the entropy condition.

Thus it is clear that mathematics and physics should go hand in hand and workers in either field understand something of the other.

Indeed, within mathematics itself, there is often an unnecessary bifurcation into 'pure' and 'applied' disciplines. Indeed in many of our Indian universities, different curricula at the masters' level lead to 'applied' students not learning basic subjects like topology or functional analysis. This is indeed unfortunate, for as the present work under review shows, if proof need be given at all, that profound research in applications of mathematics will be impossible without a strong backing in the so-called 'pure' subjects.

The work under review is a fine example which brings out the oneness of all mathematics and the unity of mathematics and physics. It is the fourth of a five-volume treatise on nonlinear functional analysis and its applications. The first three, according to the author himself, bring out the unity of pure and applied mathematics and the current volume brings out the unity of mathematics and physics.

The book attempts to build a bridge between the thought processes of mathematicians and those of physicists. An impressive array of areas of mathematical physics is discussed. In each area, an attempt is made to motivate the basic mathematical model, avoiding, however, an overly axiomatic approach. Special problems leading to important developments are discussed. At the beginning of each chapter, the basic mathematical results and ideas, which will be used in the discussions to follow, are listed and references to these results in the preceding volumes are given.

To describe the contents of a book of encyclopaedic proportions is well-nigh an impossible task and we will therefore rather take the risk of being too brief. The interested reader will surely find out more for himself.

The first section is on mechanics. The basic equations of point mechanics and the different formalisms are discussed. A second chapter is devoted to a preview of quantum theory and elementary particles.

Then follows applications to elasticity. Here we find a discussion of linear and nonlinear elasticity theories, plasticity, polyconvexity, variational inequalities, bifurcation theory, pseudo-monotone operators and convex analysis. Certain special topics, difficult to find elsewhere, as in the case of the important compensated compactness method, are discussed.

Then follow sections on thermodynamics and hydrodynamics. However, shock waves (which also use a functional analytic setting similar to plasticity) are not studied here but there is a promise of this in the next volume.

The last section is on manifolds and applications. Apart from a fairly rapid course on manifolds and differential geometry, there is a discussion of the special and general theories of relativity, fixed point theorems and applications to mathematical economics, dynamical stability and bifurcation.

The end of every chapter contains bibliographical comments and suggestions for further reading and a collection of problems some of which are either solved completely or provided with hints for a solution.

The book will be a valuable asset to any mathematics library. Indeed all volumes need be there since mathematical results discussed here are studied in earlier volumes. But the areas of applications make for fairly self-contained reading. Each section could be used in courses on the relevant subject to illustrate the deep use of mathematics in the development of the areas of physics.

Being a translation from the original in German, the English is at times stilted (see, for instance, the statement of Theorem 77.B, p. 801, or the use of the word 'knot-point' instead of 'node' in a triangulation). However, this should not in anyway diminish the value of the book. The book will rank with classics like *Handbuch der physik* or Courant and Hilberts' *Methods of mathematical physics*. However, it is a far more modern and comprehensive work compared to these. There is enough in it for a person of any speciality in mathematics or physics to dip in, enjoy, and enhance one's knowledge. Students will find it a useful source of information.

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Numerical mathematics, Singapore 1988 edited by R. P. Agarwal, Y. M. Chow and S. J. Wilson. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1988, pp. 526, S. Fr. 118. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110017.

This volume is a collection of papers presented at the International Conference on Numerical Mathematics held at the National University of Singapore during May 31–June 4, 1988.

These papers cover a wide range of important areas: approximation theory, discrete mathematics, ordinary and partial differential equations, stochastic differential integral and integro-differential equations, numerical integration, mathematical modelling, nonlinear equations, with application to free-boundary, convection, control, ill-condition, and eigenvalue problems.

In the context of approximation theory, one can see that there are plenty of papers where finite element method, finite difference method, boundary element method, collocation method and splines are discussed. Among these, it is worth noting the survey article by Babuska on p and h-p versions of finite element method. Apart from describing these versions both in terms of theory and practice, the article gives an extensive list of references related to the recent results of this new approach. Needless to say that this article is extremely useful for people who are already familiar with the usual version of the finite-element method.

Some works devoted to the resolution of nonlinear equations also appear in this volume. For instance, the paper by Nasser Doual *et al* titled as 'Global iterative solutions of elementary transcendental equations' which exploits certain ideas of the theory of chaos should stimulate interest in many people. This article reflects the effects of modern methods and tools to some of the old problems.

The interesting article of L. B. Rall on 'Numerical computation with validation' discusses one of the fundamental questions in the field. How to believe the numbers produced by the computers?

The papers appearing in this book are found to be supplemented with good list of references. On the whole, the presentation of the results and the style of writing of various authors are good. The papers provide a global view of recent developments in various fields and future prospects for research in numerical analysis. Several open problems are indicated by several authors in their papers. Of course, in a conference of this type, no particular direction in the ocean of numerical analysis can be analysed in depth. This volume ought to prove very useful for researchers in numerical analysis and is a valuable addition to their libraries.

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Numerical methods for grid equations (2 vols) edited by A. A. Samarskii and E. S. Nikolaev. Birkhauser-Verlag, Boston, Inc., 675 Massachusetts Avenue, Cambridge, MA 02139, USA, 1989, pp. 242 (Vol. 1) and 502 (Vol. 2), SFR 345. Indian orders to Springer Book (India) Pvt Ltd, 6, Community Centre, Panchasheel Park, New Delhi 110017.

Most problems of engineering and physics are modelled by partial differential equations with appropriate boundary conditions. The exact solutions are almost never possible to realise. Hence we rely on approximate solutions and the finite difference method is one of the oldest methods of approximating the solutions of partial differential equations.

In using the finite different method we establish first a mesh or grid of nodes in the domain. Then we approximate the differential operator by means of a difference operator and arrive at a linear or nonlinear system of algebraic equations to be solved. These are called the 'grid equations'.

A moment's reflection will show that the standard methods of linear algebra for solving systems of linear equations will be far from efficient while dealing with grid equations which arise out of real problems. First of all the system will be very large since a large number of nodes will be used to approximate the equation Also the system will be 'stiff' or ill-conditioned. Hence combined with the largeness of the system, the stiffness will have a disastrous effect on the quality of solutions owing to the effect of round-off errors. Also a large matrix will be difficult to store as it will occupy a lot of the area in the computer memory.

Fortunately the matrices arising out of the approximation of partial differential equations often are nicely structured. They are usually bounded. For instance, consider the Laplace operator. Its finite difference approximation yields a tridiagonal matrix (in one-dimensional problems) or a pentadiagonal matrix (in two-dimensional problems). They are also usually symmetric and positive definite.

Hence it is important to modify the existing methods to exploit the special features of the matrices to propose efficient algorithms for the solution of the linear systems.

The work under review is an important contribution in this direction. It proposes direct and iterative methods to solve linear systems arising out of the situation described above. The authors use the solution of boundary-value problems for elliptic equations as the guiding theme for the choice of the methods. In particular, almost every method is illustrated by being applied to the numerical solution of Poisson's problem in a rectangle with Dirichlet boundary conditions.

The first volume gives a description of certain direct methods of solving the equations.

The first chapter is a review of direct methods for solving difference equations. After introducing the basic concepts related to grid equations, it gives the general theory of linear difference equations, solution of second-order equations with constant coefficients and eigenvalue problems.

The next chapter deals with the elimination method, *i.e.*, Gauss elimination applied to grid equations. The final algorithms for tri- and pentadiagonal matrices are clearly written down. Variations of the method (the flow variant, cyclic elimination) are discussed. Examples of their application are given. The methods are also adapted to solve block tridiagonal matrices.

The next chapter describes the cyclic reduction method and applies it to a variety of boundary-value problems.

The last chapter discusses the discrete (or fast) Fourier transform and uses it to solve difference equations. Eigenvalue problems are discussed. The method of incomplete reduction and a staircase algorithm for solving tridiagonal systems are discussed.

In all the preceding chapters, every method is discussed in detail. Mathematical results regarding the applicability of each method are stated and proved. The algorithms are clearly written down. Finally for each direct method, an operation count is made. Applications and examples abound in the text.

The second volume is devoted to iterative methods. The basic idea is to regard the stationary equation as giving the steady-state solution of the associated Cauchy problem and then construct implicit or explicit, two- or three-level time-discretisation schemes for the evolution equation. This will give an iterative scheme to solve the original problem and the iterates will be shown to converge in a suitable (energy) norm.

This volume opens with a chapter which gives a crash course in functional analysis and formulates difference equations as operator equations. Basic concepts of iterative methods are then exposed.

The next chapter discusses two-level iteration schemes and applications. This is followed by a chapter on three-level schemes. In all these there is a study of convergence, stability and of iteration counts *i.e.*, an estimate (in terms of the size of the system) of the number of iterations needed for convergence (in a suitable energy norm).

The following chapter discusses variational type methods like the two- or three-level descent and conjugate gradient methods. Then follows a chapter on triangular methods, *i.e.*, iterative methods based on a triangular decomposition of the matrix. The standard examples are the Gauss-Seidel and relaxation methods. Convergence criteria and optimal choice of relaxation parameters are discussed. Convergence rates are estimated.

Other methods discussed and applied to various types of boundary-value problems for elliptic equations are the alternate triangular method, the alternate directions method which exploit the specific structure of the elliptic operator (especially if it could be decomposed in a convenient way). Methods are also described for solving equations involving indefinite or singular operators (as would be the case of the Neuman problem) and also for solving nonlinear equations.

The penultimate chapter discusses the solution of elliptic boundary-value problems in a variety of situations like irregular domains, elliptic systems (like the elasticity system) and the last chapter discusses the solution of elliptic equations in curvilinear orthogonal coordinates.

The methods are compared with similar examples and convergence rates are often presented so that a choice can be readily made by the reader depending on the problem in hand.

The work is indeed a classic and will be of immense use as a work of reference for those interested in approximation of solutions to boundary-value problems, especially those interested in numerical computations.

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Geometry of supersymmetric gauge theories by Francois Gieres. Volume 302 of Lecture Notes in Physics. Springer-Verlag, Heidelberger Platz 3, Postfach D-1000 Berlin 33, 1988, pp. 189, DM 34.

The *Lecture notes in physics* series aims to report new developments in physics in an informal but careful manner for the benefit of research workers. The present book is about theories which attempt to combine two attractive ideas in modern particle physics, supersymmetry and Yang-Mills gauge theories. Nonsupersymmetric gauge theories have yielded spectacular success in the last two decades in our understanding of three fundamental forces of nature–strong, weak and electromagnetic. Supersymmetry is a more speculative idea.

Supersymmetry was introduced in 1971 as a symmetry between the two kinds of particles found in nature, fermions and bosons. Even though the idea has not received any experimental confirmation so far, theoretical physicists have continued to pursue its implications because of certain remarkable properties that supersymmetric theories have. This has led to the hope that a unified theory of all the fundamental forces of nature (including gravity) will incorporate supersymmetry in an essential way. The study of supersymmetry was greatly facilitated by the concept of superspace introduced in 1974. This is a generalisation of ordinary space-time by postulating some additional dimensions. These extra dimensions (which mutually anticommute and are unphysical) make it easier to visualise the Lie algebra of supersymmetry. Secondly, when a supersymmetric field theory is quantised and studied in diagrammatic perturbation theory, the techniques of superspace greatly simplify all calculations.

The author concentrates on the former aspect of supersymmetric theories, namely, the differential geometry of the classical field theory. No attempt is made to discuss the physical consequence of supersymmetry. There are five chapters in the book. Chapter I introduces the ideas of superspace and supersymmetry transformations which act on superspace. Matter and gauge fields are then defined to be functions of superspace called superfields. Chapter II presents in greater detail the structure of Yang-Mills (nonabelian) gauge superfields. An action which defines a theory of mutually interacting matter and gauge fields is then expressed as a superspace integral of certain superfields. In the third chapter, the action and the algebra of supersymmetry transformations are rewritten in terms of ordinary fields in space-time.

In chatper IV, the author discusses the BRS algebra, which is an algebra of local gauge symmetries possessed by the action used to quantise gauge theories. The BRS algebra exists even in ordinary gauge theories, but in a discussion of supersymmetric gauge theories, it is advantageous to express the BRS algebra also as a differential algebra in superspace. The BRS and supersymmetry algebras together describe all the local symmetries of a supersymmetric gauge theory. The author then briefly introduces the important subject of anomalies which are violations of these symmetries due to quantum effects.

Chapter V generalises the idea of superspace to include extended supersymmetry. Extended superspace has N times the number of anticommuting dimensions present in the simplest theory (called $N=1$) which was analysed in the first four chapters. The structure of the superfields now becomes much more complicated, and only $N=2$ supersymmetry is described in some detail. Following this chapter, there are six appendices some of which summarise the mathematical and physical conventions used. Finally, there is an extensive bibliography referring to most of the relevant articles and books, and a detailed subject index.

The book requires some knowledge of differential geometry, rigid supersymmetry and Yang-Mills theories as a prerequisite. With this background, the author gives a lucid description of how the three may be combined in a mathematically elegant way. The book would be interesting to mathematicians and physicists who wish to learn about the beautiful geometrical structure of supersymmetric theories. For a research worker in physics, it can serve as a bridge connecting the older textbook treatment of supersymmetry and BRS algebras to the more abstract and mathematically compact treatment that is commonly found in recent articles. Finally, the book is a starting point for proceeding to more advanced subjects like superspace perturbation theory, anomalies and supergravity.

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DIPTIMAN SEN

Fermi surface effects by J. Kondo and A. Yoshimori. Springer-Verlag, Heidelberger Platz 3, Postfach, D-1000 Berlin 33, 1988, pp. 141, DM 85.

This slim book brings together five reviews of interesting problems in metal physics presented at a Tsukuba Science City Conference in Japan, August 1987. Attention to these problems was drawn by a paper of J. Kondo in 1964. Kondo, in trying to understand the unusual minima in electrical resistance as a function of temperature in some dilute magnetic alloys, showed that the perturbatively calculated conduction electron magnetic impurity scattering cross section seemed to diverge logarithmically with electron energy (with respect to the Fermi level). This was used to rationalise the resistivity minimum. The perceptive realised, however, that such a singularity presaged a growth of effective coupling between electron and magnetic impurity and is the indicator of a basic phenomenon, namely, the crossover to a new regime, where neither exists independently and the impurity becomes nonmagnetic because of strong coupling to the electron. This is the Kondo effect. It was also realised that this singular behaviour is a Fermi surface effect; because of a Fermi surface, there is a finite density of low-energy electron hole excitations in a metal, and coupling to these excitations is at the root of a number of effects discussed in the book.

Three reviews in the book, namely, those by Kondo, Mahan and Newns (with coworkers) discuss different aspects of these Fermi surface effects, namely, how they modify the dynamics of a heavy atom tunnelling between two sites in a metal (J. Kondo), how they affect the X-ray absorption and emission spectrum of an atom in a metal (Mahan) and how at atom hitting a metal surface shows down in a peculiar way (Newns, Makoshi and Brako). The interplay between sophisticated theory and even more sophisticated experiment, so characteristic of good condensed matter (or any!) physics, is very much in evidence. The other two articles review the Kondo effect and one of its consequences. The exact solution of the Kondo problem is discussed by Okiji, and Varma describes recent ideas on heavy fermions, many of which owe a great deal to our understanding of the Kondo problem.

This is a useful and opportune compendium, since except for heavy fermions, most of the other areas discussed have attained a certain maturity, after having been at the centre stage of solid-state physics in the seventies.

The basic 'Fermi surface' effect is a phenomenon of fundamental physical importance for several many-body systems, relevant wherever similar low-energy excitations are induced or exchanged. For example, the modern theory of strong interactions among quarks uses closely related ideas of scale-dependent coupling, weaker at short-length time scales and strong at large length or time scales (low energies). The logarithmic increase noted there is a basic theoretical idea of quantum chromodynamics.

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