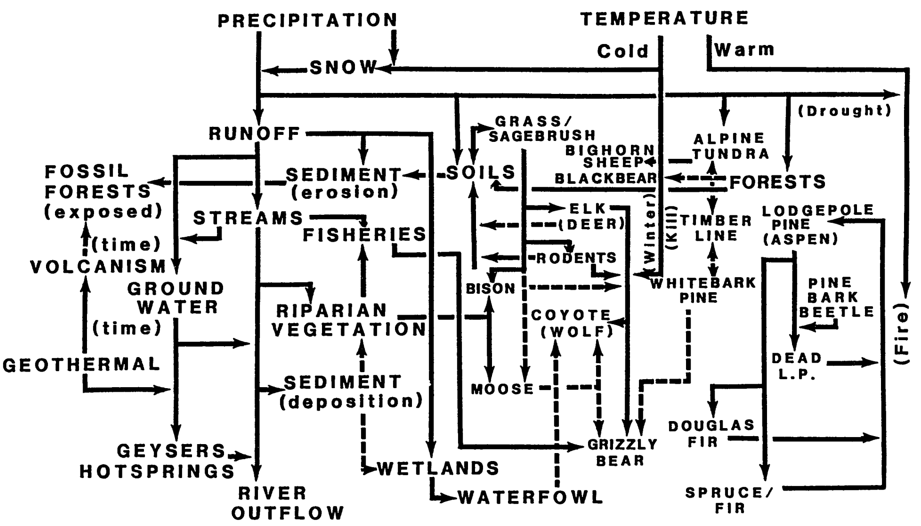

"A conceptual model of the flows and interactions among many of the major components of the Greater Yellowstone Ecosystem." [From Duncan T. Patten's paper in *The Greater Yellowstone Ecosystem*]

and Sax discuss various legal aspects of public land management, and Budd expresses the fear that coordinated management in the GYE will spell the end of multiple use. O'Toole presents a plan for using recreation fees as incentives to limit timber harvest in the national forests.

The next section deals with the impacts of the 1988 fires. Knight introduces the issues, and Varley and Schullery defend Yellowstone's fire policies. Minshall and Brock examine the impacts of the fires on stream ecosystems; Brown explores the issue of prescribed burning; and Van Dyke *et al.* conclude that prescribed burns are good for elk. An interesting aside by Lopoukhine describes how the U.S. reaction to the 1988 fires has influenced fire policy in Canada.

Aspects of wildlife ecology are covered in part 3. Boyce starts it by defending the "natural regulation" policy. Coughenour and Singer decide that overgrazing is all a matter of definition, whereas Chadde and Kay provide some fairly convincing evidence that an overabundance of elk has strongly impacted at least one plant community in Yellowstone Park. Merrill and Boyce hypothesize that summer range may be just as important to elk dynamics as winter range, and the brucellosis problem is explored by Thorne *et al.* The final chapter in this section presents paleoecological data that suggest that all the human-induced perturbations of Yellowstone's vegetation in the last century still fall within the range of fluctuations that have occurred naturally within the last 15,000 years or so.

The wolf issue is discussed in part 4. Mech answers the objections posed to reintroduction, and Singer shows that the prey base is adequate to support wolves without severely affecting ungulate populations. Ream *et al.* describe the dynamics of a naturally colonizing wolf population in the Glacier National Park area, and Bath explores public attitudes about wolf reintroduction.

The final section, by the editors, speculates on the future of the GYE. They believe that the GYE is more valuable in its natural state than as a landscape fragmented by development and extensive human settlement. In order for it to return to a more natural state they favor a second-generation version of natural regulation, called "natural process management," to be applied to the area as a whole. Natural process management would allow fire, predation, ungulate dispersal, and disease to transcend jurisdictional boundaries and proceed throughout the entire GYE with a minimum of human interference. This implies, of course, that multiple use would be greatly diminished or eliminated throughout the region.

Though all of us who love wilderness and whose hearts are thrilled by a falcon's stoop or a coyote's call would love to see this happen, my guess is that it never will. The multiple-use philosophy is thoroughly ingrained in the minds of westerners (and their elected representatives). Large numbers of people who live in the Greater Yellowstone area depend upon extractive industries for their livelihoods. Converting a ranching, logging, and mining economy to one based on tourism and recreation is offered as a solution to the latter problem, but this is much more easily said than done. Cleaning motel rooms is not considered equivalent employment to a high-paying job in a lumber mill. Moreover, tourism and recreation are far from gentle in their effects on the natural environment, particularly when these activities involve millions of people every year.

If something of worth will be preserved in the Greater Yellowstone for future generations, it is going to result from the people who live there realistically reconciling exploitationist and preservationist goals. The national forests and their users will have to recognize that multiple use does not mean using every square mile of land for every allowable activity and that they have a responsibility to provide a reasonable buffer from most of these activities around the parks. For their part, the parks' supporters are going to have to realize that more, rather than less, management will be required to preserve the GYE's species, communities, and some of its natural processes.

The editors, who are clearly committed to natural process management, would probably disagree. Nevertheless, they have assembled a book that explores a reasonably healthy variety of views on a complex subject, and *The Greater Yellowstone Ecosystem* is certainly a far more reasoned statement of the management dilemma than its recent predecessor, Alston Chase's *Playing God in Yellowstone* (Atlantic Monthly Press, 1986).

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Gravitation Theory

Lectures on Non-perturbative Canonical Gravity. ABHAY ASHTEKAR. World Scientific, Teaneck, NJ, 1991. xx, 334 pp., illus. $86; paper, $48. Advanced Series in Astrophysics and Cosmology, vol. 6.

One of the most significant goals of present-day theoretical physics is to develop a quantum theory of gravitation that corresponds classically to general relativity. Research to this end has been actively pursued during the past 25 years and mainly has divided into two approaches.

The first approach, in effect, breaks up the space-time metric into a background metric (usually taken to be flat) and a part that is treated as an ordinary quantum field in this background metric. This type of approach usually encounters the following two serious problems: (i) divergent expressions usually occur in perturbation theory and cannot be eliminated by renormalizations; and (ii) the most interesting questions concerning strong field behavior are very difficult even to formulate—much less answer—because of the essentially perturbative nature of the approach. Indeed, since the background metric is not, by itself, physically measura-

Vignettes: Technological Advance

Let me relate a brain teaser I often pose to beginning robotics students: design a robot to wash the dishes. Usually the students conceive a machine with two hands that must pick up each dish, inspect it for dirt, pick up a brush, dip it in soap, scrub the dish, and so on. After the discussion has gone on for a while, I remind them that local department stores sell dishwashing robots for $250.

—Daniel Whitney, in *Robotics, Control and Society: Essays in Honor of Thomas B. Sheridan* (N. Moray *et al.*, Eds.; Taylor and Francis)

The reference librarian . . . snickered in disbelief when I asked him how to look up the number of portable radios sold in 1939 and 1940. "There were no portable radios then," he snapped with authority, and added, "That was before the transistor."

—Michael Brian Schiffer, in *The Portable Radio in American Life* (University of Arizona Press)

An exciting thing was happening at Livermore. They were building a supercomputer, and I will certainly confess to being a cycle junkie. Computers are never big enough or fast enough. I have no patience at all with these damned PC's. What I didn't realize when I went over to Livermore was that as long as physicists are running the show you're never going to get any software. And if you don't get any software, you're never going to get anywhere. Physicists have the most abysmal taste in programming environments. It's the software equivalent of a junk-strewn lab with plug boards, bare wires and alligator clips. They also seem to think that computers (and programmers for that matter) are the sorts of things to which you submit punched card decks like you did in the mid-sixties.

—Bill Gosper, in *More Mathematical People: Contemporary Conversations* (Donald J. Albers *et al.*, Eds.; Harcourt Brace Jovanovich)

ble, it is very difficult to formulate any physically meaningful statements whatsoever. String theory is at present by far the most prominent member of this class of approaches, and it is believed to be successful with respect to overcoming the first problem.

The second approach starts with the Hamiltonian formulation of classical general relativity (or some suitable generalization thereof) and attempts to formulate a quantum theory via a "canonical quantization" prescription. The spatial metric on a three-dimensional hypersurface and its extrinsic curvature are normally taken to play the role of the canonically conjugate "position" and "momentum" variables in the classical phase space. States then are taken to be functions of the position variable (and are referred to as "wavefunctions of the universe") that satisfy certain equations arising from the constraints present in classical general relativity. This approach is better suited to dealing directly with strong field issues. However, two serious problems also are encountered here. First, there is a severe difficulty ("the problem of time") in giving an interpretation of the wavefunction of the universe in terms of probabilities of outcomes of measurements made by observers. (This is the counterpart of problem ii of the first approach, but it arises in much sharper focus here because one does not now have the "crutch" of a background classical space-time.) Second, even if the first problem is solved, one would expect to encounter serious difficulties in specifying a precise choice of Hilbert space and (regularized) operators representing observables of interest. (This is the counterpart of problem i of the first approach; it arises much more sharply there because one has standard perturbative rules for choice of Hilbert space and regularization of operators in the first approach.)

Without doubt, the most interesting new idea in the canonical quantization of gravity to arise during the past decade was the introduction of new canonical variables on the phase space of general relativity by Abhay Ashtekar. Instead of working with the traditional metric-extrinsic curvature variables, Ashtekar introduces a complex connection and a "soldering form" as the fundamental variables. At the classical level, the Ashtekar formulation is, of course, completely equivalent to the standard formulation of general relativity. Even here, however, the form of the constraints is significantly simpler in the Ashtekar variables—although some additional constraints and "reality conditions" must be now imposed—so new avenues of attack on some classical problems are opened up. Most interestingly, the Ashtekar reformulation suggests some entirely new ideas on how to choose the Hilbert space and representation of observables in the quantum theory. The most promising of these ideas at present is the "loop quantization" program (introduced by Carlo Rovelli and Lee Smolin), which exploits the close similarity between Yang-Mills theory and the Ashtekar formulation of general relativity.

It remains a task for future research to determine how far one can go via this approach toward overcoming the two main problems of the canonical quantization approach. However, the mere fact that the possibility of making progress toward these goals cannot be dismissed out of hand already demonstrates that the Ashtekar formulation is worthy of study by researchers (and potential researchers) in quantum gravity. Thus there is a definite need for a comprehensive, pedagogically oriented account of this approach and its ramifications. Such an account was given four years ago by Ashtekar and co-workers in a set of lecture notes entitled *New Perspectives in Canonical Gravity*, but these notes are already considerably out of date for at least the following reasons: there have been many new developments in the "loop quantization" approach; the structure of the "reality conditions" has been clarified and a new viewpoint on how to implement them in the quantum theory has been developed; and there have been some important pedagogical advances. In particular, it is understood how the original "3 + 1" Ashtekar Hamiltonian formulation can be obtained from a covariant four-dimensional action principle, and it was recognized that one can work with triads rather than spinors. Consequently, the Ashtekar formulation can be introduced much more simply and directly than was done in the previous lecture notes.

The new set of lecture notes by Ashtekar provides an excellent, up-to-date account of his reformulation of general relativity and of the new approaches to canonical quantum gravity that it has suggested. The book is well organized and well written. Clear summaries given at the beginning of every chapter serve as useful guideposts, and a quick summary of the entire book is given in the first 30 pages, so that the reader can get a comprehensive overview of the program with a minimum investment of effort. Sufficient explanation and detail are provided in the book that an advanced graduate student with a good knowledge of classical general relativity and quantum theory should be able to follow most, if not all, of the discussion. In addition, many interesting side comments are made throughout the book. Finally, some useful appendixes on spinors, quantization of constrained systems, and other basic topics are provided.

I have very few criticisms of the book, and only one worthy of mention. I would have benefitted from more discussion of the difficulties and pitfalls of the proposed approach to quantization, particularly via the loop variables approach. Specifically, since one does not expect to have an easy time giving an exact formulation of any nonlinear field theory (much less general relativity), it should be expected that severe difficulties will arise when one attempts to specify precisely the choice of Hilbert space and specify a consistent regularization scheme for the operators representing the observables of interest. There is barely any mention of these issues in the book, and certainly not sufficient discussion to convey a clear impression of the nature of the difficulties that ultimately would have to be confronted in order to convert the loop quantization approach into a rigorously defined theory.

In summary, this book is very successful in achieving its goal of giving a clear, up-to-date introduction to the approach to canonical quantum gravity pioneered by Ashtekar. It is essential reading not only for anyone who intends to do research on this approach but also for anyone at the level of an advanced graduate student or beyond who is interested in broadening his or her perspectives on the theory of quantum gravity.

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Photosynthesis

The Photosynthetic Apparatus. Molecular Biology and Operation. LAWRENCE BOGORAD and INDRA K. VASIL, Eds. Academic Press, San Diego, CA, 1991. xxviii, 495 pp., illus. $139. Cell Culture and Somatic Cell Genetics of Plants, vol. 7B.

With recent refinements in the techniques for the transformation of photosynthetic organisms it has become possible to interrupt or delete genes of choice and to introduce site-directed point mutations. Researchers are thus now in a position to probe the roles of individual subunits of the protein complexes that constitute the photosynthetic apparatus and to understand how individual amino acids contribute to the redox and kinetic properties of the constituent proteins.

Bogorad and Vasil in the chapters they have solicited for this volume attempt to provide the biochemical, functional, and molecular biological framework for appreciating some of the contributions that the transformation techniques as well as random mutagenesis have made to our understanding of photosynthesis. Though with one exception the chapters are concerned with oxygenic photosynthetic organisms, there are also references to the homologous polypeptides, enzymes, and pigment molecules present in the photosynthetic bacteria.

Three chapters, by Vermaas and Ikeuchi, Chitnis and Nelson, and Widger and Cramer, deal with the redox complexes of the oxygenic electron transport chain. That on photosystem II is the most detailed, with an extremely thorough discussion of primary and secondary electron transport function of the reaction center, integrating kinetic and structural information. The authors show an appreciation of recent controversies and give a critical reading of a vast array of information assembled in an intelligible manner. The chapter on photosystem I touches on a wide variety of topics of interest having to do with structure, regulation, and evolution. The chapter on the cytochrome b_6/f complex is a useful comparative anatomy of this complex and its homologs, stressing structural similarities and topology.

The chapter by Jagendorf, McCarty, and Robertson is a delight to read, containing an equilibrated balance of functional, structural, and genetic information on ATPase-ATP synthase from higher plants, cyanobacteria, mitochondria, and bacteria. This chapter brings together in a complementary fashion information on mutants, cross-linking, and chemical modification, enabling the reader to appreciate the discussion of opposing models of ATPase function.

The chapter by Bryant on cyanobacterial phycobilisomes is among the most detailed, with emphasis on the gross structure, roles, stoichiometry, and location of individual subunits. It includes an extensive discussion of operon structure and the consequences of interposon mutagenesis, of which the author is one of the prime practitioners. This chapter is so thorough that that by Tandeau de Marsac on chromatic adaptation, itself a thorough effort on light control of differentiation and pigment gene expression, inevitably retreads some of the same ground. Another chapter on light regulation, this time in chloroplasts by Link, is well written, with a good introduction to control sites for gene expression in plastids and an emphasis on chloroplast differentiation in C4 plants. Another form of plastid differentiation to amyloplasts and chromoplasts is described in an interesting chapter by Kobayashi.

Two general chapters on oxygenic and anoxygenic photosynthesis are included. In trying to touch on many aspects at once these somewhat sacrifice depth and coherence and contain some errors. Chlorophyll and carotenoid biosynthesis, Rubisco assembly, and nuclear-plastid interactions are also represented in separate chapters.

A listing of chloroplast protein-coding genes toward the end of the book is useful for referencing sequences but could have been improved by identification of the gene products. The subject index is not very useful, and the book lacks an author index. However, the bibliographies associated with each chapter are for the most part extensive and current through 1989 and include titles of papers.

This volume brings together a diverse sampling of the photosynthetic world. Some recent work on site-directed mutagenesis of the reaction centers and cytochrome *bc*1 complex of the purple non-sulfur photosynthetic bacteria, much of it illustrative of the power of molecular biology for the probing of function, would have been a welcome addition. Also unrepresented is much fine recent work on transport of proteins into the chloroplast and thylakoid. But the topics that are represented receive for the most part thorough treatment, and the reader is directed to reviews that fill the gaps. Those interested in the topics covered will undoubtedly find themselves enlightened, whether they be neophytes or more mature photosynthesizers.

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Books Received

Advanced General Relativity. John Stewart. Cambridge University Press, New York, 1991. viii, 228 pp., illus. $49.50. Monographs on Mathematical Physics.

Bilharzia. A History of Imperial Tropical Medicine. John Farley. Cambridge University Press, New York, 1991. xii, 359 pp., illus. $59.50. Cambridge History of Medicine.

Character Tables and Compatibility Relations of the Eighty Layer Groups and Seventeen Plane Groups. Daniel B. Litvin and Thomas R. Wike. Plenum, New York, 1991. x, 201 pp., illus. $85.

Developmental Behavioral Neuroscience. Megan R. Gunnar and Charles A. Nelson, Eds. Erlbaum, Hillsdale, NJ, 1992. xiv, 249 pp., illus. $49.95. Minnesota Symposia on Child Psychology, vol. 24. From a symposium, Minneapolis, Oct. 1989.

Dirichlet Forms and Analysis on Wiener Space. Nicolas Bouleau and Francis Hirsch. De Gruyter, New York, 1991. x, 325 pp. Studies in Mathematics, 14. $69.

The Electronic Structure of Atoms. Levente Szasz. Wiley Interscience, New York, 1991. xvi, 571 pp., illus. $125.

The Elements. John Emsley. 2nd ed. Clarendon (Oxford University Press), New York, 1991. viii, 251 pp., illus. $49.95; paper, $22.50.

Food. Fact and Fictions. Ralph I. Freudenthal and