

model (the spin-boson model made exactly soluble in rotating wave approximation). Schleich uses the designation Jaynes-Cummings-Paul model to alert readers to the less well-known work of Harry Paul. Exact dynamical solutions and many examples are given, including instructive ones that include atom-field entanglement and its use in state preparation. Three chapters then exploit these developments to examine interactions that include the quantum effects of atomic motion. In this context, Schleich treats atoms and ions in traps, in free space, and in optical lattices.

The concluding chapter uses Wigner functions and phase space visualization to examine aspects of atom optics, returning the book to its opening theme and completing our guided tour of the quantum jungle. Except that it's not the end of the book. There are fully 90 pages of side thoughts, derivations, and overflow discussions in 17 appendices that include, for example, one devoted to the square root of the Dirac delta function. These would make a small reference work by themselves, and they show in another way Schleich's sensitive attention to detail, for which most students will be grateful. The same care is also displayed in the annotated citations, a score or more at the end of nearly every chapter. There are also homework-style problems, for the dedicated reader. Is there anything for the student that should be here that is not? I doubt it. My strong recommendation is to sign on and enjoy the tour.

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Molecular Engineering of Nanosystems

▶ Edward A. Rietman
AIP Press / Springer-Verlag,
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Nanotechnology is an explosively growing field. K. Eric Drexler's book *Engines of Creation* (Fourth Estate, 1990) showed how creative molecular engineers might be able to make a wide variety of nanoscale molecular machinery. While Drexler's book opened eyes to the opportunities in molecular-scale engineering, there has been a need for a book dealing with the more rigorous aspects of chemistry and physics needed to take this field to fruition.

Molecular Engineering of Nanosystems by Edward A. Rietman takes the

discussion one step further by providing an intuitive, scientific framework for understanding nanoscale systems. The book is part of Springer's Biological Physics series, but the preface suggests the targeted audience might be computer scientists. Rietman has organized the book around his precept that "solution-phase chemistry and protein engineering will bootstrap us into the first phase of nanotechnology." This seems like quite a reasonable starting point; a tremendous number of biological processes involve controlling molecular architecture on nanometer length scales, so it makes sense to look

to natural systems as a guide for synthetic nanosystems engineering.

The book starts with a review of some of the important concepts from solution-phase chemistry. It then moves on to discuss the dynamics that control intermolecular interactions, the formation of molecular systems, and, ultimately, protein and DNA engineering.

The order of presentation, generally moving from fundamental science toward complex systems, seems reasonable. The placement of material within the individual chapters occasionally seems less well organized. A section of about one-and-a-quarter

pages on self-assembly in chapter 3, and its eight equations, are reproduced nearly verbatim in another section on self-assembly in chapter 5. Overall, however, the choice of topics and the order of their presentation appear to be well thought out.

The early parts of the book attempt rather sweeping summaries of large fields of science relevant to nanoscale engineering. For example, chapter two takes on the Herculean task of summarizing the most important relevant ideas from solution chemistry. While the attempt is admirable, the success is undermined by conceptual

inaccuracies and a number of significant errors. For example, a kinetic rate constant is equated with a thermodynamic equilibrium constant, and the discussion of quantum chemistry gives an incorrect equation (in which the wavefunction for the particle-in-a-box apparently exhibits no dependence on position). Quantum chemistry is treated in some detail, and Rietman does a good job with a number of important concepts. However, frontier orbital theory, which was developed in the 1970s and 1980s by Kenichi Fukui, Roald Hoffman, and R. B. Woodward, and which is one of the more

important concepts in modern organic chemistry, appears to be missing.

The most disappointing part of this book is the presence of a relatively large number of errors and inconsistencies. For example, a chapter on intermolecular interactions gives a good overview of Coulomb interactions and discusses in detail the theories of intermolecular forces. But the discussion is marred by frequent juxtaposition of "forces" and "energies" in a number of places and such errors as an incorrect equation for the van der Waals' equation of state for a liquid. Another surprising aspect of the book is that, although there are numerous graphs, in many cases no units are specified in the figure or the text, even though numerical values are given.

The book's later chapters are more qualitative and generally stronger. The concepts are well presented, although the discussion occasionally appears somewhat dated. This shortcoming is most apparent in the section on molecular electronics, in which most references date from the 1980s, and almost none of the explosive growth since 1997 is mentioned.

Despite its flaws, the book should be useful to those who might need a basic introduction to some of the important issues in nanotechnology and the influence of the chemical and biological sciences on the nanotechnology revolution. Many important references are indicated in the text, making it a potentially useful jumping-off point for further study in the primary literature. Those seeking a qualitative picture of nanoscale systems engineering will find *Molecular Engineering of Nanosystems* a useful reference. But those looking for a book dealing rigorously with the fundamental science underlying nanotechnology will have to wait.

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