the *Collected Papers of Albert Einstein*, shedding light on such diverse topics as the influence on Einstein of his readings as an adolescent, the impact of Immanuel Kant's philosophy on Einstein, and the genesis of special relativity. It is a very valuable volume for all scholars who are seriously interested in the intellectual development of the young Einstein.

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## Light Science: Physics and the Visual Arts

Thomas D. Rossing and Christopher J. Chiaverina
*Springer-Verlag, New York, 1999. $79.95 (442 pp.).*
*ISBN 0-387-98827-0*

Efforts to make physics courses more meaningful to nonscience majors are continuing by bringing the course work closer to the students' experiences with nature and art. I have taught elective courses in light and color and in sound and music, as well as a required "core" course called, "Exploration of Color." For the light courses, I used *Seeing the Light* by David Falk, Dieter Brill, and David Stork (Harper & Row, 1986). It was somewhat less suitable for the core course. So I was pleased to see that *Light Science* by Thomas D. Rossing and Christopher J. Chiaverina was described in its preface as "intended for students in the visual arts and for readers interested in art." This new book on light, as did Rossing's *The Science of Sound* (2nd ed.; Addison Wesley, 1990), updates existing texts. The book on sound does this with discussions of electronic music and digital techniques, while the light book does it with chapters on advances in holography, computer images, optical recording, communication, and photonics.

The first 8 of the book's 14 chapters deal with the basic physics of light and color which, to a large extent, can be found either slightly more or slightly less mathematically treated in other texts. The structure is similar to that of *The Science of Sound*: text, summary, references, glossary, review questions, and experiments for home, laboratory, and classroom demonstrations. In addition there is an appendix containing about 60 pages of laboratory experiments, which would be useful if a laboratory were to accompany the course.

The frontispiece of the book is denoted as an "ambigram," a word that I could not find in any of my dictionaries. It is in fact a picture with twofold rotational symmetry. This made me think of "topsy turvy" pictures, which look the same upside down as right side up, and of the *Turvy Topsy Contest*, which was run by Arthur Schawlow in the periodical of the Optical Society of America (*Optics News*, February 1975): Produce a slide that can never be right way up! (For winning entries, see *Optics News*, January 1976.) In chapter 13 of their new book, Rossing and Chiaverina return to ambigrams, citing a musical counterpart by Mozart. (There are other well-known examples of musical symmetry, for example, in Igor Stravinsky's *Canticum Sacrum* and Paul Hindemith's *Hin und zurück*.)

Artists use color theory, often in more than an intuitive way. In the 1979 exhibit of the Armand Hammer Collection at the Museum of Fine Arts in Houston, I recall seeing sketches by Paul Gauguin showing his understanding of ray tracing, prisms, and color combinations, with accompanying notes on art theory. Rossing and Chiaverina give a number of well-known applications, as in pointillist, anamorphic, and op art. Sometimes, in turn, artists make a contribution to the science or technology of art: Two musicians, Leopold Godowsky Jr and Leopold Damrosch Mannes invented the Kodachrome process. (But this is a half-truth: They both also had physics degrees!) There are interesting sections in the appendices of *Light Science* on analysis of art materials and conservation and restoration of paintings. These subjects are not treated in the other texts that I consulted.

Holography, the creation of Dennis Gabor, is discussed, from the early use of the laser in this application by Emmett Leith and Juris Upatnieks, and white-light reflection holography by George W. Stroke and Antoine Labeyrie, to present-day TV holography and computer-generated holograms. The basic physics, however, is not explained adequately.

There are a few incorrect statements in the book. The measurement of the speed of light by Olaus Rømer (1644–1710) was not made with use of the Doppler effect; Christian Doppler lived from 1803–1853. Madam Chen-Shiung Wu and Eric Ambler never received the Nobel Prize.

While I can appreciate that authors don't want to scare students with too much mathematics, burying formulas in the text is cosmetic and counterproductive, particularly when these are required in the "exercises" (not called "problems"). Only halfway through the book do display formulas appear. There are numerous other errors, more or less significant, which I would hope a second edition would correct. Careful editing should eliminate unnecessary repetitions and the introduction of terms without definitions. I can understand the unhappiness of students who encounter such shortcomings. Notwithstanding these criticisms, *Light Science* should serve well its stated readership.

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## Bose–Einstein Condensation of Excitons and Biexcitons and Coherent Nonlinear Optics with Excitons

Sviatoslav A. Moskalenko and David W. Snoke
*Cambridge U. Press, New York, 2000. $85.00 (415 pp.).*
*ISBN 0-521-58099-4*

*Bose–Einstein Condensation of Excitons and Biexcitons and Coherent Nonlinear Optics with Excitons*, by Sviatoslav A. Moskalenko and David W. Snoke, is a most useful text by two physicists each of whom has made substantial contributions to the field of Bose–Einstein condensation (BEC) with excitons, a subject attracting increasing interest at present. My own awareness of this subject goes back to 1993, when I read a paper reporting evidence of BEC in an excitonic gas; the paper caused quite a stir. I was on sabbatical at that time working at NIST, in Gaithersburg, Maryland, and so had time to read it properly. Snoke was a coauthor on the paper, which described a significant development clearly, and a heated debate arose about what had been observed and the potential for future experiments.

Excitons are weakly interacting composite bosons, and one should, therefore, be able to observe BEC in its pure form (BEC is seen in its pure form only in weakly interacting systems) using a gas of excitons. For this and other reasons, there had been an effort to produce a sufficiently dense and cold excitonic gas with which to observe BEC.

That was an exciting time for research in BEC in general, with breakthroughs in the production of atomic condensates soon to occur. (This closely related field has grown