Parts of the book are probably well suited for a special-topic graduate class in magnetism, but students may have to read first (or concurrently) more broad-based discussions of magnetism. In particular, *Theory of Magnetism*, by Key Yosida (Springer-Verlag, 1996) includes discussions not only of itinerant magnetic systems but also of magnetism in localized spin systems and in dilute alloys. In addition, the shorter monographs, *Spin Fluctuations in Itinerant Electron Magnetism*, by Toru Moriya (Springer-Verlag, 1985), and *Quantum Theory of Magnetism*, by Robert M. White (Springer-Verlag, 1970, 1983) can provide some alternative views of the state of the field—at least up to the early 1980s.

Theory of Itinerant Electron Magnetism contains very clear presentations of some important aspects of magnetism of the 1990s. Discussions of half-metallic ferromagnets and of the GMR effect in magnetic multilayers are very illuminating. More recent developments, such as TMR, CMR, and magnetic quantum phase transitions, are not included. However, as these new areas of research unfold, readers might expect these topics to appear in later editions.

In summary, *Theory of Itinerant Electron Magnetism* by Jürgen Kübler is a very good book for researchers engaged in basic and applied magnetism. It offers a personal and focused view of itinerant magnetism based on LDA from a leading expert in the field, and it describes in detail the relationship between electronic structure and magnetic properties of itinerant electrons in realistic systems.

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Neutron Interferometry: Lessons in Experimental Quantum Mechanics

Helmut Rauch
and Samuel A. Werner
Oxford U. Press, New York, 2000.
$120.00 (393 pp.)
ISBN 0-19-850027-0

The availability of copious quantities of thermalized neutrons makes them an ideal probe in condensed matter physics and materials research. This same abundance makes them the particle of choice for many fundamental physics investigations. A prime example is neutron interferometry, which is a technique developed to investigate a wide variety of fundamental aspects of quantum theory.

Helmut Rauch and Samuel Werner have been pioneers in the field of neutron interferometry since the first demonstration of a neutron interferometer in 1974; their book, *Neutron Interferometry: Lessons in Experimental Quantum Mechanics*, is both a very readable introduction to the subject and a comprehensive and up-to-date review of this elegant experimental technique. It is written for the advanced graduate student and researcher and serves as a reference text for the field of neutron interferometry.

Interferometry is a technique familiar to all physicists and can be carried out with any wave phenomenon. An incident beam of particles with wavelength λ is split and then recombined, forming an interference pattern that is sensitive to any change in the effective path length of one or both legs of the interferometer. Changing this "optical" path length in a controlled manner allows the experimenter to probe the perturbing interaction with extraordinary precision.

In contrast to the familiar optical interferometers, which employ wavelengths $\approx 10^{-6}$ meters, for neutron interferometry the de Broglie wavelength is about 10^{-10} m. The neutron interferometer uses Bragg reflection from perfect silicon single crystals, in place of mirrors, both to split the beam and recombine it. Neutrons are advantageous in that they are sensitive to the four basic interactions—strong, weak, electromagnetic, and gravitational—which makes the neutron interferometer a particularly versatile tool for testing fundamental physics concepts. Indeed, just the existence of the neutron interferometer is a striking example of the wave–particle duality of quantum mechanics.

The first half of *Neutron Interferometry* introduces the basic aspects of neutron interferometers and the interactions of neutrons with matter. It is a very readable exposition, which, by necessity, includes the detailed quantum mechanical mathematics to elucidate fully the fundamental operation of neutron interferometers and the utility of the technique. This material can be compared with the compendium of articles edited by Ulrich Bonse and Rauch, *Neutron Interferometry* (Oxford U. Press, 1979). The present text brings together in a coherent description most of the material in this earlier collection; it also, of course, includes developments in the field in the intervening 20 years.

The second part of the book describes some of the benchmark experiments of neutron interferometry. For example, rotating a classical vector by 2π restores the original state, while, quantum mechanically, the rotation of the spin of an $S = 1/2$ fermion particle is expected to change the sign of wavefunction, and the spin must be rotated by 4π to return to its initial value ($\Psi(0) = -\Psi(2\pi) = \Psi(4\pi)$). This 4π spinor symmetry of fermions was for many years thought to be an unobservable nuance of quantum mechanics—until it was demonstrated experimentally, with a neutron interferometer, by varying a magnetic field in one leg and observing the change in the interference pattern. The neutron interferometer has been used in an analogous manner to examine a wide variety of topological and geometrical effects on the phase of the neutron. Examples include the Aharonov–Casher effect (vector Aharonov–Bohm effect) and gravitationally induced quantum interference.

One of the interesting aspects of the Rauch–Werner work is the willingness of the authors to gaze into the future. They discuss possible applications of interferometry in materials science, an application that is just in its infancy, and they include an intriguing chapter on "forthcoming and more speculative experiments." This chapter incorporates tests for nonlinear terms in the Schrödinger equation, quaternions in quantum mechanics, delayed choice experiments, non-Newtonian gravity effects, and a host of other fascinating possibilities. The only shortcoming in Rauch and Werner's text is the very short, two-page index. Interferometry is a complex and advanced subject, and a more complete index would have been useful, particularly in a reference text for people who are not full-time practitioners in the field.

It is clear that the field of neutron interferometry will continue to be vital and exciting for many years to come and that Rauch and Werner's *Neutron Interferometry* will become the standard text for the field.

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The Structure of the Nucleon

Anthony W. Thomas
and Wolfram Weise
Wiley-VCH, New York, 2001.
$90.00 (289 pp.).
ISBN 3-527-40297-7

Nuclear physics has entered a new and challenging period. The discipline's orbital motion of the constituent quarks and gluons, the roles of strange quarks and instantons, and the condensate structure in the nucleon—which remain to be elucidated by future experimental and theoretical advances.

In synthesizing the field of nucleonic structure, the authors have chosen not to follow a traditional textbook development suitable for beginning students. Rather, mathematical details—derivations of needed cross sections, for example—are left to appendices. Thus the book can serve well as a supplementary reference for all students and as a primary text for advanced students grounded in basic nuclear physics and QCD. It is a book that would usefully sit open on the desk of all professionals in the field.

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Applications of Nonlinear Fiber Optics

Govind P. Agrawal
Academic Press, San Diego, Calif., 2001. $84.95 (458 pp.)
ISBN 0-12-045144-1

Govind P. Agrawal's *Applications of Nonlinear Fiber Optics* is an extension of his *Nonlinear Fiber Optics* (3rd edition, Academic, 2001), an earlier successful text, and much of the theory in the new book is taken from that reference. *Applications of Nonlinear Fiber Optics* covers important technical topics in fiber optics and optical communications, with emphasis on nonlinear effects.

Agrawal first describes fiber gratings, along with phenomena associated with Bragg diffraction. He covers various fabrication techniques for producing fiber gratings, explaining how irradiation changes the index. A description of fiber gratings as optical filters, and supporting experimental data, follow. Next, Agrawal analyzes nonlinear effects in fiber gratings; some of these effects result in optical bistability. The book discusses Bragg solitons—pulses formed by the combined action of the Kerr effect and fiber grating dispersion at a carrier frequency near the grating bandgap—along with their experimental verification. Other subjects include photonic crystal fibers, fiber couplers as optical switches, and nonlinear switching.

The author gives the impression that nonlinear switching is approaching practical applications. A critical reading of the evidence presented, however, suggests otherwise, in view of the high pulse energies required and the poor response of the switches. The switches could prove useful only if major performance improvements are achieved; one would have expected that Agrawal would be more critical of their present state.

Nonlinear effects are enhanced by resonance, thus it is natural that particular attention is paid to Fabry–Perot and ring resonators, especially to nonlinear phenomena in such resonators. Sagnac interferometers are studied along with their nonlinear switching properties. The book states that parametric amplification in a Sagnac interferometer can occur below the 3-dB quantum limit. What should have been pointed out in this connection is that the amplification is phase sensitive, the quadrature phase is attenuated in the process, and the concept of noise figure must be approached with care. The discussion of nonlinear phenomena in interferometers concludes with the Mach–Zehnder and Michelson interferometers. The author's enthusiasm for nonlinear processes may have led him to overstate their practicality. The responses of nonlinear devices are poor and will limit their use, unless unknown and untried methods provide substantial improvement.

Central topics of optical communications are optical amplification, its spectral response, the associated noise, and the noise figure of the amplifier. I found an error in the noise figure (4.1.17): The expression should read $F_n = 1/G + 2n_{sp}(G - 1)/G \approx 2n_{sp}$; without the 1/G term we would have noise figures of less than unity for $G \rightarrow 1$. Dispersive and nonlinear effects are taken up. The Maxwell–Bloch equations for amplification of pulses that are short when compared to the transverse relaxation time are introduced, followed by the Ginzburg–Landau equation. The author gives attention to the amplification of autosolitons, pulses that are amplified without change of shape. In the discussion of amplifiers, as in most of the book, the author faces the challenges to notation posed by his vast coverage, derived from many sources in the literature. The same symbols are used to designate different quantities. A list of symbols and their meaning would be a welcome addition to the next edition.

The discussion of fiber amplifiers is followed by coverage of laser action caused by the application of feedback to amplifiers. Cavity designs are discussed, those that achieve single-mode operation on the one hand and mode-locked operation on the other. Different rare earth lasers are mentioned, but the main emphasis is on erbium-doped fiber lasers. Active mode-locking, harmonic mode-locking, and the vast literature on realizations of such lasers are reviewed.

Passive mode-locking using saturable absorbers and additive-pulse mode-locking, with polarization rotation or with the figure-eight laser, are described in detail. The author states his belief that the limit on the pulsewidth with either method is set by the "Kelly sidebands." This may be true for soliton lasers, but it is not for stretched pulse lasers. The sidebands are hardly noticeable in the latter; the changing character of the pulse along the ring prevents the coherent superposition of the different sources of continuum generation. The shortest pulses (63 fs, ref [241]) have a bandwidth considerably wider than the gain bandwidth.

Pulses emitted from mode-locked lasers can be compressed using self-phase modulation. Criteria for optimum compression with the avoidance of pulse pedestals are described, as are compression schemes based on higher-order soliton excitation and use of dispersion-decreasing fiber. The book concludes with extensive coverage of fiberoptic communications of on the one hand "linear" systems, in which the nonlinearities have to be circumvented, and on the other soliton communications, in which at least the main effect of the Kerr nonlinearity is used to provide stability for pulse propagation in the presence of anomalous dispersion.

Agrawal next discusses dispersion management, as used in all long-span terrestrial and transoceanic transmission. He also covers the ability of dispersion management to overcome cross-talk induced by four-wave mixing. A discussion of stimulated Brillouin scattering (SBS) follows, along with ways of overcoming it by raising its threshold. Four-wave mixing and its deleterious effect on the signal-to-noise ratio in a wavelength-division multiplexed system is explained by simple analytic arguments.

The author touches on design issues confronted by a lightwave-system designer, and the issues of noise and timing jitter, along with means of controlling them, are addressed in the soliton discussion. Dispersion-managed soliton propagation, a scheme that has received a great deal of attention in the last few years, is characterized theoretically, and ample experimental evidence of its efficacy is presented.