match Selinda's dress under such conditions?

Mindful of such difficulties, Kuehni traces the development of color-order systems. The earliest system considered is that of Xenophanes, a natural philosopher who lived in the 6th century BCE. Plato and Aristotle proposed one-dimensional scales that didn't include green or blue. The natural philosopher Avicenna introduced the first multidimensional color scale in the 10th century. The notion of color circles began in the Middle Ages with limited scales that physicians used to classify urine. Another expression of the circle idea, by Sigfrid Forsius, occurred in the 16th century. It was Isaac Newton who brought the circle idea to maturity; he used the spectral colors he got from a prism and identified the center of the circle with white. Kuehni suggests that Newton chose seven basic colors to reinforce an analogy with musical tones, and that he invoked a nonspectral purple to complete his color circle in conformity with the one-octave tonal circle derived by René Descartes.

By now, you may have guessed that Kuehni does not credit physicists with all the answers and breakthroughs in color science. That message, although implicit, emerges eloquently from his arrangement of the mosaic tiles of his history. The book describes a number of color-order systems, many more than just the several most popular, and supports its discussion with more than 500 references. Newton, though, receives less than three pages, and that includes a figure juxtaposing Descartes's tonal and Newton's color circles. Hermann von Helmholtz, Hermann Grassmann, James Maxwell, and Erwin Schrödinger together receive about five pages, replete with five figures.

As a retired industrial color expert with a book on colorant formulation to his name, Kuehni understands well the physics of color measurement. However, he views perception rather than physics as the proper reference point for creating a color-order system. He seems reluctant to encumber either his history or the perceptual basis of color order with the ideas of basic colorimetry. For example, only in a single sentence (page 164), does one find a definition of tristimulus values: three weighted wavelength integrals of the light spectrum that represent the stage of vision that commences with a luminous stimulus and ends with the absorption of light by the photopigments of the eye. When Kuehni calls tristimulus space nonlinear (page 347), he clearly is relating that space to the space of perceived colors and not to physical light intensity, because tristimulus coordinates are linear in intensity.

Consonant with the perceptual emphasis, Kuehni enumerates such techniques for quantifying perception as color naming, magnitude estimation, and visual thresholds. Such efforts precede Newton; an interesting application is Francis Glisson's 1677 scale to classify the color of hair. Kuehni also exhaustively describes attempts to create color-order systems in which equal distances correspond to equal perceived-color differences. His discourse includes many models, some non-Euclidean, that connect light to perceived color. Fortunately, Kuehni defers the detailed model descriptions until after he has defined tristimulus values.

As a physics-oriented color scientist, I find the physical colorimetry to be sketchy and not tutorial. For example, Kuehni's brief discussion of tristimulus values is not grounded in such general principles as the Grassmann laws, which declare the linearity of color matching and hence the primacy of those values. Indeed, Kuehni doesn't mention Grassmann's laws at all. Instead, he launches into the warts of the CIE system that conventionally represents tristimulus values. Although Kuehni's statements are accurate, they will not teach novices.

In all fairness, Kuehni's abruptness of style is even handed and perhaps necessary for a book of such a wide historical scope. No mindset, ancient or modern, receives a long discussion. Each contribution, however, is explained briefly and reported traceably. I only hope Kuehni will add an author index to his next edition to increase the value of the large reference list.

My recommendations: Dip into *Color Space and Its Divisions* as a sightseer, historian, or philosopher. Read it as a color scientist who wants to know who did what first. But do not expect a tutorial.

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Magnetic Materials: Fundamentals and Device Applications

Nicola A. Spaldin
Cambridge U. Press, New York, 2003. $110.00, $40.00 paper (213 pp.). ISBN 0-521-81631-9, ISBN 0-521-01658-4 paper

Today's Web surfers rely on magnetic devices to navigate the Internet, but their ancestors were navigating the high seas with magnetite compass needles hundreds of years ago. Thus, the impact of magnetic materials on science and technology is a phenomenon both ancient and modern. Magnetic materials currently excite the pioneering spirit in condensed matter physics (see, for example, the article by Neil Mathur and Peter Littlewood in PHYSICS TODAY, January 2003, page 25). They also spur the entrepreneurial spirit, giving us data storage, sensors, motors, and transformers—to name some of the major applications.

Why then has there been no appropriate entry-level text for beginners? Existing texts do cover basic principles and applications, but the length and level of detail are unsuitable for an initial overview by undergraduates, graduates, or researchers new to the field. But now all that has changed. Fortunately, a good introductory book on magnetic materials is no longer an oxymoron.

Nicola Spaldin's *Magnetic Materials: Fundamentals and Device Applications* is well written and hard to put down. It quickly takes the reader on an epic journey from the most basic principles of magnetism to the cutting edges of technology. Those who complete the odyssey will develop a coherent overview of magnetism and magnetic materials past, present, and future.

Spaldin is an associate professor in the materials department at the University of California, Santa Barbara (UCSB). Using various theoretical and computational methods, she examines the fundamental physics of new magnetic materials that may be technologically important. She has taught with much enthusiasm across a range of levels and has won several awards in the process. She has been granted NSF funding to improve the quality and relevance of graduate education at UCSB and has participated in international science education and outreach programs. Her passion for undergraduate teaching is reflected in the contents and style of her book.

Topics are developed in a concise manner and are efficiently interrelated. That interrelationship is particularly apparent in the opening text of each chapter. For example, in one chapter, diamagnetism is presented as an extension of the atomic physics that explains spin and orbital moments. In a subsequent chapter, paramagnetism is discussed as an effect that tends to overshadow diamagnetism. And in the next chapter, ferromagnetism and other types of magnetic order are developed out of paramagnetism using molecular fields, that is, the local effective fields due to the magnetic nature of the material. In addition, Spaldin has done an especially good job of writing the chapter on ferromagnetic domains and hysteresis.

The practical realities associated with the field of magnetism are well explained in Spaldin's book. A whole chapter is devoted to magnetic data storage, and many examples throughout the text illustrate applications of the different categories of magnetic materials, even diamagnets. Spaldin also provides a timely discussion of the possible advantages of magneto-optical recording and magnetic semiconductors. On a practical and essential note, she covers SI and cgs systems. She then offers explicit interconversions, an important addition because of the persistent lack of consensus in the literature and in the workplace.

Spaldin imbues her narrative with the history of the subject. She gives names, dates, and original figures and references. For example, the Bitter technique is illustrated with a figure, taken from Francis Bitter's original 1931 publication, showing magnetite deposits on a crystal of nickel. His method helped researchers to see, through microscopy, ferromagnetic domain boundaries. Even the quotations that open chapters are of historical, philosophical, and scientific significance.

The book works as a self-contained undergraduate course on magnetic materials. The exercises are imaginative and pitched at the appropriate level for beginners. The fully worked solutions are mathematically complete and contain a significant amount of helpful prose. Overall, Spaldin brings a nice literary style to the book. She refuses to stick to the language of dusty authoritarian texts and occasionally flirts with varying degrees of informality. At the risk of offending those who may actually think in the language of dusty authoritarian texts, Spaldin captivates readers with her style, which makes learning a pleasurable and effective experience.

Returning to the matter of substance, one criticism is the omission of classic subjects in magnetism, such as permanent magnets, the Landau theory of phase transitions, and the Ising and Heisenberg models. But omitting these subjects is acceptable because until now, I believe, it has been impossible to find a concise and accessible magnetics book for novices. But the long wait is over—*Magnetic Materials* is the missing book.

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Principles of Data Analysis

Prasenjit Saha
Cappella Archive, Great Malvern, UK, 2003. $12.00 paper (109 pp.). ISBN 1-902918-11-8

Available free online at http://ankh-morpork.maths.qmw.ac.uk/~saha/book

Probabilities are ubiquitous in physics. Physicists use them routinely in statistical and quantum physics, analyses of experimental data, and elsewhere. Encounters with probabilities typically involve abstract ensembles of identical systems or repeatable measurements, with probabilities interpreted as frequency ratios. This "frequentist" approach is the only way many physicists understand probabilities.

More generally, even if frequency data are unavailable, one may regard a probability as a likelihood based on prior information. The Bayesian approach, which goes back more than 200 years to Thomas Bayes and Pierre-Simon Laplace, enables one to consider probabilities without introducing frequency ratios.

In *Principles of Data Analysis*, theoretical physicist Prasenjit Saha focuses on Bayesian statistics and the maximum-entropy approach, a framework in which one identifies probabilities consistent with prior information such as average values and maximizes the entropy function to obtain best values for the probabilities. To get the Bayesian flavor, consider a data set D, a set of specified parameters ω, and a mathematical model M. If $P(\omega|D,M)$ is the probability of ω given D and M, then Bayes's theorem is $P(\omega|D,M) = P(D|\omega,M)\,P(\omega|M)/P(D|M)$. $P(\omega|M)$ is the *prior* probability of ω, given the model M without any data. $P(D|M)$ is constant for given D and M and $P(\omega|D,M)$ is a *posterior* probability that accounts for information contained in D. Specifying a useful prior $P(\omega|M)$ is a challenging aspect of the Bayesian approach. When Bayesian methods are applied to a given data set and two candidate models, they allow one to evaluate which model is favored by the data.

Saha's coverage includes Bayes's theorem; the binomial and Poisson distributions, with an example showing effects of choosing different priors; Gaussian distributions; the central limit theorem; random walks; the Monte Carlo technique (without explicit use of Bayesian concepts); least squares and distribution function fitting, both within a Bayesian context; information entropy; the maximum-entropy principle; and entropy in thermodynamics. The chapter on entropy and thermodynamics provides a succinct and clear, though relatively abstract, exposition of classical equilibrium thermodynamics and some statistical mechanics. Based on the maximum-entropy technique, the chapter does not require the material on Bayesian statistics that constitutes much of the book.