in the foundations of physics in the late 19th and early 20th centuries, and the circumstances in which relativity was received by the German physics community.

Pyenson argues that it was Einstein's secondary-school teachers in Munich and Aarau rather than his professors at the Federal Institute of Technology in Zürich who most influenced his scientific outlook. From the former he received a sound education in the fundamentals of mathematics and learned, above all, to appreciate the importance of careful observation and experiment in science. From his professors in Zürich, especially from Hermann Minkowski, Einstein received a heavy (and distasteful) dose of highly abstract mathematics that had little to do with physical reality. This issue of the physical versus the mathematical approach to nature became an irritating and eventually a haunting one for Einstein. It is also one of the leitmotifs of Pyenson's study.

Einstein's education took place while his father and uncle pursued their electrotechnical business, a business that went from great promise to unmitigated failure. Pyenson's detailed account of the fate of the Einsteins' firm rewards the reader with increased understanding about a number of Einstein's well-known attitudes: his seemingly natural feel for electrical instrumentation and processes, his hostility toward capitalism and despisal of those enamored of material things in life, and his disdain for a Germany that led to economic failure and exile for the Einstein family. That failure, along with the Einstein family's membership in the Jewish community of Munich, Pyenson argues, were important elements in giving Einstein a sense of being an "outsider."

The second of Pyenson's three themes—his analysis of non-Einsteinian attempts to unite mechanics, electromagnetism, and gravitation—ranges far beyond the expected recapitulation of important scientific papers. For Pyenson believes that challenges to the educational importance of mathematics and classical languages in an industrializing Germany and certain beliefs about the epistemological relationship of mathematics and physics played important roles in the attempt to lay secure foundations for physics and in the interpretation of relativity theory. The center of these non-Einsteinian attempts was Göttingen, where mathematicians and mathematical physicists like Felix Klein, David Hilbert, and Hermann Minkowski held sway at the turn of the century. Pyenson argues that Minkowski's formalistic interpretation of special relativity was actually an attempt to develop a new theory of matter that reflected the mathematical "harmony" of the world. Whereas Einstein's approach emphasized conceptual clarity and allowed experimental testing, Minkowski's favored mathematical rigor and elegance at the price of empirical verification. By 1914 the attempt of men like Einstein and Max Planck to build a picture of the physical world was, Pyenson claims, largely replaced by a mathematical instrumentalism. Most of Minkowski's mathematical colleagues as well as a number of mathematical physicists and philosophers, Pyenson states, allowed pure mathematics "to dictate the form of physical reality." The result, he claims, was that for many "relativity was understood to concern abstract, unphysical, absolute space—all that its creator Albert Einstein had originally laboured to dispel" (p. 139).

Pyenson's third and final theme concerns the circumstances of relativity's reception. In addition to discussing different interpretations of relativity theory, he recounts the editorial practices of the *Annalen der Physik* and the character of Einstein's early scientific collaborations. Between 1905 and 1918 Planck and Wilhelm Wien edited the *Annalen*, Germany's leading physics journal. These "gatekeepers," as Pyenson calls them, sought to publish papers that illuminated the physical meaning or concepts of relativity; they left manuscripts that stressed mathematical interpretations to their mathematician colleagues in Göttingen. Pyenson concludes his study by examining Einstein's collaborations with Jakob Laub, Walther Ritz, and Erwin Freundlich, each of whom had studied at Göttingen. Their support of Einstein's work and approach led them to become, Pyenson concludes, "victims of the rejection of his thought by the Wilhelmian physical science establishment" (p. 238).

This handsomely produced and highly detailed book is not for newcomers to Einstein studies. Those who have yet to read some of the numerous important studies of Einstein and his route to special relativity will profit little from Pyenson's work, most of which has previously appeared in article form. This is, instead, a book for Einstein aficionados: for those who want to learn more about what textbooks he used in school, what the family business was like, what Einstein's peers thought of his work, and so on. Pyenson's diligent research illuminates many aspects of these and other subjects. Though some of his conclusions (concerning, for example, the influence of educational reform in mathematics and of philosophical predispositions on theoretical physics), will probably be controversial, he brings fresh and interesting information to support them. With the help of Pyenson's study and the eagerly awaited first volume of Einstein's papers, scholars and scientists of all varieties will be able to extend our knowledge of the young Einstein and the advent of relativity.

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Motor Control of the Hand

Hand Function and the Neocortex. A. W. GOODWIN and I. DARIAN-SMITH, Eds. Springer-Verlag, New York, 1985. x, 314 pp., illus. \$34.50. Experimental Brain Research Supplementum 10. From a symposium, Melbourne, Aug. 1983.

Intricate use of the hand for tactile explorations and precise manipulations of the environment characterizes primates and is exceptionally well developed in humans. Efforts to understand the neural basis for this complex behavior necessarily lead to an analysis of the sensorimotor areas of the cerebral cortex devoted to the hand. In the absence of general principles as a guide, how can this difficult subject be approached? What emerges from this book, which resulted from a satellite symposium of the 29th congress of the International Union of Physiological Sciences, is an overview of cortical physiology as revealed, primarily, through the recording of the responses of single cortical neurons while a monkey explores and manipulates its surroundings. Sensory and motor aspects of this behavior are discussed, including the areas of the cortex that are activated by different kinds of somatic sensory stimuli, the way in which sensory signals influence cortical activity that is responsible for hand movements, and the kinds of movements that correlate with activity in different cortical motor areas. The results will be familiar to those intimately acquainted with these subjects; for others, this volume, although not comprehensive, offers a succinct introduction to several important issues. The style and quality of the papers in the volume vary.

The hands are used in making tactile discriminations of textured surfaces. How and where these discriminations are represented in the cortex is unknown. Carlson emphasizes that cortical

area 1, which contains one of the multiple representations of the hand in the postcentral gyrus of some primates, may convey an evolutionary advantage for texture discrimination capacities to monkeys that have this extra representation. Darian-Smith and colleagues show that only neurons in somatosensory cortex fire differently when a monkey actively palpates textured surfaces of different spatial gratings. They also show that the discharge patterns are confounded by the speed of finger movements over the surfaces. They suggest that some unknown mechanisms or cortical regions provide for subtraction of the patterns of finger movements to allow identification of the responses that are unique to the surfaces. Alternatively, as Iwamura and colleagues suggest, neurons responsive to particular features of an object, such as edges or degrees of hardness, may abstract the basis for more complex discriminations. Nelson shows, however, that the interactions between sensory inputs and movements are complex, since the patterns of neuronal response to a vibrotactile stimulus in different parts of somatosensory cortex vary considerably in relation to the phases and context of active movements of the stimulated hand. What effect might the premovement inhibitions of sensory induced discharges studied by Nelson have on the responses noted by Darian-Smith *et al.*? Only minimally considered though they are central to the understanding of texture discrimination capacities are the intensive (Lederman), modal, and temporal features that specify textured surfaces.

Motor control of the hand is generally considered similar to that for any movements of the body but may differ considerably for fine movements, such as precision grips. In a review of earlier work by Phillips and others, Evarts emphasizes that, like motor control of the speech apparatus, fine hand movements are characterized by a high degree of fractionation and individuation of the muscles of the hand. Proprioceptive inputs from these muscles contribute to a transcortical reflex through motor cortex that is particularly active in modulating motor cortex discharges that are used in accurate positioning and precise fine movements. The purpose of this feedback is to stabilize limb position, according to Evarts. Papers by Muir and Cheney *et al.* show by means of the methods of spike-triggered averaging that these motor cortex neurons are active in phase with and probably encode simple parameters of active movements of the intrinsic hand muscles during precision grips; the outflow from a single motor cortex neuron fractionates to multiple muscles as postulated previously. During fine movements there is evidence that these motor cortex discharges are linked to particular muscles.

Several papers consider the question of which cortical areas are important for directing movements. Georgopoulos *et al.* show that neurons in areas 4 and 5 are concerned with the direction of a movement and not the trajectory or targeting of the movement. Trajectory and targeting may be served by neurons in the supplementary motor cortex, where cells show a "modality-specific preparatory process for sensory-triggered motor responses" (Tanji), or by cells in area 7, where responses are stimulus-related but contingent upon the performance of movements (Lamarre *et al.*). These results still do not indicate how the particular trajectory of a movement is coded by the discharges. Is it by synchronously controlling groups of muscles, by setting joint angles, or by learning some topographical relationship of the hand in space? Answering this question and locating where in the cortex this process occurs might be pivotal to understanding fine movement controls and the subtractive processes that may be needed to extract sensory signals received during active touch.

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Some Other Books of Interest

Embryology of Angiosperms. B. M. JOHRI, Ed. Springer-Verlag, New York, 1984. xxvi, 830 pp., illus. $115.

This work, characterized by its editor as an advanced treatise, consists of 16 chapters by a total of 19 authors. The opening chapter, by Johri and Ambegaokar, traces the study of angiosperm embryology from 1694 to the current era. There follow chapters on the microsporangium (Bhandari), the ovule (Bouman), the female gametophyte (Willemse and van Went), the pollen grain (Knox), fertilization (van Went and Willemse), the endosperm (Vijayaraghavan and Prabhakar), the embryo (Natesh and Rau), polyembryony (Lakshmanan and Ambegaokar), and gametophytic apomixis (Nogler). The role of polyploidy is dealt with by D'Amato and the structure and the germination of the seed are dealt with by Boesewinkel and Bouman and by Jacobsen. The remaining chapters discuss embryology as related to taxonomy (Herr), homologies and phylogeny (Favre-Duchartre), and experimental embryology (Johri and Rao). The book has both taxonomic and subject indexes.—KL

The Experimental Biology of Bryophytes. A. F. DYER and J. G. DUCKETT, Eds. Academic Press, Orlando, Fla., 1984. xviii, 281 pp., illus. $68.50. Experimental Botany, vol. 19.

Noting that none of the several books about bryophytes published in the last few years has been "directed primarily towards the broadly-based experimental approach," the editors of this volume have set out to provide such a treatment. A brief introduction by Richards is followed by accounts of structure and ecological adaptation (Proctor), breeding systems (Wyatt and Anderson), cytogenetics (Newton), culture (Lal), cell and plastid cycles (Paolillo), and development (Knoop). The remaining chapters deal with hormonal regulation of gametophytic development (Cove and Ashton), photomorphogenesis (Hartmann and Jenkins), uptake of mineral elements including pollutants (Brown), and photosynthesis and its products (Valanne). The editors note the lack of a chapter on ultrastructure. A subject index concludes the book.—KL

Books Received

Alcoholism in the Professions. LeClair Bissell and Paul W. Haberman. Oxford University Press, New York, 1984. xvi, 214 pp. $24.95.

All the World's a Fair. Visions of Empire at American International Expositions, 1876–1916. Robert W. Rydell. University of Chicago Press, Chicago, 1985. x, 328 pp., illus. $27.50.

Alternating Copolymers. J. M. G. Cowie, Ed. Plenum, New York, 1985. xii, 281 pp., illus. $47.50. Specialty Polymers.

Anaerobic Treatment of Forest Industry Wastewaters. P. Rantala and A. Luonsi, Eds. Pergamon, New York, 1985. x, 326 pp., illus., + appendix. Paper, $44. Water Science and Technology, vol. 17, No. 1. From a symposium, Tampere, Finland, June 1984.

Analysis in Classes of Discontinuous Functions and Equations of Mathematical Physics. A. E. Vol'pert and S. I. Hudjaev. Nijhoff, Dordrecht, 1985 (U.S. distributor, Kluwer, Hingham, Mass.). xviii, 678 pp. $117.50. Mechanics: Analysis, 8.

Lift Is Where You Find It. Joe Stein. Zig Zag Papers, Zig Zag, Ore., 1985. xiv, 207 pp., illus. Paper, $7.95.

The Literature of the Life Sciences. Reading, Writing, Research. David A. Kronick, assisted by Wendell D. Winters. ISI Press, Philadelphia, 1985. xiv, 219 pp. $29.95. The Library and Information Science Series.

Lithium. Current Applications in Science, Medicine, and Technology. Ricardo O. Bach. Wiley-Interscience, New York, 1985. xx, 422 pp., illus. $80.

Living Coral Reefs of the World. Dietrich H. H. Kühlmann. Arco, New York, 1985. 185 pp., illus. $24.95. Translated from the German edition.

Low Dose Oral and Transdermal Therapy of Hypertension. M. A. Weber, J. I. M. Drayer, and R.

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