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Max Planck

The Dilemmas of an Upright Man. Max Planck as Spokesman for German Science. J. L. HEILBRON. University of California Press, Berkeley, 1986. xiv, 238 pp. + plates.

Max Planck is best known for his derivation of an equation describing the distribution of energy emitted by heated "black bodies." The derivation required (it was shown) the notion of energy quanta, a prime impetus to the quantum revolution and a prime constituent of its resolution, quantum mechanics. Planck's fame as perceived instigator of, and participant in, the revolution—combined with his personal stature, temperament, and connections—rendered him early a leading spokesman for German science and a leading administrator of its institutions. Heilbron's thoroughly researched and delightfully written account of the public Planck provides significant insights into this sometimes enigmatic figure and the dilemmas he faced.

Planck's lifetime (1858–1947) spanned the entire second and third reichs in Germany, the republican interlude of the '20's, both world wars, and the preparatory years of the present Federal Republic. He was involved in virtually every public controversy over science and every science-policy issue of his era. Heilbron shows that the key to Planck's responses lay not without but deep within his being. A descendant of pastors and professors, Planck was born into a rising Prussia that would soon unify the empire and bring Germany to the pinnacle of scientific and industrial power. He came of age just as Germany reached that pinnacle, and he easily identified the unity of self and of science with that of his state. Political unity did not survive the Great War, nor did intellectual unity survive the centrifugal forces of this century. Only Planck's ingrained personal integrity and devotion to duty remained to him, forming the leitmotiv of his life's work and, paradoxically, the source of some of his own dilemmas.

Planck was, of course, foremost a scientist, and his foremost public concern was the defense of his realist, deterministic conception of science against an increasingly subjective and irrational attitude of the public toward science. Heilbron nicely traces Planck's evolving resolution (on his own terms) of the "tension" between the supposed transcendent truth of science and the human qualities of its practitioners. While this occurred in concert with the changing cultural situation of German physics, it increasingly revealed Planck's implicit religious position.

Planck's ultimate dilemma arrived with the Third Reich. As an administrator, he felt forced to choose between two evils: working with the regime in order to gain concessions for science, while compromising on other matters; or openly opposing the regime and thereby inviting a total loss of support. Planck, by temperament, chose the first alternative and took upon himself the burden of "saving and salvaging" what he could. Did the upright man make the right decision? Should he have been, or long remained, in such a situation? In the end, of course, not even a man of Planck's stature and authority could avert the murderous perversion of morality and "duty" by his countrymen; nor could he avert the tragedy that befell many of his colleagues, his science, and, finally, himself. How do Planck's experiences, reactions and development compare with those of other scientists and Germans of his generation? What lessons can we learn from them? Heilbron's sympathetic, yet critical, case study does not answer all these difficult questions, but it does give us a nearly unique view of this fundamentally private figure. It deserves careful reading and reflection.

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Left. "Planck at work under portraits of his first wife, née Marie Merck, and their four children." [From *The Dilemmas of an Upright Man*; courtesy of Niels Bohr Library, American Institute of Physics, New York]
Above. "Planck loaded with the honors of office, 1933. The man on the right, from whom Planck has averted his head, is Wilhelm Frick, Nazi minister of the interior, who designed the law that dismissed Jews from the civil service." [From *The Dilemmas of an Upright Man*; courtesy of Max-Planck-Gesellschaft, Berlin]

Atmospheric Chemistry

The Photochemistry of Atmospheres. Earth, the Other Planets, and Comets. JOEL S. LEVINE, Ed. Academic Press, Orlando, FL, 1985. xxiv, 518 pp., illus. $79.50.

In *The Photochemistry of Atmospheres*, Joel Levine has selected topics and authors so as to show the reader how the scientific study of atmospheres is unified–from paleoatmosphere through contemporary clean and dirty air to the outer reaches of Earth's atmosphere and the atmospheres of other bodies in the solar system. A rich variety of exotic and familiar chemicals is involved, both in gaseous and condensed phases. It is seen that application of principles and data from fundamental photochemistry and chemical kinetics is permitting rapid and systematic progress in understanding how atmospheres work.

The book consists of nine chapters. The opening chapter, by Levine, reviews theories and constraints from geology bearing on the composition and evolution of the paleoatmosphere and presents photochemical model calculations. Before the advent of atmospheric oxygen and the attendant ozone it is thought that far more ultraviolet sunlight penetrated to Earth's surface. This commonly accepted view implies that ultraviolet-sensitive life forms were not viable except under water or mud until O_2 and O_3 concentrations rose to levels adequate to block ultraviolet radiation. The possibility that another ultraviolet-absorbing gas could have served to block the radiation is not discussed. A chapter on the stratosphere by R. P. Turco treats the natural ozone layer and its photochemistry more completely. It

is authoritative and complete in its coverage of gas-phase and heterogeneous chemical reactions of oxygen allotropes, nitrogen and hydrogen oxides, the halogens, and sulfur oxides. A concise history of theories of ozone perturbations due to human activities and natural causes is presented. One wishes only that more field measurements had been reviewed and compared to model predictions. An intervening chapter on the troposphere by T. E. Graedel presents a very useful broad view of atmospheric chemistry—that diverse chemical transformations represent only different pathways of chemical oxidation. It is shown that atmospheric oxidation, whether gaseous, liquid, or solid phase, is initiated not by O_2 but by radical species, O_3, H_2O_2, and others. From this perspective Graedel outlines how spatial and temporal patterns in chemical concentrations result from the interplay of source locations, chemical transformation rates, meteorological factors, and the types and rates of removal (deposition) processes. The reader may quibble with some of the distance scales that are proposed to characterize certain processes, but this chapter is conceptually clear and illuminating. Its drawings are especially insightful and educational. Considering the complexity and heterogeneity of the chemistry of tropospheric air and the surfaces to which it is exposed, this chapter is remarkable in its coverage, accuracy, and conciseness. Graedel's comments on corrosion of materials by air pollution are eye-opening but too brief.

A later chapter by W. R. Kuhn concerns the connection between atmospheric chemical composition and climate. This chapter is exceptionally good as a tutorial on physical principles, but it suffers from some outdated data and examples. Kuhn's exposition of the laws governing atmospheric infrared radiation, how these laws are used in mathematical models, and the basis of the greenhouse effect is clear and well based. His inclusion of data on the global increase of CO_2 only through 1975 weakens his case unnecessarily, as does an unclear statement of the potential greenhouse effect of tropospheric ozone (currently thought to be substantial) and too little emphasis on CH_4. Readers of Kuhn's account could profitably consult a paper by Ramanathan *et al.* in the 20 June 1985 *Journal of Geophysical Research* for updating on specifics. D. G. Torr's chapter on the upper atmosphere reviews the overall properties and morphology of the high-altitude neutral atmosphere and ionosphere through exposition of the interactions of atoms and molecules with solar radiation and each other. This long and complete chapter includes many pages of well-selected solar and spectroscopic data. It could become a textbook itself with further augmentation, such as an expanded discussion of the escape of light gases to space. Historical reasons for attention to the upper atmosphere (radio communications, satellite orbits, auroras) could be provided as well.

The remaining half of the book contains chapters on Venus (R. G. Prinn), Mars (C. A. Barth), outer planets and their satellites (D. F. Strobel), and comets (W. F. Huebner). One is struck by how much has been learned about the (sometimes exotic) photochemistry of these atmospheres through Earth-based and satellite remote sensing, flyby missions, landers, laboratory experiments, and scientific ingenuity. The value of a planetary perspective for scientific studies of Earth emerges from these chapters.

Fundamentals of photochemistry and spectroscopy that underlie their application to the study of atmospheres are not covered in this book. Calvert and Pitts's classic *Photochemistry* (Wiley, 1966) or Okabe's *Photochemistry of Small Molecules* (Wiley, 1978) are suitable references. One other topic is shortchanged in this book: the sources of chemicals in the atmosphere. One major impression left with me is how far the study of atmospheric photochemistry has come. A measure of how rapidly this field is developing is that none of these authors, whose contributions to the field are well recognized, is a photochemist by training (only one is a Ph.D. chemist). The sheer size of the questions to be addressed continues to attract good scientists from other disciplines.

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Brain Dysfunction and Repair

Hope for a New Neurology. FERNANDO NOTTEBOHM, Ed. New York Academy of Sciences, New York, 1985. x, 238 pp., illus. Paper, $50. Annals of the New York Academy of Sciences, vol. 457. From a conference, New York, April 1984.

The promise of this volume is that "recent clinical and animal work points to new opportunities for the identification and correction of brain disorders." The 13 papers included address highly selected areas of clinical investigation and basic neurobiology. The late Norman Geschwind, who participated in the planning of the conference, describes in the first chapter examples from clinical neurology of central nervous system damage and recovery. This little essay points to several problems awaiting solution, emphasizing how incomplete our current understanding of recovery is.

The chapters on clinical issues include a description of the BEAM (brain electrical activity mapping) technique, a diagnostic method producing computer-generated images that has been developed by Frank Duffy and colleagues. Early results from the study of patients with dyslexia, dementia, and schizophrenia suggest focal electrical alterations that might not be revealed by conventional electroencephalography. The BEAM technique remains controversial and further careful, controlled studies are required to validate its application in clinical neurology and psychiatry.

Donald Price and collaborators provide a short summary of the neuropathologic and neurotransmitter changes involved in Alzheimer's disease. The material contained in this chapter is well known to the neurologic community.

The chapters on basic neurobiology focus heavily on current models of regeneration and plasticity. Björklund and Gage review their work on neural grafting in animals. These remarkable studies, described in considerable detail, document the surprising capacity of fetal tissue implants to sprout, grow, and reinnervate regions of the central nervous system. Prominent in these studies are the corrections of experimental cholinergic and dopaminergic deficiencies in the striatum and hippocampus. Cotman and Nieto-Sampedro describe progress in facilitating the recovery of function after central nervous system trauma. Their studies show attempts to quantitate the neurotrophic influences triggered by injury. They emphasize the importance of glial cells in both initiating and limiting regeneration. Olson and colleagues from the Karolinska Institute describe work on experiments to restore dopamine after lesions of the nigrostriatal system. Autologous transplantation of adrenal medullary tissue to two patients with Parkinson's disease is described. These clinical trials have been criticized as premature, since similar studies in subhuman primates have not been completed.

The olfactory system is unique in its regenerative capacity—the sensory neurons are the only elements of the adult nervous system known to undergo turnover and to be replaced after experimental degeneration. This interesting work is reviewed briefly by Graziadei and Graziadei. The elegant studies of Nottebohm on brain mechanisms of song control in canaries offer a model of investigation of hormonal influences on learned behavior. Male hormones determine brain changes and the subsequent behavioral repertoire of the songbird. Neurogenesis is not limited to the period of development but