distinguished scientists advance a radical, comprehensive, and, for a time, influential critique of capitalist science. To the extent that they aimed to change as well as understand the world, their efforts—unlike those of the Royal Society or the British Association—were ultimately unsuccessful. Their goals, their means, and the outcome of their efforts were essentially different from those of politically moderate or conservative actors. Little is gained, and a good deal of analytic clarity lost, in viewing these various individuals and institutions as participants in a single cause. To group under the same heading all those who shared a concern that science "be used for the benefit of society," irrespective of how that benefit was defined, or who promoted "greater integration of science and government," whatever its ends, is to lose the capacity to make important distinctions. McGucken has produced a well-researched, comprehensive, and useful account of British scientific institutions between the Depression and the end of World War II. But he has not convinced this reviewer, at least, of the need to abandon the conventional definition of the social relations of science movement.

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Researches in the Kaiserreich

Paul Ehrlich. Scientist for Life. ERNST BÄUMLER. Holmes and Meier, New York, 1984. xvi, 288 pp. + plates. $39.50. Translated from the German edition (Frankfurt-am-Main, 1984) by Grant Edwards.

Among the most celebrated factors contributing to the rise of Imperial Germany to the first rank of industrial and military powers in the last decades of the 19th century was the active promotion by the German state, through a variety of financial and institutional arrangements, of a close cooperation between industrialists and university-based research scientists. This policy of fertilizing practice with theoretical knowledge bore immediate fruit in the chemical and electrotechnical industries. But these new science-based industries were also a frequent source of stimulus to major scientific advances and even the creation of entirely new fields of research. The career of Paul Ehrlich (1854–1915) was linked with the development of one of these new fields, immunology. In drawing upon the invaluable archival materials of the Hoechst Pharmaceutical Corporation, Bäumler's timely scientific biography provides tantalizing suggestions concerning the relations between science, industry, and the state in the Kaiserreich.

Bäumler effectively explores the connection between Ehrlich and the chemical industry to illuminate every stage of his career and the development of his science. Once describing himself as a scientist with "blinders" on, Ehrlich single-mindedly pursued several lines of research based on the exploitation of the chemistry of aniline dyes. As a medical student working on his dissertation, Ehrlich concentrated on mastering the new structural chemistry developed by Kekulé and being exploited in the dyestuffs industry. This led to the development of staining techniques for identifying cell structures and classifying the various types of leukocytes. Ehrlich quickly moved on from morphological studies to develop vital staining techniques for investigating the physiological action and distribution of substances in living cells. The basis for this new direction was his detailed knowledge of the structure of dyes. Thus, in developing the notion that the physiological effect of toxins depends upon their fixation to a cellular structure, that toxins and antibodies exhibit specific affinities for one another determined by atomic groupings enabling them to fit together like lock and key, Ehrlich exploited conceptions from dye chemistry, where, for instance, appendages to the benzene ring were known as "side chains." In explaining the creation of antibodies Ehrlich assumed that atom complexes capable of performing subordinate nutrient functions attach themselves to structures in the protoplasm as side chains. The side chains in turn have predetermined affinities for particular toxins, which they attract and bind. Overcompensation and production of side chains result in the shedding of these appendages as antibodies. Ehrlich's "side chain" theory not only was the basis for further development of his ideas in immunology, including the theory that cancer is due to changes in normal cells caused by chronic chemical or physical irritation, it also served as the basis for his groundbreaking work in chemotherapy, which culminated in the development of Salvarsan for the treatment of syphilis. Equally significant, the theory of side chains guided Ehrlich in developing precise quantitative methods for determining the antibody content of sera and standards for dosage measurement, particularly of antidiphtheria toxin, for which he was awarded the Nobel Prize in 1908.

Though Bäumler's study is a valuable contribution, it is regrettable that he devotes only superficial treatment to the scientific institutions headed by Ehrlich—the Institute for Serum Testing in Berlin and the Georg Speyer Haus in Frankfurt. In spite of the rich archival sources at his disposal Bäumler has missed important opportunities to explore, for example, the "for profit" research done at the Speyer Haus and the extent to which Ehrlich's own research interests were shaped by this environment. His fleeting treatment of Friedrich Althoff ("Ehrlich's old friend and patron"), the most powerful member of the Ministry of Culture, who shaped the careers of men like Ehrlich, Koch, and Behring while actively promoting the construction of research institutes jointly funded by private industrial firms and the government, leaves us longing for a more thorough study of the relationship between such pharmaceutical giants as the Hoechst Corporation and the state.

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Magnetic Oscillations

Magnetic Oscillations in Metals. D. SHOENBERG. Cambridge University Press, New York, 1984. xxiv, 570 pp., illus. $97.50. Cambridge Monographs on Physics.

Our present understanding of the electronic properties of solids has largely resulted from the interplay between measurements that give direct information about the electronic band structure of materials and the theoretical calculation of these electronic band states. An important and essential element in this process is the experimental determination of the energy bands at the Fermi energy. Shoenberg's book is a comprehensive review of the many experimental and theoretical considerations involved in the acquisition and interpretation of data that map out these band states. The book also reviews recent advances that permit the detailed determination of fundamental electronic parameters that characterize individual electron states at the Fermi energy.

The first important experiments in this field were performed by de Haas and van Alphen, who, in 1930, discovered that at low enough temperatures a bismuth sample exhibited oscillatory behavior as a function of an applied magnetic field.

Shoenberg's book briefly reviews this early work and nicely details the considerable progress that has been made during the last 50 years.

The book contains an excellent chapter on theory that discusses the connections between the oscillatory behavior of the magnetization, found in virtually every metallic element, and the Landau-level quantization that results when electrons are subjected to an applied magnetic field. In addition to the standard theoretical results familiar to early workers in this field, more recent advances, including the many-body interactions required for a complete description of the electronic states, are covered. The detailed chapters that follow cover every major aspect of the subject. A separate chapter is devoted to a general discussion of specific magnetic oscillatory effects that are found to be ubiquitous in measurements of physical properties at low temperatures and high magnetic field strengths. The chapter considers such effects as magnetoresistance, magnetostriction, and ultrasonic attenuation, which are often neglected in less comprehensive discussions of the subject. The book includes discussions not only of the original work that dates back into the 1930's but also of some of the most recent and significant studies of oscillatory properties in different systems. For example, there are brief discussions of the quantized Hall effect observed in a two-dimensional electron gas, the most recent advances in quantum interference effects induced by magnetic breakdown, and results concerning Fermi surface geometry recently obtained for metallic compounds. Furthermore, the author has indicated topics that are not well understood and are deserving of further work.

The book is well written, and the author succeeds in conveying his own understanding and appreciation of the subject. The book is liberally illustrated with experimental data and contains many explanatory diagrams that are exceptionally well described in lengthy figure captions. There are many tables of useful data that have been collected from many different sources. An excellent collection of appendixes enlarges upon the more mathematical aspects of the physical arguments developed in the text. There is a bibliography with well over 500 references.

The strength of the book lies in its careful, comprehensive survey of the entire field of magnetic oscillations in metals. The book will undoubtedly become a much-valued reference work for investigators in the field. In addition, the care and attention Shoenberg expends in discussing the relevant physical principles will readily permit nonspecialists to assess the significance of most published results derived from studies of magnetic oscillatory behavior.

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Interstellar Grains

Proceedings of the Workshop on Laboratory and Observational Infrared Spectra of Interstellar Dust. (Hilo, Hawaii, July 1983.) R. D. WOLSTENCROFT and J. MAYO GREENBERG, Eds. Royal Observatory, Edinburgh, 1984. viii, 174 pp., illus. Paper. Occasional Report of the Royal Observatory, no. 12.

This provocative workshop volume attempts to integrate laboratory and observational infrared spectroscopy of interstellar dust. It has quickly become a standard reference for my graduate students and me.

The 25 papers in the book concentrate on current observational and theoretical studies of grain formation and destruction, as well as on efforts to divine the nature of interstellar grains through infrared spectroscopy of specific adsorption bands and emission features and through studies of the infrared scattering and polarizing properties of interstellar grains. These observational efforts are supplemented by descriptions of relevant laboratory experiments.

A number of authors comment on the need for reliable infrared spectroscopic observations obtained at a good site with an accurately pointing telescope and a small beam size. Most of the data obtained to date on the unidentified 3.28- and 3.4-μm dust emission feature have been obtained with low spectral resolution (usually a circular variable filter wheel resolution of ~100) at a variety of spatial positions with relatively large beams. Sellgren reports that the 3.28-μm feature is found in several optical reflection nebulas and in concert with dust emission (not scattering) at a color temperature of ~1000 K. Brand and collaborators report having shown that the emission was constant across the NGC 2024 ionization edge (low-excitation HII region) using an 8-inch beam to make the observations. Similar results for other regions had been reported. The results of both Sellgren and Brand *et al.* emphasize that hard ultraviolet photons are not required to excite the feature, as had been previously hypothesized. Isaacman came to a similar conclusion in his studies of the high-excitation source NGC 7027. Gatley points out that measurements of line strength as a function of spatial position are the key to understanding the range of physical conditions responsible for excitation of the 3.28-μm emission. These measurements will play a key role in the identification of the emission mechanism and ultimately of the grain constituents of the emission. High-resolution spectroscopy by Geballe of an HII region and a high-excitation planetary nebula demonstrate the importance of an accurate determination of the underlying continuum in studies of the shape and strength of the spectral feature. It now appears that conditions for production of the feature occur in a wide variety of situations; the original contention that the feature was produced by a volatile substance located at ionization fronts has been proved incorrect. Gatley emphasizes that the feature may even be strongest where the underlying continuum is strongest but where the contrast is small. All of these papers point to the need for observations of high spatial and spectral resolution. With the advent of infrared array cameras, and with carefully chosen objects of study as well as adequate spectral coverage, it may soon be possible to provide a plausible model of feature emission. Several papers and the discussion in this volume have been pivotal in directing research efforts since the workshop.

Several papers discuss infrared reflection nebulas. Pendleton and collaborators present data on the OMC2 cluster. Dinerstein focuses on the polarimetry from 2.2 to 4.9 μm of the BN region in OMC1. She first summarizes recent observations by a number of authors who attribute the polarization of BN and IRc2 (the principal luminosity sources in the region) at least partially to dichroic absorption. However, her polarimetry of two other positions in the nebulosity, IRc3 and IRc4, suggests that they are scattering centers externally illuminated by BN or IRc2. The wavelength dependence of the polarization that she presents is suggestive; clearly a map of the polarization wavelength dependence, coupled with photometric images at several infrared wavelengths, will provide the potential for decoupling the thermal and scattering components of the emission, as well as provide insights into the scattering optical depth and the infrared grain properties. Another important series of observations that should ultimately lead to an understanding of the interstellar grain properties are the spectrophotometric and polarimetric observa-