Book Reviews

Critical Phenomena

Phase Transitions. Cargèse 1980. Proceedings of an institute, Cargèse, Corsica, July 1980. MAURICE LÉVY, JEAN-CLAUDE LE GUILLOU, and JEAN ZINN-JUSTIN, Eds. Plenum, New York, 1982. viii, 462 pp., illus. $59.50. NATO Advanced Study Institute Series B, vol. 72.

The elucidation of the properties of systems undergoing continuous phase transitions can be regarded as one of the most important achievements in physics in the last two decades. This development took place in two roughly equal periods. The first involved the accumulation of quantitative experimental data on a large number of systems, the formulation of the phenomenological theories of scaling and universality, and the development of series expansion techniques that allowed surprisingly accurate a priori estimates of critical exponents. The second was ushered in at the beginning of the last decade by the remarkable work of K. G. Wilson, who formulated the problem of continuous phase transitions in terms of the renormalization group, a mathematical transformation originally discussed in quantum field theory. The renormalization group theory clarified the mathematical mechanism underlying the earlier phenomenologies and provided additional calculational tools for evaluating critical exponents. This development gave rise to a veritable explosion of theoretical and experimental work, which has had significant impact not only on the physics of phase transitions but on such diverse subjects as percolation theory, polymers, elementary particle physics, and the mathematical theory of dynamical systems.

The 1980 Cargèse Summer Institute brought together a significant number of the most active workers on phase transitions with a view to evaluating the current level of our understanding of the subject. Two main themes run through the proceedings. The first is the quantitative reliability of the theory, both in the agreement of the theory with experiment and in the consistency between different theoretical methods. The second, which receives somewhat less attention, is the application of the theory to a wide range of different systems.

The central task set by the organizers was to resolve the long-standing discrepancies that existed between estimates for critical exponents extracted from high-temperature series on the one hand and from a field theoretic analysis using the renormalization group on the other. According to the hypothesis of universality both classes of models should yield the same exponents. In this highly quantitative phase of the theory B. G. Nickel, one of the contributors to the book, stands out. A number of years ago he had succeeded in calculating series coefficients for a field theory in three dimensions up to seventh order in the coupling constant, and this work allowed the accurate determination of critical exponents using the renormalization group, as is described in the book in the lectures of E. Brézin and J. Zinn-Justin. The corresponding calculations in lattice spin models using high-temperature series were carried out over a period of 20 years and are discussed in great detail in this volume, in the lectures of G. A. Baker, Jr., W. J. Camp, M. E. Fisher and J. H. Chen, D. S. Gaunt, S. McKenzie, Nickel, and J. J. Rehr. It is clear from these papers that the central problem is not the determination of the exponents themselves but rather the estimation of the uncertainties attached to their values.

Although most of the authors are somewhat more cautious in their papers in this volume than in their previous work, the general trend of values and uncertainties for lattice models in the book lies outside the range quoted for the field-theoretic models. The one important exception is in the paper by Nickel, who arrived at Cargèse with another one of his virtuoso achievements, the calculation of six additional terms in the series for the body-centered-cubic lattice. These longer series lead to changes in the estimated exponents that bring them into essential agreement with the field-theoretic values. An important additional contribution of Nickel's work concerns error estimates. Nickel reanalyzes the earlier series taking the so-called confluent corrections into account more generally than before and finds systematic deviations from previously accepted values, even without taking his longer series into account. The moral of the story seems to be that estimates of uncertainties should include all reasonable interpretations of the data and not just the spread of values obtained under one particular set of assumptions. There now seems to be almost universal agreement that earlier discrepancies have receded into the noise, the only dissenters being Baker and his co-workers, who still consider the differences significant. The book captures this story in the very middle of its development, and we must await further work, presumably along lines sketched out here, for a completely satisfactory resolution of the problems raised.

The theory is compared in depth in the book with the best available experiments. The importance of confluent corrections to the leading singularities is stressed by the four experimental contributions (by G. Ahlers, D. Beysens, M. R. Moldover, and J. V. Sengers), all of which report overall consistency with the renormalization group predictions for exponents. It is clear from these papers, however, that an experiment can never unambiguously determine a critical exponent, except within rather large uncertainties. What experiments can do is to test certain hypotheses concerning the critical behavior. From this point of view the modern theory is remarkably successful, since it passes most tests and in fact has not unambiguously failed any one. It must be understood, however, that the error bars quoted for experimental exponents are usually also conditioned on very special assumptions and should not be interpreted as excluding values outside the estimates.

The portions of the book dealing with more general applications of the theory review polymers in solution (J. des Cloiseaux), critical behavior of interfaces (D. J. Wallace), bicritical points (Fisher and Chen), critical dynamics of superfluids (Ahlers), and the Monte Carlo renormalization group method (R. H. Swendsen). In each case one is struck with the versatility of the concepts and the ability of the theory to account for subtle and sophisticated effects in a quantitative way and to make contact with experiments in a wide range of physical systems.

The book contains much information for the specialist interested in the estima-

tion of critical exponents and a good summary of the experimental situation in fluids, as well as a number of pedagogical introductions to particular topics. It cannot be regarded as an up-to-date review of the whole field, however, since the choice of papers is conditioned by the usual limitations of a conference report. The reader is primarily struck by the wealth of good physics, both experimental and theoretical, spanning many different fields, that has come out of the work of the last two decades. The field of phase transitions can truly be regarded as a paradigm for a successful assault on a deep and challenging problem in physics.

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Neurobiology

Glial-Neurone Interactions. Papers from a meeting, Titisee, Germany, April 1981. J. E. TREHERNE, Ed. Cambridge University Press, New York, 1982. iv, 246 pp., illus., + plates. $60. *Journal of Experimental Biology*, vol. 95.

This book is the result of the third Company of Biologists Ltd. discussion meeting. The papers in the book cover most of the current ideas about glial-neuron interactions and help to clarify some of the important remaining questions about this difficult subject.

Papers by Lane and by Landis and Reese that describe anatomical studies in which freeze-fracture and electron microscopy were used to investigate cell-cell interactions in the nervous system give a good synopsis of what is known about cell membrane specializations. The papers emphasize the possible relations of such specializations to cell adhesion or coupling, ions and metabolic exchanges, axonal guidance, and trophic support.

Since Kuffler's work in the 1960's, glial cells have been thought to be involved in the ionic control of the fluid environment of the nervous system. Using *Necturus* as a model, Orkand *et al.* present an extensive study of membrane properties of neuroglia and relate ionic changes to control of glial metabolism. Similarly, Treherne and Schofield explain the mechanism of ionic homeostasis in an insect by an interesting model in which active and passive processes involving the neuroglia and an extracellular matrix are required for cation regulation. With a very useful preparation, the retina of the honeybee drone, Coles and Tsacopoulos investigate the possible relations between ionic and metabolic control and suggest interesting correlations between K^+ movements and glycogen metabolism. Extending the physiological approach, Sykova reports that K^+ modulates neuronal transmission by modifying glial cell function and some of its metabolic pathways.

Glial cells are also thought to be involved in more specific interactions with nerve cells and axons. Villegas reports an extensive study of the relation of axons and Schwann cells in the giant nerve fiber of the squid, presents evidence for the synthesis, storage, and release of acetylcholine by Schwann cells, and suggests a feedback mechanism acting on the Schwann cell that regulates its membrane potential and ionic permeabilities following axonal excitation. Lasek and Tytell describe a particular protein (traversin) synthesized by the glial cell and transferred to the axon. They also discuss the role of other macromolecules in such transfers and suggest different mechanisms that may be involved in other, similar transfers. Following the same general idea, Currie and Kelly report specific uptake of different amino acids and demonstrate a high-affinity glutamate uptake property of glial cells. In a very clear paper, Mudge reports that the peptide content of cultured sensory neurons may vary depending on whether nonneurons are present or absent. Such properties are viewed as vitally important in cell-cell interactions within the nervous system.

Roots and Brockes *et al.* discuss the use of glial markers, the limitations of their specificity, and, most important, the changes in them during development and in tissue culture. The paper is an excellent summary of changing glial cell performance in vivo and in vitro, and the reader is well advised to be careful when using glial "markers" as tools to define cell types.

The last three papers in the book deal with more general ideas about the role and importance of glial-neuron interactions during growth, differentiation, myelination, and regeneration in the nervous system. Schacher reviews the role of support cells in growth and differentiation of neurons and suggests that granules are released from the glia at different steps during development and may play a role in the general performances of neurons. In a very concise paper Brockes *et al.* report an extensive study of the immunological properties of Schwann cells and summarize some current ideas about the involvement of Schwann cells in myelination and regeneration. They also summarize the present work on the purification of a glial growth factor. In the last paper, Aguayo *et al.* summarize the evidence concerning the putative role of glial cells in the regeneration of central axons after injury. They suggest that influences arising from the nerve cell environment may play an important role in the success or failure of regeneration.

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Geology of a Passive Margin

Geology of the Northwest African Continental Margin. U. VON RAD, K. HINZ, M. SARNTHEIN, and E. SEIBOLD, Eds. Springer-Verlag, New York, 1982. xii, 704 pp., illus. $49.

Because of their importance to our understanding of the origins of oceans and the building of mountains, modern continental margins are of great interest to a broad spectrum of earth scientists. And in these times of dwindling energy supplies the petroleum potential of continental margins is well recognized.

Although many major scientific questions about the northwest African margin remain unanswered, so much has been learned recently via six legs of the Deep Sea Drilling Project and many modern geophysical studies done by the University of Hamburg and the Bundesanstalt für Geowissenschaften und Rohstoffe that it is timely to synthesize this work. The volume is a tribute to the German institutions that have aggressively researched this area and greatly expanded our knowledge of this margin, especially over the last decade.

The quality of the production is satisfactory, even with the variety of typefaces used in the 28 papers. Only a few typographical errors are apparent, and the English is of high quality. (It should be noted that the 50 contributors represent a broad spectrum of the international community, including the United States, Canada, United Kingdom, Norway, France, and Switzerland.) Maps and cross-sections are used effectively to communicate massive amounts of information and to illustrate interpretations. Historical block diagrams of various parts of the margin are extremely well done in many of the papers. Even the front and back inside covers have well-