cussed in the introduction. The attempts that are made in the book to construct bridges to the general theory of motivation are rather limited. For example, "drive" has been around for a long time. No one seems to know quite why we need the concept, but we keep putting it on display. It tends therefore to assume a variety of uncertain functions. Stellar and Stellar don't add much in the way of clarification. They write, "Motivated behavior is goal-directed behavior and is thought by most theorists to be dependent upon specific arousal or *drive* of the organism" (p. 29).

I'm not sure whether we are to accept or to abandon the Hullian notion of drive as an internal source of motivation. The term "acquired drive" is introduced in the book, but, in the light of attempts to condition eating and drinking behavior, it is not clear to me what an acquired drive is or even whether it exists.

I would like to have seen more attempt at a synthesis and more critical evaluation of the general implications of the results obtained. For example, reward needs to be central to learning theory. Although the book does justice to Cabanac's hedonic model, the opportunity to link it with Rolls's neuronal model or Bindra's incentive theory model has been missed. I was disappointed to see that contemporary studies of ingestive behavior are integrated rather little into the book. They would have provided a context for the authors' ideas.

The authors have stuck to their brief rather closely and have moved only a little way toward addressing the theory of motivation. However, even that is most welcome, and the book is to be recommended.

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Landform Evolution

Geomorphology. RICHARD J. CHORLEY, STANLEY A. SCHUMM, and DAVID E. SUGDEN. Methuen, New York, 1985. xxiv, 605 pp., illus., + plates. $30.

Geomorphology is concerned with the origin, description, and evolution of the landscape, which necessarily entails a concern with the long-term influence of tectonism and climate change. The science has its modern origins in the late 19th century, when investigators developed general models of landform evolution that could apply to landscapes having continental scale. As the authors of this book note, the measurement of geomorphic processes was avoided; the prevailing view was that landforms changed so slowly that no meaningful measurements applicable to landscape evolution could be made. Models of landform development were thus unverifiable. In the past 40 years there has been a dramatic shift toward the study of surficial processes involving the quantitative analysis of short-lived phenomena. In certain instances measurement of processes and landform change can be utilized to construct and verify models of landform development. Renewed interest in landform evolution has also been brought about by the realization that in some environments modern surface processes may only be etching the surface of a landscape inherited from an earlier geomorphic regime.

This book is notable because the authors have integrated modern concepts of landscape evolution with a comprehensive review of process geomorphology. The book has a coherent, well-defined structure. The historic development of landform models is treated by way of a thought-provoking review of the contributions of Davis, Gilbert, Penck, and King. Both the strengths of these earlier models and their weaknesses, particularly the lack of hard data on landform change, are described. The dependence of the models on the views of global tectonics that prevailed when they were developed is evident. In modern research, structure and tectonics form one of the boundary conditions for models of landform evolution. Modern theories of landscape development incorporate not only a progressive denudation chronology, inherited from these earlier theories, but also subordinate, internally driven cycles that operate through feedback and threshold mechanisms. In particular, process geomorphology has been important in identifying the nature and role of these subordinate cycles in landform evolution.

The book's treatment of structural geomorphology will provide students from outside the field of geology with an introduction to earth materials, structure, and the resulting landforms. From a pedagogical point of view this is an important consideration. In practice, however, a section of the book that discusses minerals, rocks, and sediments detracts from the continuity of the book. In future editions the section should be pared down to omit details that are not incorporated in later discussions.

The heart of the book is a review of process geomorphology in which the authors point out the major inconsistencies and gaps in our present knowledge. For example, despite nearly a century of effort, it is difficult if not impossible to make estimates of sediment transport rates and sediment budgets that can be translated into predictions of landform change. The discussion of process geomorphology will introduce the student to the complexity of the natural system.

Climatic geomorphology and the theory of morphogenetic regions are treated with caution. Such caution is warranted, for geomorphologists still do not have an adequate understanding of the manner in which climate affects landform development and process geomorphologists may have overemphasized the importance of modern processes relative to landscape inheritance from past climatic regimes in the control of landform development.

The book ends with an afterthought on the role of geomorphology in evaluating environmental problems.

Overall this is an excellent book. The level of discussion assumes some prior training in the subject. Still, the book will find wide acceptance at the advanced undergraduate and graduate levels and will be a primary reference for researchers in the field.

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Issues in Quantum Physics

The Creation of Quantum Mechanics and the Bohr-Pauli Dialogue. JOHN HENDRY. Reidel, Boston, 1984 (distributor, Kluwer Boston, Hingham, Mass.). xii, 177 pp. $34.50. Studies in the History of Modern Science, vol. 14.

Hendry begins this study of the beginnings of quantum mechanics by examining the views of Bohr and Pauli around 1922 concerning the kinds of concepts that can or should be used in a physical theory. Are all classical concepts legitimate (Bohr's view), or must theories be restricted to dealing with observable properties (Pauli's)? Are the notions of field and continuity crucial to our understanding of certain physical phenomena (Bohr), or must we work only with the notions of particle and discontinuity (Pauli)? Should energy conservation be relinquished in order to retain something like classical space-time descriptions (Bohr), or are such descriptions unimportant (Pauli)? A full chapter is devoted

to uncovering Pauli's answers to these questions in his early writings on general relativity and unified field theory. In the process, Hendry exhibits the close relation between the epistemological and methodological issues that arose in discussions of relativity and unified field theories in the teens and the methodological issues that shaped the development of quantum mechanics. Another chapter shows how Bohr's position developed out of his struggle in the teens to shape a quantum theory of the atom. Hendry then traces Pauli's and Bohr's ideas through the '20's by examining the way they influenced and were influenced by the creation of modern quantum mechanics, describing in moderately technical detail the line of research that led from early attempts to construct a quantum theory of dispersion, through the development of matrix mechanics and transformation theory, to von Neumann's Hilbert space formulation of quantum mechanics and its general probabilistic interpretation.

Notably absent from the set of issues that Hendry finds influential in the creation of quantum mechanics is whether causality should be relinquished. At the several points in his narrative where the issue of causality arises, Hendry pauses to consider Forman's thesis that the antipathy to determinism that prevailed in Weimar culture influenced certain physicists to reject causality in quantum theory. He argues that pronouncements and actions portrayed by Forman as reactions to general cultural pressure are better explained as reactions to developments internal to quantum physics. Using his own analysis of the route to quantum mechanics to reveal the origins of the Copenhagen interpretation, Hendry argues, also, that causality became a theme in that interpretation for similar internal reasons.

Much of the ground Hendry traverses has been covered by others, and readers of Hendry's own articles will recognize familiar themes. This book is much more than a summary or reworking of other scholarship, however. Hendry also utilizes details he has gleaned in his own examination of the historical documents, particularly those contained in the first published volume of Pauli's correspondence. The fruits of this research are seen most clearly in the excellent chapter on the development of transformation theory and of the generalized probabilistic interpretation of quantum mechanics, topics no one has analyzed in detail before. Moreover, Hendry uses these resources to tell a long and complicated story in a new way, revealing especially the extensive behind-the-scenes role of Pauli not only in philosophical but also in technical matters.

This book is not a "complete" history of the creation of quantum mechanics. Little is said, for example, about the origins and technical development of wave mechanics. Nor is there any attempt to portray personalities or personal lives, professional circumstances, or cultural and political climate. Indeed, the strength of the book stems, at least in part, from the attempt to identify and trace an important, coherent, and relatively independent line of development. But Hendry also leaves unanswered questions that do seem to fall within his purview. For example, we are given no clue why Pauli took the positions mentioned above. He first publicly espoused those positions while addressing questions concerning relativity and unified field theories, but, as Hendry himself points out, Weyl and Einstein addressed the same issues in the same context and disagreed with Pauli. Furthermore, there is a gap in Hendry's story. He rightly takes what we now call "the Born interpretation" as the starting point for the development of transformation theory, but he fails to recognize that this was not Born's own original statistical interpretation of the wave function. He therefore does not recognize the need for an account of the step from the one to the other.

Hendry has carved out his subject matter by trying to relate specific philosophical ideas and specific scientific developments. This results in an extremely interesting study, but it also poses problems. One arises from the attempt to tell two stories at the same time. One story is about certain ideas of Bohr and Pauli, their conflict and development; the other is about the creation of matrix mechanics and how it led to quantum mechanics and its Copenhagen interpretation. Hendry shows the two stories are more closely related than one might have thought. Yet the second has a larger cast of major characters (Born, Heisenberg, Jordan, Dirac, and von Neumann in addition to Pauli and Bohr), and the attempt to weave the two together precludes a full account of the role of these other characters. Hendry finds the primary link between the two stories in Pauli's influence on Heisenberg, Dirac, and Jordan. The result is that the influence of Born is underplayed and the way the characters in the second story were influenced by their own past work and independently fashioned methodological views is largely unexplored. Another problem, as Hendry himself notes in his "Concluding remarks," is that the focus on "ideas" gives rise to an ambiguity. When we are shown that Pauli's and Bohr's ideas clashed, are we to infer that Pauli and Bohr themselves were engaged in "an active and conscious dialogue" about them? When we are shown that a particular piece of Heisenberg's work was guided by an idea that was espoused by Pauli, are we to understand that Heisenberg got the idea from Pauli? Neither Hendry's account nor the historical evidence to which he appeals always distinguishes clearly between the conflict or influence of persons and the conflict or influence of ideas held by those persons.

This book is required reading for anyone interested in the history of quantum physics. It is also enjoyable reading. The style is pleasant, clear and yet concise. Readers who already know much about the history of quantum mechanics will learn even more, and the attempt to fashion a fairly broad but unifying perspective will be welcomed by those who have tried to understand the development of modern quantum mechanics in the '20's by reading an array of journal articles. I recommend the book also as the best entry into these topics for anyone with even a moderate understanding of mathematics and physics.

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