nize that formations were not worldwide. Eventually, the conception of the Devonian System, actually proposed by William Lonsdale, was seen as a satisfactory theoretical compromise for the stratigraphical situation of the rocks that were the subject of contention. Rudwick brilliantly reduces the various theoretical shifts to a few readily comprehensible diagrams.

The theoretical conclusion, for the philosophically inclined historian, is that scientific knowledge is a social construct, generated by real people (of differing "credibilities") working at specific times and places, with specific social interests shaping their work. Also, the meanings of theoretical terms are found to be "malleable." They gradually undergo change during the course of debate, as each side seeks to press its views; but there is no question of "incommensurability" of theoretical terms from one stage of the debate to the next. For Rudwick does not see this episode in the history of science as "revolutionary" in the Kuhnian sense, so semantic incommensurability need not be expected. Even so, the "great Devonian controversy" was obviously one in which very significant theoretical change occurred.

Actually, Rudwick's model for the processes of scientific change derives chiefly from French analysts of science such as Bourdieu and Latour. Rudwick sees the arena of scientific debate as an "agonistic field" (that is, a field of contest). So in the Devonian controversy it was not empirical data as such that eventually settled the issue. Observations had to be written down or sketched in the field and then brought to the bar of the scientific community—in this case chiefly the leading members of the Geological Society of London—for appraisal and either acceptance or rejection. Geologists had to argue their cases as forcefully as possible, and this involved a deal of toing and froing behind the scenes, to which the voluminous correspondences examined by Rudwick bear ample testimony. The overall process was analogous to the procedures in a law court, as well as being similar to the events of a military campaign. The final court of appeal would, I take it, be the practical success or otherwise of the theoretical schemes proposed.

However, it should be emphasized that Rudwick's strong interest in the social dimension of science does not lead him to embrace a thoroughgoing epistemological relativism, such as is espoused by some sociologists of knowledge. He sees scientific knowledge as "shaped" or "forged" in the heat of scientific debate, but he emphasizes the accumulation of "constraining" (but not "determining") empirical evidence, which leads to the construction of a theoretical picture that is related to the real world. His view is illuminated by the analogy of an emerging picture made up of a pattern of dots, which are added successively as empirical evidence is collected. Initially, false conjectures may be made about the picture, but eventually, with sufficient data ("dots"), consensus will be achieved as to what the picture is. Likewise, interpretative work in science is increasingly constrained by the evidence, but is at no time determined by it. Rival attempts at construing the picture may be compared to the work in the "agonistic field" of the scientific community, in which competing theoretical interpretations are proposed, attacked, and defended.

In all this, however, I think there may be a problem for Rudwick to address. For if, as authors such as N. R. Hanson would have us believe, all observations are themselves theory-laden, then there is an extra epistemological "layer" at which the social determination of knowledge may operate and which the picture analogy does not capture. Thus Rudwick's qualified realism may require further qualification. But this consideration does not seriously undermine the totality of his achievement as historian of the Devonian controversy.

As to the historical narrative, my only objection pertains to the treatment of De la Beche's side of the debate. By Rudwick's account, De la Beche seems generally to have been on the receiving end of the blasts issuing from the muzzles of Sedgwick and (particularly) Murchison (who emerges for me as a singularly unlikable character). Yet De la Beche apparently managed to float to the surface after every encounter. The reader may be left unsure how he contrived to do so.

One can hardly doubt that Rudwick has written the definitive account of the Devonian controversy. But in a sense that is not his main achievement. The important point, as I see it, is that he has provided a splendid model for research in the history of science. In the process, he offers significant support to those who regard scientific knowledge as a social construct, not objective in the full sense of the word. His construal of history will, therefore, undoubtedly please those who admire the work of writers such as Latour. They, however, may feel that Rudwick has not gone quite far enough in his analysis. By contrast, some readers of *Science* may take the view that he has already gone too far in his acknowledgment of the social dimension in the construction of scientific knowledge. It is difficult to satisfy all opinions, but there will be few who feel dissatisfied with the quality of Rudwick's archival researches and his skill in bringing the past vividly before us.

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Instabilities in Plasmas

Unstable Current Systems and Plasma Instabilities in Astrophysics. MUKUL R. KUNDU and GORDON D. HOLMAN, Eds. Reidel, Boston, 1984 (distributor, Kluwer, Hingham, Mass.). xxii, 566 pp., illus. Paper, $29.50. International Astronomical Union Symposium no. 107. From a symposium, College Park, Md., Aug. 1983.

In the past 10 years, there has been a growing recognition that problems in many diverse areas of physics are linked by a need to understand unstable current systems in magnetized plasmas. Large-scale disruptions occur in laboratory plasmas, solar system plasmas, and astrophysical plasmas. These are not only of scientific interest, they are of great practical importance for the thermonuclear fusion program and for global communications, which are seriously disrupted by geomagnetic storms. The present volume contains the proceedings of a meeting that attempted to summarize the current understanding of instabilities in magnetized plasmas and to stimulate interactions among various plasma physics communities. The volume contains a total of 63 technical papers, which cover an extremely wide range of topics, and any plasma physicist should be able to find at least a few papers relevant to his or her own interests.

A strong unifying theme of the volume is the process of magnetic field reconnection, which is the merging of magnetized plasmas containing magnetic fields in different directions. Two major laboratory experiments on magnetic reconnection are reviewed, as are the classic reconnection models of Parker, Sweet, and Petschek. In addition, examples of resistive magnetohydrodynamic simulations and particle simulations are presented, and numerous plasma kinetic instabilities that may play a role in magnetic reconnection are reviewed. The classic reconnection models still provide the

conceptual framework for laboratory studies, theory, and simulations of magnetic reconnection. However, no consensus has emerged on the microscopic processes responsible for departures from ideal magnetohydrodynamic behavior that are required for reconnection. The roles of kinetic instabilities, inertial effects, finite gyroradius effects, and more remain to be clarified. A subsidiary theme of the volume is the process of particle acceleration, which appears in many contexts, from laboratory devices to solar flares. Plasma waves and turbulence, wave-particle interactions, anomalous resistivity, and double layers are all discussed from several points of view. Again, there is little consensus on the relative importance of various processes.

The volume emphasizes theory, with no comprehensive review of relevant observations. Aside from the two reviews of laboratory reconnection experiments, there are two papers on spacecraft observations of flux transfer events and flux ropes and one on microwave observations of solar flares. There are no reviews of x-ray and optical observations of solar flares, although such observations are mentioned many times. Many of the contributions do not even cite the observational literature, let alone discuss it.

On the other hand, theory is very well summarized in the volume. The papers dealing with solar flare theory and astrophysical jet theory collectively provide a comprehensive view of the state of these subjects in 1983. Space physics is not as well covered; however, the proceedings of another conference, *Magnetic Reconnection in Space and Laboratory Plasmas* (Edward W. Hones, Jr., Ed., American Geophysical Union, 1984), complement the present volume with only minor overlap. The other volume provides a more complete account of reconnection in laboratory and solar system plasmas, from both theoretical and experimental points of view, but the present volume contains far more extensive treatments of microscopic plasma physics and astrophysical plasmas.

I enjoyed a number of the papers. The first chapter, by Sonnerup, contains as lucid an exposition of "classic" magnetic reconnection theory as I have ever seen. A review of coronal heating mechanisms by Heyvaerts and one of solar flare mechanisms by Priest are also excellent. A paper by Huba contains a useful summary of microinstabilities, and a paper by Coroniti contains a fascinating exploration of plasmas in accretion disks around black holes. A summary chapter by Vasyliunas provides an illuminating overview and commentary.

Most of the volume will be difficult reading for graduate students or for workers outside plasma physics. The volume will be most useful as a reference and a summary of current theoretical work in magnetic reconnection and plasma physics of solar flares and astrophysical jets. The discussions following each of the papers will be valuable to practitioners who understand the technical nuances, but an outsider may still find it difficult to separate the wheat from the chaff. The volume is recommended to libraries and to plasma physicists of all persuasions.

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Ecological Disequilibria

The Ecology of Natural Disturbance and Patch Dynamics. S. T. A. PICKETT and P. S. WHITE, Eds. Academic Press, Orlando, Fla., 1985. xvi, 472 pp., illus. $49.

Students of ecology have long divided into two schools of thought. Some have emphasized the equilibrial balance of nature whereas others have underscored a history of seemingly unnatural acts of geology, weather, and humans. The equilibrial view has received more attention from theorists because equilibrial models are more tractable, but it has become increasingly apparent that disturbance, on many scales of time and space, is a regular and natural component of real communities. The avowed purpose of this book is to compile and synthesize the scattered information on disturbance and patch dynamics in natural communities and ecosystems. The synthesis is weak, but the compilation is excellent. The 21 chapters by 29 contributors define most of the conceptual issues and give a representative sample of the best empirical studies. The book also serves as an annotated bibliography of over 1700 references.

The book begins with an introduction and ends with a synthesis by the editors. The burden of these two chapters is a system of conceptual definitions and a shopping list of measurements to be made in the real world. Pickett and White's definitions of disturbance and patch dynamics are necessarily vague because they must span three orders of magnitude in time and ten in space. Nearly the full range may be found at once in a single community. An annual disturbance in a square centimeter may be important for mosses on a forest floor, while the canopy trees may record the history of a hundred-year storm that devastated a thousand hectares.

If definitions are difficult to devise, the measurement of patch dynamics is a horrendous undertaking. Nevertheless, the first and last major sections of the book, on patch dynamics in nature and on their implications for the functioning of communities, record painstaking and elegant measurements. James Runkle makes the simple but powerful observation that for a wide range of temperate-zone forests the average rate of disturbance of canopy dominants is about the same, namely once in 300 to 500 years. It is the severity of disturbance and its dispersion in time and space that generate the extreme variations in life history that are apparent from one forest to another. Vertebrates are not exempt from variation in regimes of disturbance, despite the fact that they are often cited as archetypal denizens of equilibrium communities. John Wiens reviews the responses of vertebrate populations in arid lands to variation in climate, and James Karr and Kathryn Freemark review similar phenomena as found even in wetlands and tropical forests. Variation at a given scale of space and time may be interpreted at another scale as a mosaic or sequence of equilibria. Examples are given for marine communities on rocky shores and reefs by Joseph Connell and Michael Keough and for the flows of energy and nutrients in coniferous forests by Douglas Sprugel. The important observation that variation at one scale is equilibrium at another should be generalized to apply to many other communities, but nowhere in the book is this done.

The middle section of the book is the most successful at the conceptual level. Taking as its subject Adaptations of Plants and Animals in a Patch Dynamic Setting, it is concerned with the biological functions of all the properties that have been defined and measured. In particular, Charles Canham and Peter Marks explore patterns of branching architecture and seed dispersion that adapt woody plants to various configurations and spatial distributions of gaps in a forest. Timothy Schowalter draws an elegant and convincing picture of how fire, beetles, and gradients of moisture interact to produce a changing mosaic of pines and hardwoods in Texas and discusses how the regularity of this pattern is affected by variation in the climate. Population genetics in patchy environ-