

contribute significantly to the application of VII.

In addition to VII, with the aid of car-to-car communications through dedicated short-range communication technology, vehicles can collect traffic data from surrounding vehicles and predict the optimal behavior—especially acceleration and deceleration rates and routing—based on the new traffic theory, and the vehicles can act accordingly. The new car-to-car communication technology, combined with the new traffic theory, will improve safety and traffic operations significantly without the help of any external infrastructure.

Henry Lieu

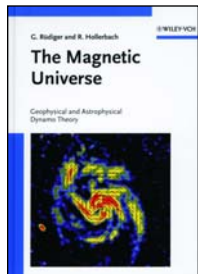
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The Magnetic Universe: Geophysical and Astrophysical Dynamo Theory

G. Rüdiger and
R. Hollerbach

*Wiley-VCH, Weinheim, Germany,
2004. \$175.00 (332 pp.).
ISBN 3-527-40409-0*

The Magnetic Universe: Geophysical



and Astrophysical Dynamo Theory by Günther Rüdiger and Rainer Hollerbach covers an impressive list of topics concerning astrophysical magnetic fields. Further, for each subject, the authors

present an extensive and complete survey of the current work, and the topics are primarily related to astrophysical dynamos in different objects: Earth, Sun, stars, and galaxies. In addition, the role of the magneto-rotational instability (MRI) in stellar formation and other applications is covered. The book provides an interesting and useful guide for experts who want to familiarize themselves with fields related to the subject.

Because of its rather lofty style, *The Magnetic Universe* really is a book for experts and not easy to read. The first chapter, though, is reader friendly and enjoyable, and anyone can easily learn interesting things concerning Earth's own magnetic field. As the book progresses, the derivations become harder to follow, and the descriptions of the observations become terser. Moreover, the reader is

not helped by the voluminous notation in the text. Definitions, often given only in earlier chapters, are sometimes difficult and time-consuming to locate. The journey would have been easier for the casual reader had the definitions been repeated in each chapter. A further criticism is that the derivations tend to be very formal, with little discussion to help readers' physical intuition or their appreciation of the assumptions on which the derivations are based. Actually, one could get a rough idea of what the physics is without following the detailed treatments. In addition, the research most completely described in the book tends to be that done by European rather than by US scientists, so US readers may sometimes find the authors' point of view to be unfamiliar.

It is generally thought that a principal difficulty with astrophysical dynamos is that they need to break flux freezing, which is very strong in large-scale systems. This is a problem one might expect the authors to address early on. Instead, the tendency in Rüdiger and Hollerbach's book is to bury the issue of flux freezing under too much formalism, mostly under the concept of turbulent resistivity. Turbulent resistivity can certainly rapidly mix fields of different signs, but it cannot destroy magnetic energy. It also does not enable one to remove field lines from a system's plasma—where they are strongly embedded by high conductivity—without removing the plasma itself at the same time. In the case of galactic dynamos, one cannot easily conceive of removing the entire interstellar medium just to double the magnetic field strength. Yet this is exactly what vacuum boundary conditions do. Thus it is disconcerting to see in the book so many detailed analytic treatments of galactic dynamos, none of which takes seriously the simple idea of flux freezing.

An additional surprise is the authors' total neglect of the role that solar surface activity—for example, flares and coronal mass ejections—must play in the solar cycle. Harold Babcock's theory of the solar dynamo is not mentioned, and his papers are not referenced; yet his is one of the models with which most astrophysicists are familiar.

In all fairness, for the authors to carry out such a comprehensive and valuable review, it must be necessary for them to disregard the needs of less-trained readers. It would hardly be possible to dwell extensively enough on each of the many topics to reach ordinary readers not versed in necessary techniques. The authors

are to be complimented on how far they have gone in chapter 3 to uncover the complicated details of the Sun's internal rotation velocities that occur in the presence of the turbulent convection. Their discussion of the tachocline appears to be new. Also, their treatment of the MRI in chapter 5 is excellent, particularly the discussion of its connection with protostellar disks and jets.

In spite of my criticisms, *The Magnetic Universe* is a valuable book to have and study. It contains many useful and interesting ideas and calculations, and it does provide an encyclopedic guide to some of the most interesting problems in astrophysics. The book is not one to be read in just one sitting. Rather, it should be savored over many sittings.

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