BOOK REVIEWS

Testing Newton

Gravitational Experiments in the Laboratory. Y. T. CHEN and ALAN COOK. Cambridge University Press, New York, 1993. xiv, 268 pp., illus. $59.95 or £40.

In Query 17 of *Notes on the State of Virginia*, Thomas Jefferson, in his own remarkable style, wrote, "The Newtonian principle of gravitation is now more firmly established, on the basis of reason, than it would be were the government to step in, and make it an article of necessary faith. Reason and experiment have been indulged, and error has fled before them." In the 200-odd years that have passed since Jefferson made this curious statement Newtonian gravitation has become, by way of experimental confirmation, even more firmly entrenched in scientific thought. It is certainly true that we now view it as a special case of general relativity, namely, the "weak field" limit. However, to a very high degree of approximation the simple inverse-square law of universal attraction constitutes an essentially complete description of the way ponderable bodies interact gravitationally.

Although the inverse-square law is elegant and compelling, it is also treacherous and exasperating to study in the laboratory. In the end there are two reasons for this. First, it describes a force that is so weak that it produces almost negligible acceleration of one test mass toward another. As a result, mechanical, electrical, and thermal disturbances can form a background of competing effects that can easily swamp the gravitational signal of the masses under study.

A second, and often more insidious, problem is that due to competing *gravitational* effects: the force of gravity between any two masses can never be measured in isolation from all other gravitational forces, because gravity cannot be screened or shielded. The gravitational force between two people on either side of a wall is the same whether or not the wall is there and no matter what the wall is made of or how thick it is. In the experimental situation, this means that everything that surrounds the test masses also acts on them, giving rise to troublesome gravity gradients at the location of the test masses.

These problems are severe, and improvement in the accuracy of measurements of Newtonian gravitation has come very slowly. In Jefferson's time the value of the Newtonian gravitational constant, G (interpreted then in terms of "the mean density of the Earth"), was known to an uncertainty of roughly 1 percent. Today we might know G to about 0.01 percent, but this is a rate of improvement of only one order of magnitude per century, still leaving G the least well known of all the fundamental constants of nature.

Y. T. Chen and Alan Cook have written one of the few books published so far that set out specifically to tell the story of how physicists have attempted to deal with these problems and study the force of gravity in the laboratory. In so doing, they have produced a volume that will be valuable not only to the community of gravitational physicists but also to the larger body of scientific workers who have an interest in precision measurements. From the beginning, the authors maintain a focus on the fundamental design issues as well as the practical considerations of building and using high-sensitivity devices like the torsion pendulum. They offer several helpful hints for experimenters and discuss techniques that are hard to find described in the scattered literature on gravitational physics, much of which is unpublished or otherwise difficult to gain access to. One such technique discussed is a process for stabilizing the drift of torsion fibers, a problem of interest to all who employ torsion pendulum instrumentation.

Particularly interesting chapters are those presenting the history of the measurement of G and the testing of the exactness of the inverse-square law. In both cases significant emphasis is placed on some of the more recent experiments. The book contains an abundance of figures and tables, yet the text retains a quantitative flavor, as the authors have been diligent about providing analytical arguments to explain underlying physical principles.

The scope of the book is such as to exclude discussion of some of the more exotic types of gravitational experiments, including the torsion-balance–based searches for a spin dependence in the gravitational force as well as most of the "fifth-force" experiments. Thus this book may not be exactly what is needed for those whose interests lie closer to the intersection between particle physics and classical gravitational physics, an area that has come into its own over the past decade. Even so, the nearly 200 references cited represent a very broad cross-section of modern experiments. *Gravitational Experiments in the Laboratory* will serve as a natural successor to the monographs of Poynting and Mackenzie published around 1900, that is, as a scholarly assessment of the field of gravitational experimentation at the close of a century.

George T. Gillies
School of Engineering and Applied Science,
University of Virginia,
Charlottesville, VA 22901

Nucleic Acid Degradation

Control of Messenger RNA Stability. JOEL G. BELASCO and GEORGE BRAWERMAN, Eds. Academic Press, San Diego, CA, 1993. xviii, 517 pp., illus. $79.95. or £61.

Despite the fact that messenger RNA was discovered over three decades ago, our understanding of the mechanisms underlying its stability and turnover is still quite limited. Nevertheless, the importance of mRNA stability to gene control is now well established, having been first surmised by Jacob and Monod, who in 1961 pointed out that the rapid changes that could be induced in gene expression were possible only if the "structural message" was short-lived.

With the advent of methodologies for detailed quantitation and analysis of individual mRNA species it has become clear that control of mRNA stability is a complex problem. The half-lives of specific mRNAs range from seconds to an hour in bacteria and from minutes to days in eukaryotes. Not only does each mRNA have its own rate of degradation, this rate can be drastically altered by changes in environment, differentiation, metabolic state, cell cycle, or even feedback from its own protein product. The mechanisms that control these changes are based on the structural determinants of the mRNA, often in combination with a wide spectrum of protein factors.

Remarkably, the control of mRNA turnover, which is every bit as critical to gene expression as the transcription rate, has been studied by a relatively small group of investigators. To some extent this reflects the difficulties involved in mapping and modeling the higher-order structure of these relatively long single-stranded nucleic acids. Additional obstacles include those involved in characterizing the complex interactions of mRNA with a spectrum of constitutive and specific nuclear and cytosolic proteins; identifying nucleases responsible for mRNA degradative events; and determining what constitutes a rate-limiting destabilizing cleavage in the degradation pathway, as opposed to a secondary or "cleanup" nuclease function. These problems have been exacerbated by the difficulty of devising genetic approaches to the identification of relevant cis and trans control elements.

Given the importance of the problem of mRNA stability, a book designed to review and integrate the various aspects of the topic is welcome; *Control of Messenger RNA Stability*, the first book dedicated to the role of mRNA stability in gene expression, is a significant contribution to the field. The first section deals with mRNA stability in prokaryotes, establishing a useful framework for the more extensive subsequent section dealing with eukaryotic systems. The book concludes with a brief summary of experimental approaches to the study of mRNA decay. The general problems addressed include the relative roles of endo- and exoribonucleases, the importance of secondary structure in defining RNA substrate specificity, the role of 5′ and 3′ terminal structures in the general scheme of mRNA turnover and nuclease resistance, and the identification of rate-limiting cleavage reactions and the nucleases involved. The prokaryotic and eukaryotic sections of the book both begin with a general overview of major themes and model systems in which mRNA stability plays a dominant role in the control of gene expression. Other contributions cover the development of in vitro systems for the study of mRNA turnover, the intimate relationship between mRNA turnover and translation, and the role of the poly(A) tail in eukaryotic mRNAs. Three comprehensive chapters on the biochemical characterization and function of ribonucleases underscore the general difficulty of assigning particular nucleases to specific steps in mRNA turnover. A separate chapter on yeast emphasizes the importance of tapping into the power of genetic selection to ferret out cis and trans determinants of mRNA stability. RNA binding proteins, about which our knowledge is expanding rapidly, will probably attract even more attention in the future.

Clearly written and with substantial background material, this book should make the subject of mRNA stability in gene expression accessible to an expanding audience. The chapters are cross-referenced, with references extending into 1993, and amply illustrated; a detailed subject index is included. Research on mRNA stability is accelerating rapidly, and this book paves the way for updates reporting on the revelations yet to come.

Stephen A. Liebhaber
Howard Hughes Medical Institute,
Department of Genetics,
University of Pennsylvania,
Philadelphia, PA 19104-6145

■

Origins of Laterality

The Evolution of Lateral Asymmetries, Language, Tool Use, and Intellect. JOHN L. BRADSHAW and LESLEY J. ROGERS. Academic Press, San Diego, CA, 1993. xiv, 463 pp., illus. $72 or £58.

Functional differences between the left side of the brain (thought to be primarily responsible for speech, rationality, and analytic and linear thought) and the right side (associated with emotion, spatial perception, and holistic and parallel thought) were first described by French physicians in the 1800s and became entrenched in popular culture after accounts of the "split-brain" studies of Sperry and Gazzaniga fascinated scientists and the general public alike. The importance of cerebral asymmetry in the evolution of the cognitive abilities that we associate with our own species has been central to the work of such thinkers as MacNeilage, Corballis, and Jaynes; although their theories vary in many respects, all essentially argue that the existence of marked cerebral asymmetries in function is associated with, and may be necessary for, higher (human) cognitive abilities such as culture, art, language, and consciousness. In *The Evolution of Lateral Asymmetries, Language, Tool Use, and Intellect* John Bradshaw and Lesley Rogers examine the comparative, developmental, and evolutionary aspects of cerebral asymmetry and cognition, in the process developing two main arguments: that cerebral asymmetries are present in many species and that many cognitive abilities that have been postulated to be associated with brain asymmetries are not uniquely human.

Bradshaw and Rogers devote five chapters to a discussion of cerebral asymmetries in birds and mammals. Here they have attempted to provide a more comprehensive review than can easily be accomplished in the space available, with the result that clarity and readability are sometimes sacrificed. Perhaps because so much material is covered, a few errors in basic biology pop up (for example, uracil is said to be incorporated into protein), and there are some lapses in the interpretation of experimental results. The species and strains used in the various studies are not always indicated, even though it is well known that for some functions (for example, birdsong) the strength and direction of asymmetry vary from species to species. Such omissions make it difficult for the authors (and the reader) to construct a general framework in which to interpret results. Also, the gross size of specific brain areas is assumed here to be directly related to their function, but this connection should not be made without caveats. For example, the posterior portion of the corpus callosum of female mice, although smaller than that of males, contains more fibers connecting the two hemispheres, resulting in more, rather than less, interhemispheric communication. Despite these flaws, the encyclopedic nature of the coverage and the extensive list of references make this portion of this book a valuable contribution to the literature on brain asymmetries in animals. The review of Rogers's work on lateralization of visual behavior in chicks paves the way for the presentation of a plausible model for the development of cerebral asymmetries. In the egg, chicks' necks are

"Left hand self-touching behavior by a young orangutan at the Orangutan Rehabilitation Center, Sepilok, East Malaysia." There is a significant left-hand predominance in face touching by orangutans and other apes as well as humans. [From *The Evolution of Lateral Asymmetries, Language, Tool Use, and Intellect*; photograph by L. J. Rogers and G. Kaplan]