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.

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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