survey nature of the book would allow selection of specific topics and demonstrates the broad range of phenomena understood through a combined classical and quantum approach. The great disadvantage at least for most U.S. physics departments, is that such specialized subjects are normally taught only at the graduate level, for which this text is inappropriate. Departments of applied physics or electrical engineering where such courses are offered at the undergraduate level may find this book of particular value. Two other disadvantages to the use of this book as a text are the complete lack of problems or a bibliography.

In sum, Massey has given us a masterful survey of atomic and molecular collision phenomena which allows one to appreciate the great scope of the field. By treating such a specialized discipline at an elementary level the book will necessarily be of more interest to individuals and libraries rather than as a text except in special situations. On the other hand, perhaps we have been challenged to rethink what is the proper introduction to modern physics. Is it through a survey of all of 20th century physics or through an in-depth analysis of a particularly fruitful field of modern physics that modern physics is best introduced?

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Essay on the Theory of Electricity and Magnetism. F. U. T. Aepinus. Translated by P. J. Connor with introductory monograph and notes by R. W. Home. 478 pp. Princeton University, Princeton, NJ, 1979. Price: $37.50. (Reviewed by Bruce R. Wheaton.)

Although some electric and magnetic phenomena were known to the ancients, the mathematical study of both properties only began in the eighteenth century. Aepinus' *Essay*, published in 1759 in St. Petersburg, stands out as the most thoroughgoing attempt before Cavendish to reduce the vaguaries of static electric and magnetic interactions to a mathematically coherent theory. Students of physics and its history are fortunate now to have this convenient English translation from the original Latin text. Aside from a Russian translation in 1951, it is the only translation of this important work that considerably refined Franklin's largely qualitative treatment of electricity.

Educated in Rostock, Aepinus came into close contact with Leonhard Euler during two years as astronomer to the Berlin Academy of Sciences. In 1757 he left Berlin as professor of physics at the relatively new St. Petersburg Academy of Sciences, and within a few years became involved in the imperial government as a favorite of Empress Catherine. Influenced by Euler's adoption of Newtonian forces in astronomy, Aepinus rejected entirely the prevalent idea that electrical and magnetic influences act by impulse or pressure exerted mechanically in the region outside the charged body. Investigations begun in Berlin on the thermoelectric properties of tourmaline convinced him of two things: that a strict parallel exists between electric and magnetic phenomena, and that each kind of interaction occurs according to action at a distance forces. The *Essay* is his fullest expression of these views.

It was Aepinus' attempt to clarify Franklin's one-fluid explanation of the Leyden jar that led to his rejection of electric effluvia. In experiments done with Wilcke in Berlin, Aepinus recognized that there is a bit of the Leyden jar in virtually all electrical oppositions. An accumulation of electric fluid in one body dynamically and continuously alters the distribution of fluid in the body it approaches. This led to the invention of the air-gap condenser and to Aepinus' revelation that, unlike the Franklinist teaching where the absolute impenetrability of the glass to the electric fire made it the seat of the excess fluid so dramatically dischargeable in the Leyden jar, there is nothing at all special about the glass that separates the conducting surfaces. Any nonconductor would work to a greater or lesser extent because it is the interaction of the two conductors across the gap that makes the condenser potent. And Aepinus demonstrated the fruitfulness of this viewpoint by a multitude of pertinent experiments, simply throwing aside, exactly as Newton had done when puzzled over the mechanism of action at a distance gravitational forces, the need to explain the origin of electric or magnetic forces at all.

One of the most remarkable consequences of Aepinus' reformulation of Franklinist doctrine was his claim that particles of ordinary matter must repel one another, just as the particles of electric fluid must mutually repel. This was necessary by symmetry to explain why uncharged bodies exert no influence on one another. Several seemingly far-fetched results such as this, justified by many careful but delicate experiments not easily performed by nonbelievers, together with the explicitly algebraic character of the arguments in the *Essay* combined to reduce its impact. It was not until very late in the century that the *Essay* began to exert the influence on electrical thought that it warranted.

Professor Home has prefaced the translation with a useful monograph, as long as the *Essay* itself, on Aepinus and the scientific context of the *Essay*. It is a pleasure to have the introduction, it being the most detailed discussion of Aepinus' life in the historical literature. But even augmented by Home's helpful notes it cannot serve as sufficient description of the *Essay* for readers lacking the perseverance to delve in the original. Aepinus' *Essay* was not the first, but was the most generally useful algebraic treatment of electricity. Yet Home gives very little help in unraveling its mathematical obscurities, in particular those lying in wait for a reader expecting modern notation and method. Home's discussion is largely qualitative, rarely descending to the specific mathematical arguments that the determined reader will encounter in the *Essay*. This is not to demean Home's monograph. It is authoritative and well documented; but it will not supplant study of the *Essay* proper.

My only reservation about the translation concerns the placement of and reference to the reproductions of the original figures. They are grouped together on single plates scattered through the book. In Aepinus' time engraving technique permitted no other recourse, and there are valid objections to introducing anachronism. But it is difficult at best to follow Aepinus' arguments and doubly so when the figure essential to his discussion is to be found 67 pages

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farther along in the text with no guidance given the reader. This infelicity is more than compensated by Home's welcome polyglot bibliography of Aepinus' widely scattered publications and of other studies on his work and influence.

Home, Conner, and the Princeton Press are to be thanked heartily for making this classic in electrical sciences more widely available to the research scholar and the historically inclined modern electrician. All considered, 1979 has been a very good year for the early history of electricity.[1]

[1] J. L. Heilbron, *Electricity in the Seventeenth and Eighteenth Centuries: A Study of Early Modern Physics.* (Univ. Calif., Berkeley, CA, 1979).

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Cosmology and Geophysics. Paul S. Wesson. 240 pp. Oxford University, New York, 1978. Price: $24.95 (Reviewed by G. M. Keiser.)

The most widely accepted cosmological model is the hot big bang model in which the universe has been expanding since its beginning roughly 10^{10} years ago. In this model, the expansion of the universe is determined by general relativity with a zero cosmological constant, and the gravitational constant and the total mass of the universe are taken to be independent of time. This model is consistent with all observations and experimental results. Several people have suggested, however, that the gravitational constant may change with the age of the universe and that matter may be continuously created. Since it is extremely difficult to measure the rate of change the gravitational constant or the rate of matter creation in a laboratory experiment, it is useful to consider astrophysical or geophysical phenomena which might provide a clear test of these cosmological theories.

Cosmology and Geophysics examines the implications that various cosmological theories, principally those in which the gravitational constant changes with time, have for the rate of change of the earth's rotation, the evolution of the earth–moon system, and the size of the earth. The author critically describes the various theories which have been proposed and discusses the motivations for and the implications of these theories. In the process, he discusses a number of interesting but unresolved questions: Is matter continuously being created? If it is, does the rate of creation depend on the amount of matter present? What is the origin of inertia? What is the significance of Dirac's large dimensionless numbers? Are the physical constants independent of time?

The author then goes on to consider the experimental evidence. Unfortunately, these experimental results and their interpretation are not clear cut. Wesson discusses the geophysical evidence in favor of an expanding earth but points out that none of this evidence is conclusive although there are indications that the rate of expansion is on the order of 5 mm/yr. Even if the earth is expanding there remain questions about whether this expansion may be attributed to either continuous creation of matter or to a changing gravitational constant.

The rate of the earth's rotation and the evolution of the earth–moon system are closely related. In a search for cosmological effects, it is necessary to carefully evaluate the experimental evidence, to estimate geophysical effects which might contribute to the measured effect, and also to determine whether the residual effects may be accounted for by cosmological theories. Wesson points out that, in the case of the rate of change of the earth's rotation about its axis, possible evidence for the rate of change of the gravitational constant or the expansion of the earth is masked by geophysical effects which also change the length of the day. However, in the case of the secular acceleration of the moon's orbital longitude it is possible to estimate the contribution of the earth's tides. Several years ago, measurements of lunar occultation of the stars indicated that there was a residual acceleration of the lunar orbital longitude which could be explained by assuming that the constant was changing at a fractional rate of $(-8 \pm 5) \times 10^{-11}$ per year or that the earth was expanding.

Within the next ten years, it is very probable that other measurements will be made which will decisively answer some of the questions raised by this book. In fact, since this book went to press, measurements of the secular acceleration of the lunar orbital longitude using eight years of data from the lunar laser ranging project have been published. These results differ significantly from recent lunar occultation measurements and imply that the gravitational constant is changing at a fractional rate of less than 3×10^{-11} per year. With advances in range measurements to planets and satellites it is likely that the rate of change of the gravitational constant will be measured more accurately. The results should be interesting since most viable theories predict a fractional rate of change of 10^{-11} per year.

This book is not intended for the casual reader. It was written to be a summary of the field, and, as such, it should be useful to those people working in the field or to other people who are interested in some of the questions raised by this book. The reader should be cautioned, however, that the present experimental evidence in favor of these alternate cosmological theories is quite tenuous.

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