Book Reviews

Newton's Letters Continued

The Correspondence of Isaac Newton. Vol. 5, 1709–1713. A. RUPERT HALL and LAURA TILLING, Eds. Published for the Royal Society by Cambridge University Press, New York, 1975. liv, 440 pp. $55.

The appearance of volume 5 of Newton's *Correspondence* will be occasion of rejoicing by all students of 17th-century science and of Newton. The edition, begun so auspiciously in 1959, has been almost at a standstill for 14 years since the death of the original editor, H. W. Turnbull. The ill health and eventual death of his successor, J. F. Scott, limited his contribution to a single volume. Now at last the edition gives every indication of renewed life under the confident editorship of A. Rupert Hall and Laura Tilling; and with confidence equal to theirs, we can look forward to its early completion.

Indeed, as far as the history of science is concerned, the remaining volumes of the edition will have progressively less interest; volume 5 carries us close to the end of Newton's active career. The third edition of the *Principia* and the second and third editions of the *Opticks* did not generate correspondence that even approaches the importance of his extensive exchange with Roger Cotes, the editor of the second edition of the *Principia*. That correspondence furnishes the core of the present volume, which begins effectively (after two minor items) with Cotes's first letter to Newton in August 1709, and ends (except for a memorandum) with Bentley's letter announcing the publication of the second edition. Most of it has long been known through the work of Joseph Edleston in the middle of the 19th century. The present volume adds 11 items to their correspondence, however, some of them significant. Thanks to the acuity of D. T. Whiteside, editor of Newton's *Mathematical Papers*, the correspondence about the second edition is further enhanced by the publication of an important paper, *De vi electrica*. (Unfortunately, the editors mistakenly equate the electric fluid discussed in the paper with the aether that Newton resurrected in the second English edition of the *Opticks*.) Despite the interest that attaches to the second edition of the *Principia*, however, Newton's life had ceased to focus upon scientific activity. Mint business, in all its monotonous proliferation of memoranda, occupies more of the volume than the correspondence with Cotes. Symbolically, the volume opens with a letter about details of the recoinage in Scotland and closes with a memorandum on pennies and farthings.

Meanwhile, the *Principia* and the Mint do not exhaust the content of volume 5. The volume also witnesses the climaxes of two of the notable conflicts of the man who claimed to hate controversy. Both had been kindled earlier; both were now fanned back into vigorous flames, apparently by Newton himself. There can be little doubt that Newton instigated the Royal Warrant that appointed him Visitor of the Royal Observatory, put Flamsteed under his power, and established the grounds on which he could publish coercively the *Historia coelestis*. Like the correspondence with Cotes, the humiliation of Flamsteed is a story already well known. It is an essential element in any complete picture of Newton, and one that becomes even more depressing with repetition.

Much the same must be said of the controversy with Leibniz, which does not occupy much space in volume 5 though it hovers ominously in the background. It is fashionable to blame its resurgence on Keill, as the present editors do. In light of the known authorship of the *Commercium epistolicum*, it must surely remain a moot question, however, whether Keill acted on his own initiative when he charged Leibniz with plagiary in the *Philosophical Transactions* or whether he acted at Newton's behest. Be that as it may, the *Commercium epistolicum*, Newton's own composition which he foisted onto an "impartial" committee, appeared in 1712, and from that time on the battle with Leibniz would never be far from Newton's consciousness.

In all, the years 1709–13 covered by volume 5 were an important period in Newton's life. It is a joy to have them covered by the definitive edition of his correspondence. To be sure, the volume is not free from flaws. The editing of the correspondence with Cotes, so rich in scientific detail, does not attain the level of technical proficiency we expect to receive in an edition under the imprint of the Royal Society. Nevertheless, the volume is thrice welcome. If, as we have every reason to hope, its appearance presages the early completion of the entire edition, we shall be fortunate indeed.

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Historical Inventory

Historical Studies in the Physical Sciences. RUSSELL MCCORMMACH, Ed. Vol. 5, *Physics circa 1900: Personnel, Funding, and Productivity of the Academic Establishments.* PAUL FORMAN, JOHN L. HEILBRON, and SPENCER WEART. Princeton University Press, Princeton, N.J., 1975. x, 188 pp. $12.50.

In this slim, ambitious volume, Forman, Heilbron, and Weart present an inventory, quantified to the degree possible, of the academic physics enterprise around 1900 in Austria-Hungary, Belgium, the British Empire, France, Germany, Italy, Japan, the Netherlands, Russia, Scandinavia, Switzerland, and the United States. It is the first such multinational study, and its publication is an event of major significance in the study of the social history of physics.

For each country, the authors, who are all historians of science, have assessed the number and personal incomes of academic physicists, expenditures for laboratory equipment and plant, and productivity in research, meaning paper publication rates. The necessary data were nowhere conveniently gathered, and the authors explored a wide variety of dusty sources, including the reports of universities and professional societies, government and budgetary documents, and autobiographies and memoirs, along with scholarly treatments of physics and higher education. To facilitate comparisons across national boundaries, they have presented all income and expenditures in German marks and have summarized the data in a series of well-constructed tables.

The authors acknowledge that neither their subjects nor their sources made for precise analysis. But they have processed the data with admirable good sense and brought to bear upon it their considerable knowledge of the history of modern physics. The text, which explicates the statistics clearly, absorbingly, and sometimes wryly,

flashes repeatedly with telling observations upon the life of physics at the turn of the century. European professors, who earned enough to be members of the haute bourgeoisie, were shocked to discover that the wives of American colleagues often had to do their own housecleaning. On the other hand, in the United States everyone became an assistant professor, or so Sommerfeld once told a student, while in Germany, according to a sample analyzed by Forman, Heilbron, and Weart, a privatdozent had only about a 3 in 5 chance of obtaining a chair even after years of sacrifice. On the scientific side, perhaps the most expensive item in the well-stocked laboratory of the day was its 60 to 70 milligrams of radium, which at 250 to 300 marks a milligram was expensive indeed. Bespeaking the changing subject matter of physics, the new laboratory of 1900 was built without the traditional tower, previously deemed indispensable for experiments in free fall or pendulums. All the same, physicists of the day did pay enormous—later generations would say ridiculous—attention to insulating their new houses of research from vibration, including the vibration of nearby traction lines.

The rich statistical data here assembled constitute a benchmark for the history of physics in each of the nations surveyed, but the multinational scope makes this study especially arresting. In Germany, the United Kingdom, France, and the United States, the numbers of academic physicists per million of population or per milliard of national income were the same. And some American laboratories, notably the Jefferson Physical Laboratory at Harvard, enjoyed annual budgets comparable to that of the Cavendish. Yet America produced proportionately fewer papers than the leading European nations. Forman, Heilbron, and Weart candidly declare that they can say nothing on the basis of their study about "the relative contribution of each paper to the progress of physics, or about the existence and significance of national gifts and styles." Without the assessments made in this volume, however, the task of explaining the relatively low rank of the United States in world physics at the turn of the century would be all the more difficult. *Physics circa 1900* is not only a stimulating portrait of the discipline. It establishes a solid evidential foundation from which historians and sociologists may proceed to understand the perpetuation and diffusion of national styles, along with the social circumstances which make for intellectual vitality in physics.

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The X-ray Revival

Atomic Inner-Shell Processes. BERND CRASEMANN, Ed. Academic Press, New York, 1975. Two volumes. Vol. 1, Ionization and Transition Probabilities. xii, 468 pp., illus. $47.50. Vol. 2, Experimental Approaches and Applications. x, 220 pp., illus. $27.50.

Many problems of single and multiple inner-shell physics were left rather dangling when x-ray studies were largely abandoned in the years of World War II. New applications in condensed-matter physics, ion-atom collisions, astrophysics, and plasmas have now reexposed some of the unsolved problems and offered new tools for their treatment and new phenomenology tending to sharpen one's perceptions concerning them. In these two volumes Crasemann and the numerous contributing authors have aimed to expound key areas of the recent x-ray revival.

In the first volume, technical details of the experiments have been suppressed with good effect in permitting the data to be more quickly grasped. This is particularly evident in the chapter on ion-atom collisions (Richard). Several of the contributors to the volume are well known for work in calculation and modeling of inner-shell processes, and they provide treatments at a satisfying depth. The occasion of preparing chapters for this work has, moreover, led the theoreticians to an uncommon clarity of exposition. Thus, though most of the information in the chapters on charged-particle excitation (Madison and Merzbacher), photoionization (Cooper), and transition probabilities (Kelly) and energies (Larkins) is available in the literature, it is made considerably more accessible.

That some of the "hard" problems are now being grappled with to good effect is evident from Larkins's treatment of double-vacancy states and Åberg's discussion of coupled transitions. Both these phenomena need clarification before the taxonomy of x-ray satellites can be worked out. The newly revived interest in the extended absorption fine structure is not reflected in the book, however. The impetus in this area came from work with the intense x-ray beam from an electron storage ring, which was not completed in time for this book.

The second of the two volumes is oriented toward the experimental detail omitted from the first. Though the chapters are individually interesting, the volume as a whole is less successful. The contribution on proportional counter methods (Fink) is up to date and includes the recent work on position-sensitive detectors. Likewise, electron spectrometry (Krause) is as well represented as it could be in a one-chapter summary. In this case literature, including texts, treatises, and reviews, is already available in abundance. On the other hand, the chapter on radioactive atoms (Rao) should really have been in the first volume, since it is mainly a data summary and review. The chapter on crystal spectroscopy (Cauchois and Bonnelle) provides a satisfactory summary of basics and some guidance through the literature, but it neglects recent instrumentation, such as channel-cut and monolithic monochromators, and makes little use of recent dynamical theory.

Missing altogether from the work is discussion of radiation sources or collision chambers. There are unique problems and interesting techniques associated with target systems for accelerators. There have also been developments that might have been covered pertaining to electron bombardment x-ray sources, rotating anodes (mentioned in Krause's chapter), crossed beams, and so on. Nowhere does one find discussion of the problems associated with the x-ray wavelength scale and its connection with the scale of binding energies. Another conspicuous omission has to do with synchrotrons and storage rings. Although only a fraction of the newer results could have been included, the sources were well characterized and were in use at a sufficiently early date.

These flaws aside, the volumes are an admirable effort. I would recommend them to anyone wanting to know where the x-ray business has gone since Compton and Allison and volume 30 of the Flugge Handbook.

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Tropical Reptiles

The Biology of Sea Snakes. WILLIAM A. DUNSON, Ed. University Park Press, Baltimore, 1975. xii, 530 pp., illus. $34.50.

For most of this century research on sea snakes was more or less confined to clinical studies of the effects and treatment of their bites, a considerable effort to isolate and define biologically active components and properties of the venom, some taxonomic work, and much natural history, most of it anecdotal. Our knowledge was for the most part erratic and defied generalization.

Recently, a number of investigators have examined sea snakes with the result