1702 "had settled on a thermometer scale having 60° as the boiling point of water and 7½° as the melting point of ice," so that one-eighth of the scale extended to subfreezing temperatures. On a visit in 1708, Daniel Gabriel Fahrenheit (1686–1736) "saw Rømer calibrating . . . meteorological thermometers [spirit] at a temperature of 22½° on his scale by comparison with one of his own thermometers in a vessel of warm water. . . . Later in 1708 Rømer changed his scale so that the melting point of ice became 8°."

Fahrenheit used this scale, multiplied by 4, for spirit thermometers in 1714 and for mercury thermometers in 1717. Apparently the young visitor thought Rømer's warm-water calibration represented body heat, which he used, first as 90°, later as 96°, for his upper point, keeping $4 \times 8 = 32°$ for the melting point of ice. "He did not use the boiling point of water as a fixed point, but stated it as 212°"; soon after his death it generally replaced body heat as the upper fixed point.

In England around 1700, many thermometers were scaled according to latitude, with small numbers for equatorial heat, large ones for polar cold: 0° = Extream Hott, 90° = Extream Cold. In 1723, James Jurin (1684–1750), secretary of the Royal Society, asked for pressure and temperature observations from throughout the world and recommended spirit thermometers made by Francis Hauksbee (1687–1763) bearing such a scale. At Uppsala, Sweden, regular observations were made with a Hauksbee thermometer from 1726 to 1750.

Another thermometer with 0° at the boiling point was sent to Uppsala in December 1737 by Joseph Nicolas Delisle (1688–1768), a French astronomer who directed Peter the Great's observatory from 1725 to 1750. In 1724 in Paris, he and his brother had calibrated spirit thermometers at "0° in boiling water and 100° in the Observatory cellars," which, being 28 meters deep, were around 12° C. In St. Petersburg, having no cellar, he used only one fixed point, 0° for boiling, on his mercury thermometers, calibrating them according to the contraction of mercury. In Moscow in 1738, his associate, Josias Weitbrecht (1702–1747), found that ice melted at 149.5° Delisle, and recalibrated the scale to make it 150°, having found that mercury contracted by 150/10,000 when cooled from the boiling point to the ice point.

Anders Celsius (1701–1744), professor of astronomy at Uppsala since 1730, apparently disliked both Hauksbee's and Delisle's scales. By the end of 1741 he had marked a new scale on Delisle's mercury thermometer, keeping 0° for boiling but putting 100° for the ice point, at 151.8° Delisle. The same year, Celsius induced his Uppsala colleagues to offer a chair to Carl von Linné, or Linneaus (1707–1778), who had just become uncomfortable at Stockholm. Linné liked thermometers with 0° at the ice point—he had ordered one in 1737—and inverted Celsius' scale after his friend died in 1744. By 1745 he had ordered "a centigrade thermometer with the zero at the ice point" for use in his greenhouses, and similar thermometers were used, from 1747 onward, by Märten Strömer (1707–1770), who succeeded Celsius at the observatory.

Beginning in 1730, René-Antoine Ferchault de Réaumur (1683–1757) tried to bring order out of thermometric chaos by determining the volumetric increase in alcohol from the ice point to the boiling point of water. He assigned to this expansion "80 parts in 1000, mainly because 80 is 'a number convenient to divide into parts' "; Rømer had similarly liked 60. After a few decades 80° was set at the boiling point, although Réaumur had always used only the ice point and his expansion factor for alcohol.

"In 1736, it appears, the Académie Royale des Sciences had sent to the Lyon observatory, and also to several other parts of the kingdom, Réaumur thermometers." Jean Pierre Christin (1683–1755), of the Lyon Académie, tried to make mercury thermometers according to Réaumur's volumetric procedure, and by May of 1743 had deduced that mercury expanded by 6700/6600 when heated from the ice point to the boiling point. His instrument-maker, Pierre Casati, began producing 0–100° mercury thermometers, which were used in southern France despite the opposition of Réaumur and his Paris colleagues.

Middleton does not point out the equivalence of the expansion coefficients of Christin and Delisle-Weitbrecht: 1/66 = 15/1000. He concludes that identification of the "inventor" of the centigrade temperature scale, since 1948 officially designated as the Celsius scale, depends on definitions of invention and of scale. Celsius had 100 degrees between the boiling point (0°) and the ice point (100°) in 1741. Linné reversed the scale by 1745. By May 1743, Christin had a mercury thermometer with 0° at the ice point as the only fixed value, although the boiling point was approximately 100°.

Much, much more detail is given by Middleton about these matters, about arguments on the invariance of the ice and boiling points, about the slow development of the concept of temperature, about absolute temperature and gas thermometers, about self-registering thermometers (the conventional minimum thermometer with "dumbbell" floating index dates from 1780, the maximum with a constriction from 1852), about thermographs and metallic and electric thermometers, and about the exposure and protection of meteorological thermometers and their ventilation. The handsomely printed volume contains 82 figures, almost all reproductions of original engravings.

But the accounts are often bewildering, with few attempts at integration. The parallelism between simultaneous developments is not stressed, and in many places the chronology is hard to establish: the picture is blurred by too much detail. Lack of cross-referencing makes necessary frequent recourse to the excellent and comprehensive index —which contains life-span dates not given in the text. A tabular chronology of the salient developments would be welcome. Those who would rely on Middleton in revising or framing their capsules of thermometric history must read and re-read this book carefully. I hope that the summaries offered here, of the early development of the thermometer and of its present scales, represent fairly Middleton's mind.

ARNOLD COURT
San Fernando Valley State College, Northridge, California

Curious Beliefs

The Midwife and the Witch. THOMAS ROGERS FORBES. Yale University Press, New Haven, Conn., 1966. 210 pp., illus. $6.50.

The study of superstitions, magic, and the use of mystical symbols is a fascinating and revealing way to view the culture and heritage of a people. Forbes, a professor of anatomy at Yale University School of Medicine, defines superstition as "an unreasoning and unquestioning belief in some aspect of the natural or supernatural" (p. vii) along with the practices resulting from such belief. He sees superstitions as growing out of the human need to understand and predict events. Many superstitions, though lacking empirical validation, have embodied some logical elements and have offered comfort and reassurance in troubled times. Because of the many inexplicable phenomena connected with reproduction and childbirth, an especially large number of superstitions have grown up around this subject. In *The Midwife and the Witch,* a fascinating record of a variety of such superstitions and practices, Forbes has provided a few glimpses into the medical practices, social life, and intellectual traditions of the times—primarily the period from the late Middle Ages to the 17th century.

The book is composed of ten more or less independent chapters, dealing with such topics as sex reversal (specifically in fowl), sexual anomalies in animals (such as the freemartin), fertility and pregnancy tests, sex prediction, and the variety of good-luck charms employed during childbirth. The last three chapters are specifically concerned with the midwife—her social status, her role as medical and spiritual guide, her alleged relations with the powers of evil, and the attempts made by both church and state in the later 16th and early 17th centuries to raise the standards of her profession.

The book is elaborately researched and contains a vast collection of information about many curious beliefs. The variety of means employed to predict the sex of an unborn child provides a particularly good example of the detail which the author brings to this study. We learn that observation of the urine of a pregnant woman was frequently used in Renaissance Europe as a means of sex prediction. One test involved allowing a vial of urine from a pregnant woman to stand overnight; if the liquid became cloudy at the bottom of the vial the child would be male; if the liquid became cloudy in the middle region of the vial the child would be female. If no turbidity was visible it was certain that the woman was not pregnant at all. Another urological test involved the effect of the urine on germination of seeds. It was widely believed in the 15th and 16th centuries that seeds watered with urine from a pregnant woman would germinate faster than those watered with urine from a nonpregnant woman. Furthermore, germination was supposed to offer a reliable prediction of the child's sex. Barley and wheat seeds were sown at the same time in a small plot of earth, and watered with urine from a pregnant woman. If the wheat sprouted first, the child would be a boy, but if the barley sprouted first, the child would be a girl. In recounting these and other curious beliefs, Forbes shows how many paths man has followed to satisfy his impatience over events of the future.

To the historian of medicine the insights which the chapters on the midwife, in particular, give into many aspects of medical practice in 16th- and 17th-century Europe are interesting and valuable. The appalling state of the knowledge possessed by most midwives, the lack of any standards for entrance into the profession, and the often dangerous combination of rule-of-thumb practices and magical procedures involved in actual childbirth indicate how little was known among most people about reproductive phenomena. A particularly interesting aspect is the story of attempts of both church and state to upgrade the midwife profession by licensing procedures. The author points out that most such attempts were aimed principally at insuring that the midwife had a good character (that is, was not in league with the Devil) rather than at insuring that she possessed a thorough knowledge of her profession. Nowhere did the boundary between sound medical practice and superstition become more indistinct than in connection with reproduction and childbirth during this period of western history.

Particularly useful to scholars is the extensive bibliography of over 900 items which Forbes has included. Many secondary items provide valuable hints for further and more specific research on a variety of topics raised in the present study. Inclusion of many quotations from primary sources is also a help to scholars, while providing an intriguing authenticity for the author's account.

Many of the chapters in the book are modified versions of articles previously published in various scholarly journals, and as a result the book as a whole lacks unity. Chapter 2, a detailed discussion of the etymology of "heifer," "freemartin," and "ridgeling," does not add anything important to our understanding of past beliefs about sexual anomalies. A difficulty that stems partly from the lack of unity is that the author has not drawn many conclusions from his work. Even within the individual chapters, there is little attempt to analyze the common sources of certain beliefs, the philosophical and religious assumptions underlying a particular set of superstitions, or the relations between views of the supernatural in general and important social or intellectual trends of the times. It may be that such analyses are at this point impossible because of an insufficiency of such specific studies as those Forbes has presented, but one might wish that Forbes himself had kept these larger aims in view.

Despite these disappointments, however, the book is a valuable and extremely interesting supplement to studies (such as F. J. Cole's *Early Theories of Sexual Generation*, Oxford University Press, 1930) on early ideas about the biology of reproduction.

GARLAND E. ALLEN
Department of the History of Science, Harvard University, Cambridge, Massachusetts

A System of the World

Celestial Mechanics. Vols. 1–4. PIERRE SIMON DE LAPLACE. Translated, with a commentary, from the French edition by NATHANIEL BOWDITCH. Reprint of 1829–39 edition. Chelsea, New York, 1966. 3940 pp., illus. $79.50.

The close of the 18th century in astronomy is nowhere more completely epitomized than in the great Treatise on Celestial Mechanics of Pierre Simon de Laplace, which appeared in five enormous volumes between 1799 and 1825. As a synthesis of astronomical thought since the 17th century it embraces the achievements of the major mathematical astronomers of the continent who built so well upon the firm accomplishment of Isaac Newton: d'Alembert, Clairaut, Euler, Lagrange, and others. Laplace joined his skills and discoveries to them all in the creation of a scientific masterpiece, but it was above all from Lagrange that he received the most. On certain special problems, such as those dealing with secular inequalities, the two were almost constantly in touch; between 1773