and behavior of the premotor neurons in the oculomotor system are very well understood, it is often feasible to record from cells in slice preparations whose behavioral properties have been well characterized in the awake animal. Thus it may be possible to relate membrane properties to normal function. Although such work is in its infancy, the potential is exciting.

Both volumes contain much new and exciting material and should be required reading for anyone with an interest in vestibular physiology.

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New Haven Observers

Astronomy at Yale, 1701–1968. DORRIT HOFFLEIT. Yale University, New Haven, CT, and Connecticut Academy of Arts and Sciences, New Haven, 1992. xviii, 230 pp., illus. $40. Memoirs of the Connecticut Academy of Arts and Sciences, vol. 23.

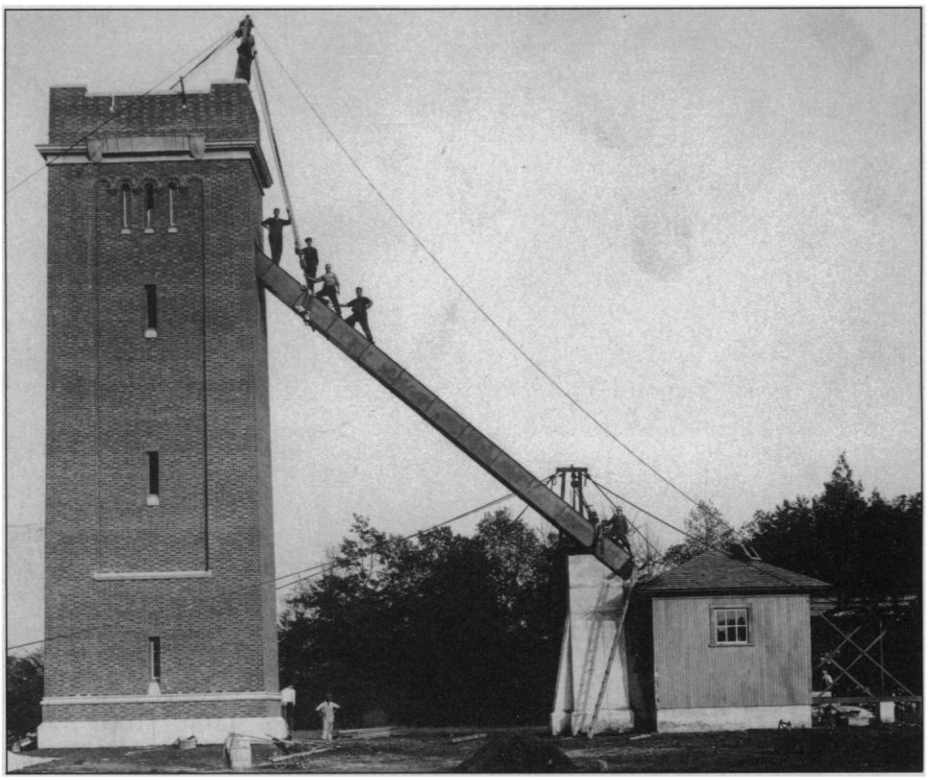
If you like celestial mechanics you will love this book. In fact if you like astronomy, you will find much of interest in it. It is a history of astronomy at one of the oldest universities in the United States, founded in 1701 as Yale College, the third in the colonies, after Harvard and William and Mary. The author, herself a professional astronomer now retired, tells her story largely in the form of a series of short biographies and reports on the research the Yale professors did. But Yale College began as a training school for ministers, and astronomy was one of the classical subjects they were expected to learn. The earliest students were allowed to choose whether to learn the Ptolemaic or the Copernican theory, that the sun revolved around the earth or vice versa. Gradually science took over.

The first recorded meteorite fall in the United States, in 1807, was investigated by Benjamin Silliman and J. L. Kingsley of Yale. Although Thomas Jefferson was supposed to have said "It is easier to believe that two Yankee professors would lie than to admit that stones could fall from heaven," they were right in their conclusions. Several later Yale astronomers, especially Dennis Olmsted, Edward C. Herrick (actually the college librarian and treasurer), Ellis Loomis, and Hubert A. Newton studied the orbits of meteors and fireballs, their connection with comets, their passage through the earth's atmosphere, and the meteorites that some of them became when they reached the ground. This work culminated in the meteor photography of W. L. Elkin in the first part of this century. Hoffleit, herself an expert in this field, describes their research carefully and accurately. She uses straightforward physical reasoning but gives quantitative details and references to very many of the published scientific papers, the primary sources for her book.

In its early years Yale had several significant astronomical firsts. In 1829 its new 5-inch achromatic telescope, obtained from the Dollond and Sons optical firm in London, was the largest refractor in America. In 1843 Arthur W. Wright received the first Ph.D. degree awarded in the United States, for his thesis on the computation of meteor orbits. Margaret Palmer entered the Yale Graduate School in 1892, the year it was first opened "to candidates without distinction of sex." In 1894 she became the first woman astronomer to receive her Ph.D. from an American university. Her thesis was the calculation of the definitive orbit of Comet 1847 VI, which had been discovered by Maria Mitchell, her undergraduate teacher at Vassar.

Closer to our time Ernest W. Brown, Frank Schlesinger, and Dirk Brouwer were the outstanding figures in Yale astronomy. Brown, born and educated in England, spent much of his life deriving and calculating the motion of the moon. In its most simplified form, this is the three-body problem of celestial mechanics, for the gravitational forces of the earth and the sun are both important. Brown's theory took every known force into account, including all the subtleties of the earth's form and orbit, as well as the perturbations of all the other planets. Frank Schlesinger, who became the director of Yale Observatory in 1920, developed astrometry, the precision measurement of stellar positions, parallaxes, and proper motions, into a fine art. His successor, Dirk Brouwer, who had come to Yale in 1927 from Leiden, was another expert in the celestial mechanics of the solar system. Much of his work was devoted to calculations of very accurate orbits of asteroids and planetary satellites. When the space era began in 1957 with the launching of Sputnik, he, his students, and his colleagues quickly became the leaders in solving the new problems of the orbits of artificial satellites and space vehicles.

Throughout this book Hoffleit emphasizes astronomical ideas and discoveries. It is highly concentrated on Yale, with little context of other observatories or universities, the wider world of science, America, or the world at large. Hoffleit writes gracefully and the book is copiously illustrated



Yale's Loomis telescope tower under construction, around 1915. Described in the 1915–16 Yale *Catalogue* as "a new type of instrument designed mainly for the photographic determination of stellar parallaxes," the Loomis telescope proved unsuitable for such work and "was eventually used for variable star observations." [From *Astronomy at Yale, 1701–1968*] with drawings and photographs. Astronomers will like it and celestial mechanicians will love it, but scientists in other fields may find it a little too specialized for their tastes.

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The Construction of Stars

Structure and Evolution of Single and Binary Stars. C. W. H. DE LOORE and C. DOOM. Kluwer, Norwell, MA, 1992. xvi, 458 pp., illus. Paper, $69. Astrophysics and Space Science Library, vol. 179.

Our current understanding of stellar evolution is one of theoretical astronomy's greatest achievements. The ability to derive the general properties of known stars—including the sun—from basic physical laws has enabled astronomers to establish the age of our galaxy, the origins of all elements heavier than helium, and (indirectly) the size of the observable universe. Current unsolved problems in this field affect our understanding of theoretical physics (the solar neutrino problem) and of the evolution of life on earth (star and planet formation; solar irradiance variations and the greenhouse effect).

In *Structure and Evolution of Single and Binary Stars*, de Loore and Doom set out to introduce the physical principles and results of stellar structure and evolution at a level accessible to advanced physics and astronomy undergraduate students. After a brief introduction of observed stellar properties, the authors develop the basic building blocks and describe the numerical techniques needed to construct a model star on a modern computer. They then delve into our current understanding of the evolution of single and double stars as a function of their mass and describe how present theory explains the wonderful variety of single and binary stars we observe in the universe today. They conclude their account with many tables summarizing the structural properties of model stars.

For the most part, de Loore and Doom present a clear picture of the tools and results of modern stellar evolutionary theory. The description of the main physical ingredients for a model star—the thermodynamic properties of the gas, nuclear reaction rates, and opacities—provides an excellent introduction for a student and a good review for any practicing astronomer. The problems in these chapters help to develop the important results or aid the beginner in acquiring an intuitive understanding of how stellar interiors work. The chapters on the evolution of low-, intermediate-, and high-mass single stars are reasonably complete and note both the main successes and some of the remaining uncertainties of standard models. The chapter on the evolution of massive binary stars—the primary interest of both authors—is very good, and the tabular material in the last chapter should be useful for astronomers trying to confront observations of stars with theoretical predictions.

In spite of these general strengths, the book is not an ideal introduction to modern stellar evolution theory. For example, simple derivations of the mass-luminosity relation for main-sequence stars and the thin-shell instability for red giant stars would give students and researchers alike a better appreciation for the behavior of detailed