

Did Newton Need Hooke's Program to Divine Planetary Motions?

Meanest Foundations and Nobler Superstructures: Hooke, Newton and the "Compounding of the Celestiall Motions of the Planetts"

Ofer Gal

Kluwer Academic, Norwell, Mass., 2002. \$69.00 (239 pp.). ISBN 1-4020-0732-9

Reviewed by George E. Smith

In *Meanest Foundations and Nobler Superstructures*, Ofer Gal examines Robert Hooke's influence on Isaac Newton's theory of planetary motion. The basis for that influence was a brief correspondence extending from late 1679 to early 1680. Hooke initiated the correspondence by asking what Newton thought of his idea that a planet's motion has a part tangent to the trajectory and a part "encurved" by an attraction to another body. At the end, Hooke suggested that the attraction obeys an inverse-square law, and proposed that Newton apply his "excellent method" of calculus to define the curves of planetary motion.

The book's title comes from a remark Hooke makes in the preface to his early masterpiece, *Micrographia* (1665): "If I have contributed the meanest foundations whereon others may raise nobler Superstructures, I am abundantly satisfied." Gal's main contention is that Newton's nobler superstructure rested on what Gal calls "Hooke's program"—that is, the treatment of planetary trajectories as motions that would be rectilinear were it not for inverse-

square forces encurving them.

The great value of Gal's book lies in his analysis of how Hooke arrived at his conception through his research in optics during the 1660s and on springs and clocks in the 1670s. From the optics came Hooke's notion of inflection, the encurving of light through a medium of varying density like Earth's atmosphere; and from the springs came a notion of "power," or the capacity to effect or restrain motion, instantiated in the balance springs of Hooke's timepieces.

Crucial to Gal's analysis is his insistence that Hooke had a scientific style radically different from Newton's, typically not described even in current writings on the philosophy of science. To understand Hooke, Gal argues, one must not construe his theorizing as a set of clearly formed propositions, much less mathematical propositions. Rather, Hooke's theorizing forms a heuristic framework for performing experiments and designing devices, extended by qualitative analogy to planetary motion. Gal thus illuminates content in Hooke's program that is largely invisible from a Newtonlike perspective.

On Hooke's influence, Newton himself had a strong opinion. In 1686, after he had sent Book 1 of the *Principia* to his editor, Edmund Halley, and had learned from Halley that Hooke had claimed priority for inventing the "rule of decrease of gravity," Newton argued in a letter to Halley:

But grant I received it afterwards from Mr Hook, yet have I as great a right to it as to ye Ellipsis. For as Kepler knew ye Orb to be not circular but oval & guest it to be Elliptical, so Mr Hook without knowing what I have found out since his letters to me, can know no more but that ye proportion was duplicate *quam proxime* at great distances from ye center, & only guest it to be so accurately & guest amiss in extending yt proportion down to ye very center, whereas Kepler guest right at ye Ellipsis. (*Correspondence* [of Isaac Newton], volume 2, H. W.

Turnbull, ed., Cambridge U. Press, 1960, page 436.)

The dispute with Newton was but one of many priority accusations that Hooke made against others, accusations that diminished his standing both in his time and in ours. As Gal poignantly remarks,

The steps are characteristic of Hooke; they begin with a very simple laboratory device, barely related to either mechanics or cosmology, continue with numerous ingenious transformations and manipulations, and end, as we have seen, with bad feelings. (p. 22)

Quite apart from Hooke's pattern of accusations and Newton's lack of grace in failing to acknowledge Hooke, Gal explores Hooke's influence in terms of the evolution of 17th-century thought—a field in which Gal is an expert. Gal rightly dismisses the question of priority to the inverse-square rule as uninteresting—several individuals besides Newton and Hooke had at least suggested it. Instead, Gal argues that Newton appropriated Hooke's general way of conceiving the problem. Before his correspondence with Hooke, Newton (along with many others) thought of the planetary orbits as involving equilibrium between, using Newton's phrasing, "an endeavor to recede from the center" associated with circular motion and some other mechanism.

Nevertheless, Gal's assessment suffers from shortcomings. Gal ignores the *Principia* itself and instead compares Newton's treatment of uniform circular motion in the late 1660s with his short 1684 tract on Keplerian motion. By focusing on Hooke and ignoring the *Principia*, Gal neglects the monumental contrast between Hooke and Newton. Newton had his own program. One of its central concerns was to derive theoretical results from phenomena and to stay away from mere suppositions. Gal's analysis shows that Hooke's thinking revolved around just the sort of suppositions that Newton distrusted. Hooke's efforts on

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planetary motion attest to an enormous gap between his conceptualization of the problem and evidence for his conclusions. As ungracious as it was to Kepler and Hooke, Newton's defense of his claim to the ellipse and the inverse-square rule appears less petty and more warranted when viewed in the context of *his* program.

That disagreement aside, I find *Meanest Foundations and Nobler Superstructures* to be an excellent resource in the history of science and particularly valuable for its recognition of Hooke's scientific style.

Biophysics: An Introduction

Rodney M. J. Cotterill
Wiley, New York, 2002.
\$115.00, \$39.95 paper (395 pp.).
ISBN 0-471-48537-3,
ISBN 0-471-48538-1 paper

When I started reading Rodney Cotterill's *Biophysics: An Introduction*, I got bogged down because the first part deals with energies, forces, and the making and breaking of bonds, and includes appendixes on quantum me-

chanics and the hydrogen atom. Is there any biophysics here? Read on. One soon learns about useful biophysical techniques ranging from x-ray diffraction to optical tweezers; about DNA, RNA, and proteins; about energy production, including photosynthesis; about membranes and their excitation; and about biological movement and its control. That last topic leads to a treatment of higher brain function, the focus of the author's current research. Cotterill even offers an illuminating discussion of consciousness and free will, topics that are rarely, if ever, seen in books on biophysics.

Biophysics is not an in-depth treatment of a few subjects but a broad introductory survey text—from atom to Adam. It is based on a course Cotterill taught for many years at the Technical University of Denmark in Lyngby. The treatment is concise, balanced, and readable. Each chapter includes exercises and suggestions for further reading. Added material, including solutions to exercises, can be found on the author's Web site. The book is worth considering as a text for an introductory course for undergraduates.

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Gerhard Herzberg: An Illustrious Life in Science

Boris Stoicheff
NRC Press, Ottawa and McGill-Queen's U. Press, Montreal, 2002.
\$49.95 (468 pp.).
ISBN 0-660-18757-4

Boris Stoicheff has done a magnificent job in writing *Gerhard Herzberg*, a scholarly and loving biography of the great spectroscopist who was his close friend for almost 50 years. Noted for his own work in Raman spectroscopy and nonlinear optics, Stoicheff spent the early years of his career (1951–64) in Herzberg's spectroscopy laboratory at the National Research Council (NRC) in Ottawa, Canada. Herzberg was at home in three communities: physics, in which he had formal degrees and did most of his research; chemistry, in which he was awarded the Nobel Prize; and astronomy, his first love, in which he made important spectroscopic identifications.

Stoicheff's book provides an intimate picture of Herzberg the man and the details of his environment. Throughout the text, one sees photographs of him with colleagues, friends,

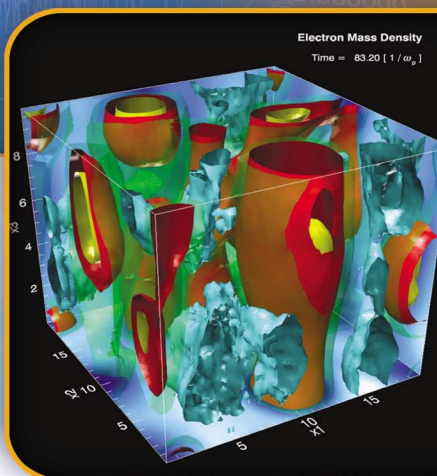
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