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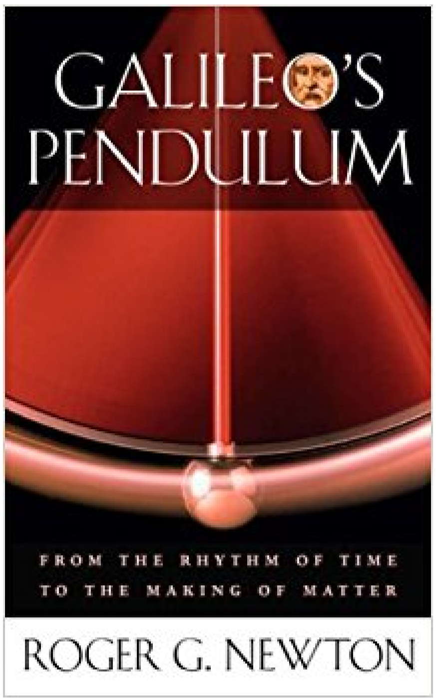
Galileo's Pendulum: From The Rhythm Of Time To The Making Of Matter



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Synopsis

Bored during Mass at the cathedral in Pisa, the seventeen-year-old Galileo regarded the chandelier swinging overhead--and remarked, to his great surprise, that the lamp took as many beats to complete an arc when hardly moving as when it was swinging widely. Galileo's Pendulum tells the story of what this observation meant, and of its profound consequences for science and technology. The principle of the pendulum's swing--a property called isochronism--marks a simple yet fundamental system in nature, one that ties the rhythm of time to the very existence of matter in the universe. Roger Newton sets the stage for Galileo's discovery with a look at biorhythms in living organisms and at early calendars and clocks--contrivances of nature and culture that, however adequate in their time, did not meet the precise requirements of seventeenth-century science and navigation. Galileo's Pendulum recounts the history of the newly evolving time pieces--from marine chronometers to atomic clocks--based on the pendulum as well as other mechanisms employing the same physical principles, and explains the Newtonian science underlying their function. The book ranges nimbly from the sciences of sound and light to the astonishing intersection of the pendulum's oscillations and quantum theory, resulting in new insight into the make-up of the material universe. Covering topics from the invention of time zones to Isaac Newton's equations of motion, from Pythagoras' theory of musical harmony to Michael Faraday's field theory and the development of quantum electrodynamics, Galileo's Pendulum is an authoritative and engaging tour through time of the most basic all-pervading system in the world.

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Customer Reviews

Newton (What Makes Nature Tick) explains the premise of his slim volume in a single sentence in the introduction: "This book is about the rhythm of time, how that rhythm was finally regulated by Galileo’s pendulum, the impact the oscillations of the pendulum had on our perception of that rhythm, and how these oscillations were later found to manifest themselves in many other natural phenomena." The book’s eight chapters touch on a wealth of topics: circadian rhythms in living organisms; the conceptualization and design of calendars; the construction of clocks, from sundials and water clocks to those powered by pendula and cesium; and the development of physics from Isaac Newton to modern quantum electrodynamics. Indeed, the array is too broad for the disparate elements to come together and form a coherent whole. Additionally, the range of material here is unlikely to be fully satisfying to most readers; the basic history of science will be accessible to the nonspecialist but not compelling for the scientist science buff, while the highly technical mathematical sections will certainly cut off the general reader. Anyone wanting to understand how humans first defined time and how it became systematically measured might want to turn to the relatively recent Einstein’s Clocks and PoincarÃƒÂ©’s Maps, by Peter Galison. 34 photos and illus. Copyright Ã Â© Reed Business Information, a division of Reed Elsevier Inc. All rights reserved.

Physicist Newton, editor of the Journal of Mathematical Physics, here addresses nonexperts on the subject of time--specifically, the measurement of its passage. The range of things that measure time, from living creatures to atomic clocks, brackets Newton’s intriguing narrative of time’s connections, in the middle of which stands Galileo’s famous discovery about pendulums. They exhibit isochronism, that is, a fixed period of oscillation, which is important, as Newton explains, because it offered a principle for accurately measuring the duration of a unit of time. The ensuing search for precise oscillators, from mechanical pendulums to vibrating atoms of quartz, drives his story forward. En route, Newton touches on both the greatest names in physics and clockmakers, such as John Harrison, inventor of the seagoing chronometer and the star of Dava Sobel’s Longitude (1995), thus fruitfully entwining the fundamental discoveries of science with the progress of timekeeping technology. Science buffs will delight in the links Newton makes in this readable tour of how humanity marks time. Gilbert TaylorCopyright Ã Â© American Library Association. All rights reserved

Like so many stories about Galileo, his flash-of-inspiration about pendulums is an unverifiable legend, but it is a great one. Bored by mass in the cathedral of Pisa, he started watching the chandelier hanging from a long chain, and timing it with the best clock he had available, his own pulse. Maybe he wasn’t the first one to notice this, or to wonder about it, but the pendulum blown by drafts took as long to swing back and forth whether it was making a big arc or a small one. The observation was not exactly true, and his means of measuring it were not exact, and maybe the whole thing didn’t happen anyway. Nonetheless, Galileo did discover a secret about pendulums that has profoundly affected physics and the whole world ever since. In _Galileo’s Pendulum; From the Rhythm of Time to the Making of Matter_ (Harvard University Press), Roger G. Newton has started from this very first observation of a "simple harmonic oscillator" and briskly traced the concept up through quantum theory. The book contains some daunting math, which the author invites those so inclined to skip, but has scientific history and a summary of physics that is exhilarating and clear. A simple harmonic oscillator (SHO) is only deceptively simple. It can be completely understood mathematically, but gives enough complexity in its variants to be eternally interesting. The most obvious SHO, the pendulum, has its most famous use in clocks, and there are four chapters here on the history of clock-making. It was Galileo himself who, having noticed the regularity of the pendulum swing, realized that a pendulum would be the perfect timer to regulate a clock. He himself designed an escapement for such a pendulum, but only after his death did the design get put into action. Pendulum clocks had their problems, as readers of _Longitude_ know. The coiled balance spring of clocks that could be used aboard ship has, via its elastic properties, the same oscillation potential as a pendulum. Eventually clocks were regulated by tuning forks; the tines of the fork, too, show SHO. Even better results came from electrically vibrating a quartz crystal at millions of times a second, another SHO. Crystals do slowly age, and their periodicity eventually varies, but electrons do not. Atomic clocks, which are more accurate even than the rotations and revolutions of the Earth which clocks are supposed to measure, are based on the frequency of electromagnetic waves emitted when cesium electrons are excited. Having brought clocks into the quantum realm, the author goes back to trace the physics of oscillation. It was Isaac Newton with his laws of motion who explained why a pendulum acted the way it did, and enabled its motion to be mathematically evaluated. The movement and forces on a pendulum can be graphed, and show up as sinusoidal waves, which are observed all over the place in nature. Fourier discovered that time functions, even if they weren’t sinusoidal, could be expressed as sums of different sinusoidal waves. Metaphorically, acoustical and electromagnetic phenomena could be reduced into summed pendulums. Michael Faraday originated the idea of the electromagnetic field, and James Maxwell put the field on a mathematical basis, with, of course, a sinusoidal foundation. Einstein rode an imaginary wave of light to come to his conclusions that reformulated the concepts of space and time. During the last part of the twentieth century, quantum electrodynamics showed that every constituent of matter can be regarded as quantum of different fields, and at the heart of quanta are, surprise, harmonic oscillators. _Galileo's Pendulum_ takes only thirty pages to go from Faraday to quantum electrodynamics, and there are other books to give deeper analysis of the history of physics. However, for the non-physicist, the author has provided a small history with the unique viewpoint of keeping pendulums in sight throughout. Readers will find this an excellent brief review of a surprisingly universal natural phenomenon.

Galileo's Pendulum: From the Rhythm of Time to the Making of Matter In Galileo's Pendulum, Robert G. Newton provides a concise and fascinating discussion of how the accurate measure of time spurred mankind on to some of its most remarkable scientific discoveries. Newton begins his book by surveying the earliest attempts to measure time, beginning with the civilizations of the ancient Near East. The measuring of days, months, and years led to more complex endeavors to get a hold on time. But for Newton, the discovery by a young medical student named Galileo in 1581 of the time measuring properties of a swinging pendulum was the seminal event. That discovery provided scientist with a measuring means that enabled them to construct clocks and then watches, that became vital to the measuring of sound and light waves that eventually lead to quantum physics. Newton launches from Galileo's insight into an explanation of the inventions and intellectual ideas it gave birth to with an ease that compels the reader's attention as it must have the author's. Anyone wanting to understand the importance of time, not only to our routine daily lives but as the underpinning of many of the scientific discoveries that facilitate our lives and inspire us to dream about the secrets of the universe, is advised to read this book.

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