



The Quantum Beat: Principles and Applications of Atomic Clocks

Fouad G. Major

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One of the indicators of the level of technological development of a society has been, throughout history, the precision of clocks it was able to build. This book examines the physical principles underlying the workings of clocks--from the earliest mechanical clocks to the present-day sophisticated clocks based on the properties of individual atoms. Intended for non-specialists with some knowledge of physics or engineering, the book treats the material in a broad intuitive manner, with a minimum of mathematical formalism. The presentation covers a broad range of salient topics relevant to the measurement of frequency and time intervals. The main focus is on electronic time-keeping: clocks based on quartz crystal oscillators and, at greater length, atomic clocks based on quantum resonance in rubidium, cesium, and hydrogen atoms, and, more recently, mercury ions. The book treats the revolutionary changes that the optical laser has wrought on atomic standards through laser cooling and optical pumping, and it discusses the application of these clocks to global navigation--in particular Loran-C and the Global Positioning System. The book also touches on such topics as atomic resonance line shape, the relativistic Doppler effect and general notions of time, including the relativity of future and past, the clock paradox, the Sagnac effect and finally, time reversal symmetry.

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