

Vapour cell atomic clocks and the measurement of time

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The accurate measurement of time and the development of compact instruments that provide a temporal reference constitute the topic of my presentation. After a general introduction on this fascinating and vast topic, I will focus on a particular challenge that still occupies artisans, watchmakers, and more recently engineers and physicists for decades now. This challenge consists in realising a relatively stable clock (or frequency standard) that one can transport and employ in difficult environments, such as on the open seas, and/or that still operates correctly after a series of shocks and vibrations such as those occurring in a rocket during a launch in space. This clock has to be sufficiently reliable as to ensure, often without maintenance, the correct functioning of a wide range of applications such as (tele)communications and (satellite) positioning and navigation. The lives of people or the economic activity of whole countries may rely on these clocks. At the same time, the clock must have a reduced volume, modest consumption, and possibly a low price. Despite these application-oriented motivations, the development of these precision instruments has led to a number of fundamental investigations in the field of atomic physics and metrology as well as a series of technological advances in interdisciplinary research (electromagnetism, electronics, micro technology, etc.). I will present several examples of recent and on-going investigations aiming to realise either a 1 litre clock that displays an instability below 1 nanosecond after one day of averaging time (for satellite navigation), or a 0.01 litre clock that ensures a 1 microsecond stability over a similar averaging time (for synchronisation of telecommunication and power distribution networks).