Optical clocks strike again

http://www.firstlight.cn 2006-12-19

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[摘要] 6 December 2006：Physicists in the US have created a highly-stable optical clock that could push the precision of these new timekeepers beyond that of conventional atomic clocks. Optical clocks keep time by using visible light to probe the unwavering energy levels within atoms. While they have the potential to be much more precise than microwave-based atomic clocks, they have suffered from stability problems due to the motion of the atoms. This new optical clock gets around this problem by trapping strontium atoms in an optical lattice thereby restricting their motion.

[关键词] Optical clocks;atomic clocks;strontium atoms

Optical clocks are based on a specific transition between atomic energy levels that involves the absorption of laser light at a very precise frequency. A laser is used to stimulate the transition and, once absorption begins, a feedback mechanism stabilizes the laser light at the precise absorption frequency. A device called a "femtosecond comb" is th

Unfortunately this process can be easily disturbed by the motion of atoms, which is a key challenge facing designers of optical clocks. Jun Ye and colleagues at JILA at the University of Colorado have now managed to reduce these motion

-related effects by trapping strontium atoms in a one-dimensional optical lattice --

a periodic structure of atoms that are held in place by interfering laser beams.

According to Ye, the optical lattice allows the probing laser light to interact coherently with the atoms for a longer period of time. "We are the first group to demonstrate that coherent interactions can last for nearly one second", he says.

The clock operates at 430 THz and up to 4.3 × 1014 cycles can be counted during one measurement, which boosts the precision of the measurement. Ye's clock has a precision of 2 Hz in 430 THz, or about five parts in 1015. This makes it less precise than a mercury ion atomic clock created by NIST in the US and state

-of-the-art atomic clocks – both of which can achieve one part in 10 15 precision.

However, an important feature of this new clock is that it can deliver a strong and stable signal. This could open the door to measurements longer than one second, which could ultimately push the precision to one part in 1017. Atomic clocks currently measure over about one day and have reached their practical limit at about one part in 10 15 preci