ATOMIC CLOCKS

Timekeeping in microgravity

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Atomic clocks that can function in space could offer improved accuracy compared to ground-based clocks when used for global navigation satellite systems, or fundamental observations of Earth. The most accurate clocks, such as the cold-atom PHARAO clock that will be added to the International Space Station, are bulky, and compact clocks, such as hydrogen maser-based systems that are currently used on small satellites, are less stable. Other types of compact clocks, including those based on a trapped-atom on a chip and those based on microelectromechanical systems and optoelectronic devices, also exist, but they do not meet the stability requirements for microgravity applications. Mehdi Langlois and colleagues at the Observatoire de Paris, Institut d'Optique d'Aquitaine and Université de Bordeaux have now developed a stable and compact cold-atom clock that has been tested under simulated microgravity conditions.

The clock is based on ^{87}Rb atoms and works using isotropic light cooling, where the reflected and scattered laser beams in a spherical cavity can cool down the atoms. After cooling the atoms and preparing the required state, the transition is interrogated through interferometry. All the clock functions — including the cooling, the state preparation, the microwave interrogation and the signal detection — happen inside the spherical cavity. The researchers carried out measurements in simulated microgravity during parabolic flights on board an Airbus A300. Because the atoms are affected by gravity, the stability of the clock is expected to improve in space, and the short-term stability of the clock in zero gravity was found to be better than the measurements on the ground. The stability is also expected to be improved further in low-noise environments such as a satellite.

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