Hydrogen Optical Lattice Clock

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Defining the values of constants is the best method to define units since it separates the definition from the realization. For example, there are two very different methods to realize the kg. In the future, there can be other methods of realizing the kg that adapt to possible advancements in technology without changing the definition. With the reform of the SI system, all but one of the units are now based on defined constants. The only remaining (natural) object is the cesium atom that is used to define and realize the SI second. A hydrogen lattice clock would allow us to complete the process and remove the last object from the SI system.

We propose a trap for atomic hydrogen that is not more complex than a usual optical atomic clock. It is based on a magic wavelength optical dipole trap, similar to the current most accurate optical clocks. The trap can be loaded without Doppler cooling which avoids an extremely difficult 121 nm laser. The $1S - 2S$ transition with a natural linewidth of 1.3 Hz would be the clock transition driven in a Doppler-free manner. Hence, only moderate temperature and no Doppler cooling are required. Our compact setup could be operated as a computable optical clock to redefine the SI-second as well as to improve spectroscopic data to test Quantum Electrodynamics.