Redefining Second with Optical Atomic Clocks

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Researchers have conducted the **most precise comparison of optical atomic clocks** to date, paving the way to **redefine the SI unit of time — the second — by 2030.**

- **Current Definition of the Second (SI Unit of Time):** Since **1967**, the **second** has been defined as **9,192,631,770 cycles** of **microwave radiation** emitted by a **Caesium-133 atom**, serving as the **foundation of global timekeeping** through **caesium (Cs) atomic clocks**.
- **Atomic Clocks:** An **Atomic Clock,** invented by **Louise Essen in 1955,** is a **high-precision timekeeping instrument** that measures time using the **vibrations of atoms.**
    - **Atomic clocks don't directly measure time**. Instead, **they generate radiation with a fixed frequency (frequency is essentially the inverse of time).**
- **Optical Atomic Clocks:** They surpass traditional atomic clocks in accuracy, using atoms like **Strontium-87**, **Ytterbium-171**, and **Indium-115** for **10,000× higher frequency precision**.
    - They use **lasers to trigger atomic transitions**, producing **highly coherent light** with **stable frequency and wavelength**.
- **Difference Between Atomic and Optical Clock: Optical clocks** can maintain precise timekeeping with a drift of only **1 second over 15 billion years**, making them **100 times more accurate than traditional cesium atomic clocks**. **Cesium atomic clocks** lose about **1 second every 300 million years**.
    - The **cesium clocks operate at a frequency in the microwave range** of the electromagnetic spectrum. In contrast, **optical atomic clocks** function at much **higher frequencies in the optical (visible) range**, enabling their superior precision.
- **Applications of Optical Atomic Clocks:** Its potential applications include **quantum sensing**, **high-speed network synchronization**, **space science**, and **testing fundamental physics**.
    - In the future, they may even **redefine the SI unit of time—the second**.

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