# Observation and absolute frequency measurement of a new narrow-linewidth transition in ytterbium

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Optical lattice clocks have attained remarkable levels of accuracy in time measurements. However, ongoing enhancements in stability and accuracy remain crucial for refining metrological applications and fundamental physics searches. Ytterbium (Yb) is a commonly selected atoms in optical lattice clocks. Theoretical predictions suggested the existence of an additional narrow-linewidth transition involving the excitation of an electron from an inner-shell 4*f* orbital, a phenomenon not directly observed until recently. We successfully observed this novel narrow-linewidth transition in $^{171}$Yb and conducted the first absolute frequency measurement, utilizing the depletion of atoms resonating with the narrow-linewidth transition from a magneto-optical trap. The obtained absolute frequency has 12-digit accuracy: 695 171 054 858.1 (8.2) kHz for the F = 3/2 hyperfine state. Our investigation further extended to the measurement of magnetic properties, including the g factor and hyperfine structure.

The observation of this transition paves the way for several pioneering research avenues. It offers a novel method of investigating the time variation of the fine structure constant and exploring potential new forces between an electron and a neutron, as well as testing the violation of Lorentz invariance. Moreover, the introduction of a secondary clock transition highly sensitive to external fields can potentially improve the stability of an optical lattice clock by simultaneously monitoring external perturbations affecting the resonant frequency of the primary clock transition.

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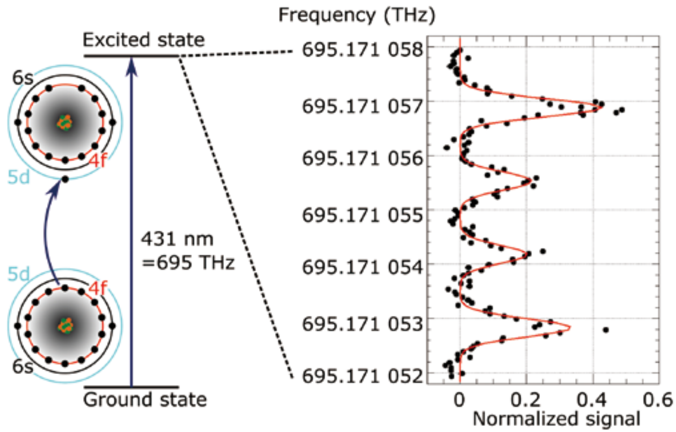


Change in the electronic structure of the observed transition and spectrum of the transition for the F = 3/2 hyperfine transition level