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Absolute optical frequency measurements of Cs two-photon transitions with a femtosecond frequency comb

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We study by direct excitation with a mode-locked femtosecond optical frequency comb, multiple transitions in Cs atoms in a vapor cell at room temperature. We improve by up to two orders of magnitude the uncertainties in the absolute optical frequency and hyperfine structure of the $6s\ ^2\mathrm{S}_{1/2} \rightarrow 8s^2\mathrm{S}_{1/2}, 9s^2\mathrm{S}_{1/2}$, and $7d^2\mathrm{D}_{3/2,5/2}$ transitions in ^{133}Cs. Cesium is one of the well studied heavy atoms, with atomic structure calculations on the order of 1%, and has provided a fertile testbed for fundamental tests of atomic theory and QED. This work reports on a simple and novel experimental approach that allows simultaneous recording of multiple transition frequencies. Atoms in a vapor cell at room temperature have a broad Doppler velocity distribution which allow selective excitation by discrete modes of a mode-locked femtosecond comb. This, in turn, results in stepwise multiphoton resonant transitions in the atoms. We model the collected spectra using a standard 2γ formula and use least square fitting routines to extract improved values of absolute optical frequencies and coupling constants.

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