

Two-photon frequency references for optical clocks and hyperfine spectroscopy using hot rubidium vapour

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We present our monochromatic two-photon frequency references at 778 nm, operating on the $5S_{1/2} \rightarrow 5D_{5/2}$ transition in Rubidium. These laboratory frequency references use Doppler-free frequency modulation spectroscopy of the approximately 500 kHz broad transition, with resonance detection via the fluorescence at 420 nm. We stabilise the frequency of our spectroscopy lasers to the center of the transition using electronic feedback control systems. The fractional instability of our lasers, derived from a beat-note between two independent references, is below $2 \cdot 10^{-13}/\sqrt{\tau}$, reaching down to $6 \cdot 10^{-15}$ for averaging times τ of 1000 s. We present details of the spectroscopy setup and the fluorescence detection system, as well as details on the performance evaluation. In addition to frequency metrology, we used our setup to measure the dipole, quadrupole and octupole hyperfine structure constants of Rb $5D_{5/2}$. Our precision surpasses the state-of-the-art by approximately one order of magnitude.

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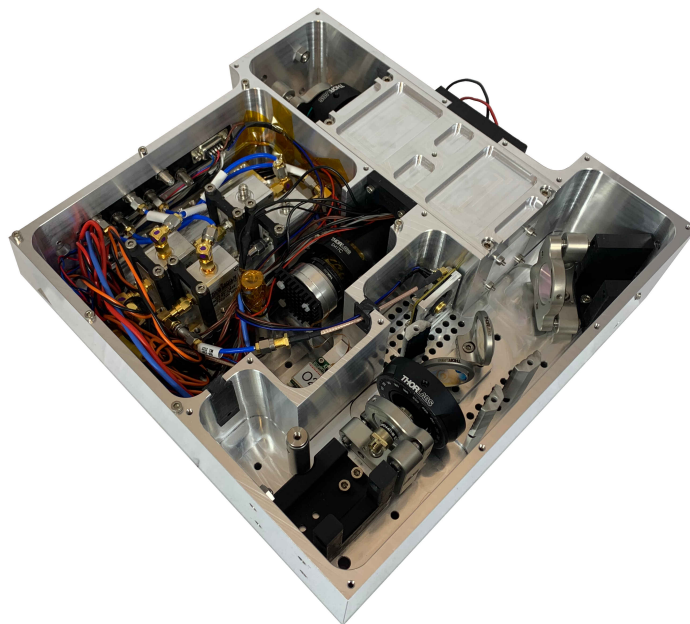


Figure 1. Photograph of the setup. The dimensions of the encasing are 290 mm \times 290 mm \times 94 mm.