Reduction in the blackbody radiation shift uncertainty of optical clock transitions in $^{171}Yb^{+}$

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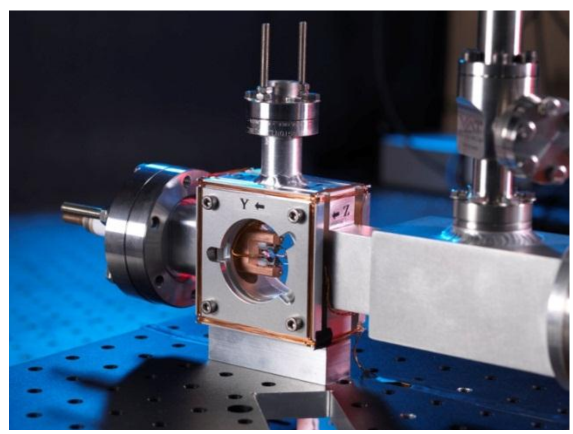
Recent advances in the field of single-ion frequency standards have resulted in optical atomic clocks with systematic uncertainties in the 10^{-17}- 10^{-18} range, below that of the best caesium fountains. At this level of precision, frequency shifts caused by the blackbody radiation (BBR) of the trap environment start to limit the achievable performance of the standard. In the case of Yb^{+} the mid-IR radiation emitted will cause a frequency shift which varies on the order of 10^{-18} per kelvin at room temperature[1, 2].

There are two parameters which contribute to this shift: the spectral intensity of the IR radiation that the ion receives, determined by the temperature of the ion's environment, and the magnitude of the shift coefficient itself. Work is presented here to reduce the current uncertainty on both of these parameters.

Dielectric heating in ion traps can cause temperature rises of up to several hundred kelvin if thermal performance is not considered in the design. By selecting materials with high thermal conductivity and low dielectric loss tangents this temperature rise can be significantly reduced. Combining good thermal design of the trap structure with in situ measurements of the trap temperature, the effective temperature observed by ion the can be well characterised.



The BBR shift coefficient in Yb^{+} currently has a large uncertainty due to the difficulty of theoretical calculations in such a complex ion. The shift must therefore be experimentally determined which to date has an uncertainty of 46% (5×10^{-17} at 300 K) [1]. We will perform direct measurements - in collaboration with MIKES - of the perturbation to the clock transition frequency when the ion is exposed to an IR laser with a wavelength of 7µm. This forms a suitable approximation to the room temperature BBR field and thus significantly reduces the dominant systematic uncertainty for the Yb^{+} octupole transition frequency.

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