Using highly charged ions to probe possible variations in the fine-structure constant

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The sensitivity of an atomic transition to variations in the fine structure constant, $\alpha = e^2/\hbar c$, scales proportionally to the ionisation energy. Therefore highly charged ions can be much more sensitive probes of space-time α-variation than atoms or near-neutral ions.

To be competitive with current limits on time-variation of α in the laboratory, optical transitions should be used. To maximise sensitivity, the transition should be between orbitals with different principal quantum number and different angular momentum in highly charged ions. Optical transitions such as this can occur in a limited subset of highly charged ions when the orbitals involved are nearly degenerate [1,2]. We have identified several such systems and shown that the transitions have a number of properties that could make them suitable reference transitions for atomic clocks with high accuracy [3,4].

We present recent theoretical developments on the identification and characterisation of the most promising systems for a highly charged ion clock. In addition, transitions in Ir^{17+}, first proposed as a clock candidate in [2], are being studied using the Heidelberg Electron Beam Ion Trap. We will report on the experimental progress and the implications for a functional clock.

References

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