QED theory of isotope shift

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The isotope shift is defined as the difference of the transition frequencies of different isotopes of the same element, averaged over all fine and hyperfine sublevels. A remarkable feature of the isotope shift is that the relative contribution of the finite nuclear size effect to it is much larger than that to the transition energies. Because of this, the isotope shift is particularly suitable for determination of the nuclear charge radii differences. Theoretical description of the isotope shift is simpler in comparison to the energy levels since only restricted set of operators contribute to it [1].

Interestingly, conflicting results for the nuclear charge radii differences were obtained from various transitions and experiments [2]. Namely, the helion-alpha particle charge radii differences obtained from ordinary and muonic helium were in 3.6σ disagreement with each other [3, 4]. Recently, it was pointed out that the second-order hyperfine correction was underestimated and the mixing with higher excited states brought the two results into a better agreement [5]. In our paper [6] we calculated the complete second-order hyperfine correction and shown that the results from ordinary and muonic helium are in very good agreement. Here, we will present these results and the current status of QED theory of isotope shift.

References

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