# Precision spectroscopy of transitions from the metastable 2 $^3S_1$ state of $^4$He to high *n*p Rydberg states

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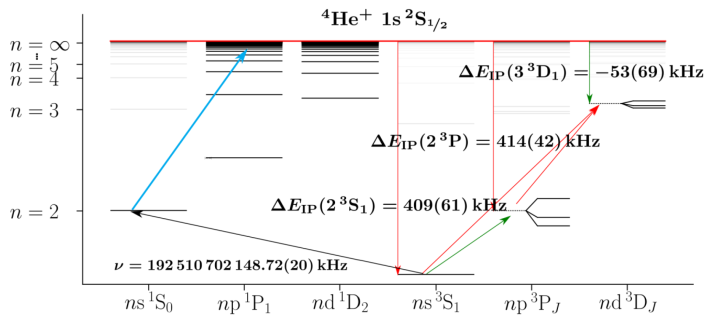
The metastable He ($(1s)^1(2s)^1$) atom in its singlet ($^1S_0$) or triplet ($^3S_1$) states is an ideal system to perform tests of *ab-initio* calculations of two-electron systems that include quantum-electrodynamics and nuclear finite-size effects. The recent determination of the ionization energy of the metastable 2 $^1S_0$ state of $^4$He [1] confirmed a discrepancy between the latest theoretical values of the Lamb shifts in low-lying electronic states of triplet helium [2] and the measured 3 $^3$D ← 2 $^3S_1$ [3] and 3 $^3$D ← 2 $^3$P [4] transition frequencies. This discrepancy could not be resolved in the latest calculations [5,6].
Currently, we focus on the development of a new experimental method for the determination of the ionization energy of the 2 $^3S_1$ state of $^4$He via the measurement of transitions from the 2 $^3S_1$ state to *n*p Rydberg states. Extrapolation of the *n*p series yields the ionization energy with sub-MHz accuracy.
In this poster, we present the progress in the development of our experimental setup, which involves (i) the preparation of a cold, supersonic expansion of helium atoms in the 2$^3$S state, (ii) the development and characterization of a laser system for driving the transitions to the np Rydberg states and (iii) the implementation of a new sub-Doppler, background-free detection method. We present this new spectroscopic method, with which we cancel the $^1$st-order Doppler shift and illustrate its power with a new determination of the ionization energy of 2 $^3S_1$ metastable He.

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