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Precision isotope shift measurement in decoherence-free subspace. NITZAN AKERMAN, TOM MANOVITZ, RAVID SHANIV, YOTAM SHAPIRA, ROEE OZERI, Physics of complex systems, Weizmann institute of science — Precision spectroscopies of atomic systems are playing an important role in the testing of fundamental physics. Recently, it was suggested to use linear King plots as bounds on new physics [arXiv:1704.05068]. This proposal calls for precision isotope shift spectroscopy of narrow optical transitions. To date, the best King plot were measured with precision on the order of 1 kHz and only very few isotope shift were measured at the Hz level. Here, we present a simple scheme to measure the isotope shift with milli-Hz precision level. Instead of measuring the absolute transition frequency for each of the isotopes separately, we extract only the shift by measuring the parity oscillations of two isotopes that were prepared in a decoherence-free subspace i.e. $\mathrm{S_A D_B} + \mathrm{D_A S_B}$. Interestingly, uncorrelated state can be use as well with a penalty of reducing the parity contrast by a factor of two. We demonstrate this method on the quadrupole transition $\mathrm{S}_{1/2}$ - $\mathrm{D}_{5/2}$ in Sr^+ isotopes. Our measurement improves by six orders of magnitude over the previous measurement of this transition and forms one of most precise isotope shift measurement of optical transition. Our method can be easily implemented in existing setups of Ca^+ and Yb^+ ions which have enough stable isotope (without nuclear spin) to test King linearity to the sub-Hz level.

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