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Precision Spectroscopy of Trapped Yb^+ in Search for Dark Matter

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Recently it has been proposed to search for particles outside the Standard Model (SM) in an intermediate mass range (100 eV to 100 MeV) by means of precision isotope shift spectroscopy on narrow optical transitions. We perform such measurements on two quadrupole S→D transitions and one octupole S→F transition for five bosonic isotopes of Yb^+ with an accuracy below 1kHz, and observe nonlinearities in the corresponding King plots. Such a nonlinearity can indicate physics beyond the SM, or higher-order effects within the SM. Our data indicate that there are at least two distinct sources of nonlinearity. We identify the second-order field shift as the leading-order effect within the SM for Yb^+, and discuss possibilities for the other source of nonlinearity. In the future, more precise measurements on more transitions available for Yb^+ and Yb, in combination with improved electronic-structure calculations, can be used to distinguish between effects within and outside the SM.

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