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New ideas for tests of Lorentz invariance with atomic systems RAVID SHANIV, ROEE OZERI, Weizmann Institute of Science, MARIANNA SAFRONOVA, Univ. of Delaware, Joint Quantum Institute, NIST, Univ. of Maryland, SERGEY PORSEV, University of New South Wales; Petersburg Nuclear Physics Institute, VLADIMIR DZUBA, VICTOR FLAMBAUM, University of New South Wales, HARTMUT HAEFFNER, University of California — Searches for new physical laws beyond the standard model are of a large and still increasing interest. One avenue of research is searching for Local Lorentz Invariance (LLI) violation, and in particular, the invariance of experimental results to rotations in space. Theory suggests that a possible outcome of LLI violation is an atomic energy shift that depends on the direction of its quantization axis. However, this effect might be very small and overshadowed by typical experimental noise, mainly magnetic field drifts. Here we propose a broadly applicable experimental scheme to search for LLI violation. The scheme involves radio frequency dynamical decoupling pulses aimed at mitigating unwanted experimental noise while maintaining the desired signal. The scheme can be implemented in current atomic-clock experiments, both with single ions and arrays of neutral atoms. Furthermore, it applies for atomic systems that exhibit no optical transitions such as highly charged ions, which exhibit particularly high sensitivity to LLI violation. We demonstrate the scheme experimentally using a string of two $^{88}Sr^{+}$ ions and confirm that terms sensitive to LLI violations can be detected while rejecting magnetic field noise.

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