Tests of Lorentz Symmetry with Entangled Ions

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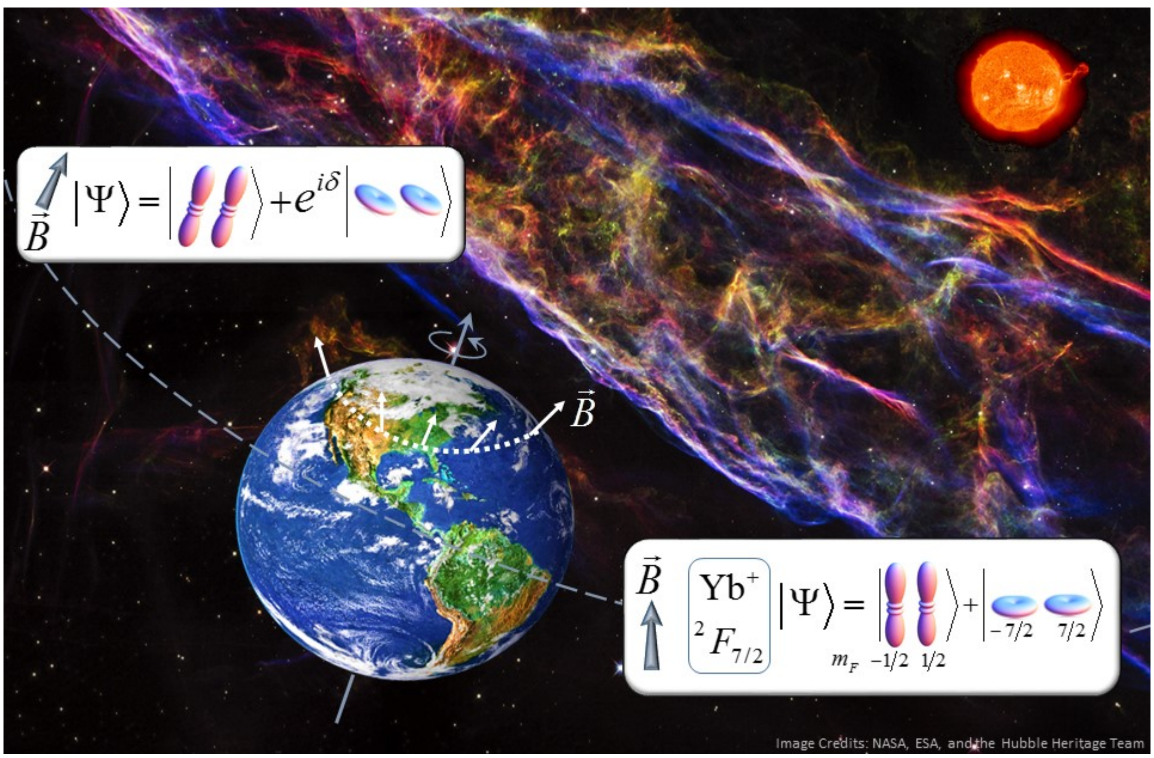
Lorentz symmetry is one of the cornerstones of modern physics. However, a number of theories aiming at unifying gravity with other fundamental interactions including string field theory suggest violation of Lorentz symmetry. While the energy scale of such strongly Lorentz symmetry-violating physics is much higher than that currently attainable by particle accelerators, Lorentz violation (LV) may nevertheless be detectable via precision measurements at low energies. I will present an overview of such tests with atomic systems, describing the most recent experiment with trapped Ca^+ ions [1] in more detail. I will report results of our new systematic study of LV sensitivities in atoms and ions that identified ytterbium ion as an ideal system with high sensitivity as well as excellent experimental controllability. By applying quantum information inspired technology to Yb^+, we expect tests of LLI violating physics in the electron-photon sector to reach levels of 10^{-23} [2] , five orders of magnitude more sensitive than the current best bounds. Similar sensitivities may be also reached with highly-charged ions.



[1] *A Michelson-Morley Test of Lorentz Symmetry for Electrons*, T. Pruttivarasin, M. Ramm, S. G. Porsev, I. I. Tupitsyn, M. Safronova, M. A. Hohensee, and H. Häffner, Nature 517, 592 (2015).

[2] *Strongly enhanced effects of Lorentz symmetry violation in entangled Yb+ ions*, V. A. Dzuba, V. V. Flambaum, M. S. Safronova, S. G. Porsev, T. Pruttivarasin, M. A. Hohensee, and H. Häffner, arXiv:1507.06048, Nature Physics, in press, (2015).