Simulations of a Muonium Atom Interferometer with Light Pulses

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Interferometers using the wave nature of atoms are powerful tools for precisely measuring interactions acting on atoms and fundamental physical constants. Atom interferometers are constructed similarly to optical ones, using components that split and reflect atomic wave packets. The methods for configuring beam splitters and mirrors can be categorized into mechanical gratings and standing light waves. These interferometers have been realized in various forms for ordinary atoms, ranging from thermal atomic beams to cooled atoms, and are employed in high-precision measurements of physical constants and searches for physics beyond the Standard Model. Muonium, a hydrogen-like atom composed of a positive muon and an electron, has played a unique role in the precise testing of quantum electrodynamics and the search for new physics through precision spectroscopy. If an interferometer using muonium can be realized, it could open up a new frontier of higher precision beyond spectroscopy. We have proposed a new experiment to determine the muon's mass from the photo recoil shift in a Ramsey-Bordé interferometer using a slow muonium atomic beam and quantum state manipulation with a series of light pulses [1]. We have studied on the generation and transport of low-energy muons [2] and the focusing of muonium atomic beams [3]. In this presentation, we report the results obtained from numerical feasibility studies of a muonium atom interferometer using light pulses.

References

[1] S. Kanda, J. of Phys.: Conf. Ser. 2462, 012029 (2023).
[2] S. Kanda et al., J. Phys.: Conf. Ser., 2462, 012030 (2023).
[3] S. Kanda, Hyperfine Interact 245, 78 (2024).