Testing Lorentz Invariance with Beta Decay

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Overview

Looking for these violations can give insight to gravity
These violations can modify the rate of beta decay
By measuring decay over many days a bound can be put on these violations
There has been an experiment which give variations on the rate at most on the order of 10^{-3}

Theoretical Framework

A calculation of beta decay parameters can be carried out with the assumption that Lorentz symmetry is violated
This manifests as a small variation in the decay rate, which has a frequency equal to the Earth's rotational frequency.
There are different terms that modify Fermi transitions (transitions where there is no angular momentum change) and Gamow-Teller transitions (which can cause an angular momentum change).
Polarizing the parent nuclei allows the measurement of more parameters that would have to have been averaged over otherwise

Experimental Results

One test was carried out using ^{20}Na beta decay. It undergoes a Gamow-Teller transitions with a half-life of .45 s.
To put a bound on any Lorentz violation, the nuclear spins were polarized with a laser. This polarization was measured by looking at the β asymmetry.
Then, this polarization was reversed, and any shifts in the decay rate was measured.

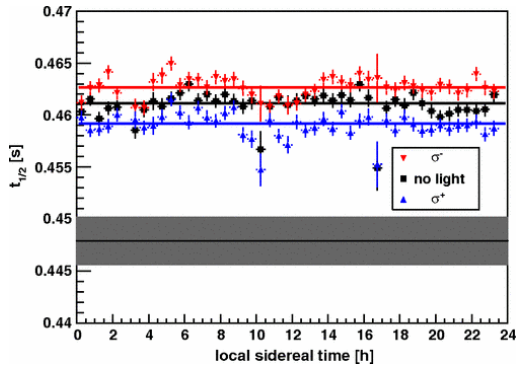

Figure: This shows the lifetimes of different polarization states. The light refers to the laser that was used to polarize the atoms.

From all this, bounds were put on multiple parameters. The bound on the dependence of the rotation of the Earth of $3 * 10^{-3}$ at a 95% confidence interval.

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