

Determination of the muon magnetic moment

Muons are long-lived particle, produced in the decays of pions and kaons originating from the interactions of primary cosmic rays with the Earth's atmosphere. Muons decay via weak interactions and, according to [1], their lifetime is

$$2.1969811 \pm 0.0000022 \mu\text{s}$$

Moreover, parity violation is also present in the decay which proceeds as follow:

$$\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu \quad \text{and} \quad \mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$$

According to [2] and [3], simple experiments can be performed measuring muons that decay in a thick absorber. If the absorber is immersed in a constant magnetic field, the muon spin, before the decay, proceeds with a frequency

$$\omega = g_\mu \frac{eB}{2m_\mu c}$$

The decay proceeds mainly along the direction of the spin of the muon and therefore, if the muon is (partly) polarized, the detected signal varies with time with ω , spin precession angular frequency.

Analyzing the data collected without and with the magnetic field, setup a Markov Chain Monte Carlo that allows to extract the muon lifetime τ_μ (B off) and the muon precession frequency ω (B on).

Further details on the apparatus and measurement principle can be found in [2] and [3].

Bibliography

- [1] S. Navas *et al.*, (Particle Data Group), Phys. Rev. D 110 (2024) 03001
<https://pdglive.lbl.gov/Particle.action?node=S004&init=0>
- [2] C. Amsler, *The determination of the muon magnetic moment from cosmic rays*, American Journal of Physics, 42 (1974) 12.
- [3] D. Bosnar *emphet al.*, *A simple setup for the determination of the cosmic muon magnetic moment*, American Journal of Physics, 90 (2022) 8