Relationship between the spin g-factor of the electron and the proton mass

Shan-Hong Li

Email: duke3366@163.com

(Septermber 08, 2022)

Abstract

A simple formula is found in this paper, which shows that the magnetic moment of the electron is related to the mass of the proton and also to the mass of the tau.

Introduction

This simple formula, we found that its initial form is as follows

$$g_e \frac{m_e}{2m_\tau} + g_e \frac{m_e}{m_p} = 0.00137841605 \tag{1}$$

g_e is the spin g-factor of the electron. m_e is the mass of the electron. m_p is the mass of the proton. m_τ is the mass of the tau, and $m_\tau = 1776.86\, MeV/c^2$ [1].

The ratio of the mass difference between neutron and proton to the mass of proton is as follows:

$$\frac{m_n - m_p}{m_p} = \frac{m_n}{m_p} - 1 = 0.00137841931 \tag{2}$$

m_n is the mass of the neutron. $m_n/m_p = 1.00137841931$, which is a recommended value for 2018 CODATA. Comparing Equation (1) with Equation (2), it can be seen that their values are very similar. We assume that Equation (1) is equal to Equation (2), then there is:

$$g_e \frac{m_e}{2m_\tau} + g_e \frac{m_e}{m_p} = \frac{m_n - m_p}{m_p} \tag{3}$$

Since the calculation accuracy of Equation (3) is not very high, we make a slight change to Equation (3), as follows:

$$\frac{g_e g_\tau}{2g_\mu}\frac{m_e}{m_\tau}+g_e\frac{m_e}{m_p}=\frac{m_n-m_p}{m_p} \quad (4)$$

g_τ is the spin g-factor of the tau. $g_\tau = 2 \times 1.00117721$, and it is a theoretical value [2]. g_μ It is the spin g-factor of the muon. The calculation result on the left side of Equation (4) is 0.001378419297. Compared with the result of Equation (2), it can be found that their difference is very small.

Due to the low accuracy of the mass of the tau, and the spin g-factor of the tau is only a theoretical value, they have a great influence on the result of Equation (4). If their influence is taken into account, Equation (4) may always hold.

References

[1] https://en.m.wikipedia.org/wiki/Tau_(particle)

[2] arXiv: hep-ph/0702026v1