The Fine Structure Constant and Electron (g-2) Factor: Questions

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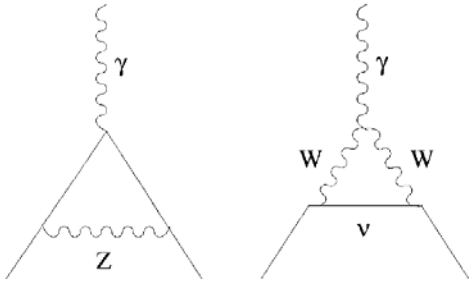
1. ***What processes are responsible for the $a_{\mu\tau}$, a_{weak}, and $a_{hadronic}$ terms in the anomalous magnetic moment expansion? [Slide 6]***

   $a_{\mu\tau}$ comes from Feynman diagrams that include virtual μ and τ particles, for example a μ+anti-μ pair creation/annihilation. Since the masses of the μ and τ are around 200 and 3500 times the electron mass (respectively), these terms are very small compared to the QED expansion.

   a_{weak} is from Feynman diagrams involving virtual exchange of weak gauge bosons, such as the following:



   Lastly, $a_{hadronic}$ is from Feynman diagrams involving virtual hadrons.

2. ***Which fields in the Penning Trap cause the cyclotron, axial, and magnetron motions?***

   The cyclotron motion (and spin precession) are caused by the axial magnetic field, while the axial and magnetron motions are caused by the quadrupole electric field.

3. ***What is the constant δ in the energy levels? [Slides 15,16]***

   The third term in the expression for $E(n,m_s)$ is the leading relativistic correction to the energy levels, and δ is defined as

$$\frac{\delta}{\upsilon_c} = \frac{h\upsilon_c}{mc^2} \approx 10^{-9}$$

   Where $\nu_c = eB/(2\pi m)$ is the classical electron cyclotron frequency.

4. ***Is this the most accurate experimental result in all of history?***

   This is a difficult question to interpret. One possible answer is no, because differences between atomic clocks can be measured to greater accuracy than this measurement. As far as a measurement of a constant of nature, it is among the most accurate: looking at the Particle Data Group table of constants, only the electron/proton mass ratio is known to greater precision. However, this is still not an absolute measurement but instead a comparison. As far as absolute measurements, this is likely to be the most accurate ever.