12. **Since hydrogen is a stable atom, why does positronium decay?**

Positronium is a system of an electron orbiting its antiparticle, a positron, which exists for approximately 10^{-10} s before annihilating into 2 photons. This reaction is likely because when matter and antimatter interact the result is annihilation. Hydrogen atoms consist of protons and electrons which are not antiparticles of each other, so they are "stable" against annihilation. Protons and electrons can annihilate each other in the reaction

$$p + e^- \rightarrow n + \nu_e,$$

which is endothermic and requires more than 13.7 eV, the ground state energy of the electron, to occur. Hydrogen requires external energy to "decay" so it a stable atom. The above reaction is similar to the neutron decay reaction $n \rightarrow p + e^- + \bar{\nu}_e$, which is exothermic and occurs naturally, with a half-life of 10 minutes.

NOTE: These two reactions can be obtained from each other by replacing each particle by its antiparticle when it is moved to the opposite side of the reaction.

— Rick Burges

13. **Where are the other dimensions that string theory predicts?** The extra dimensions that string theory predicts cannot be readily explained. The number of spacetime dimensions varies from 10 dimensions to 26 for the various string theories. Some scientists explain these dimensions as "rolled up" dimensions. This concept cannot be comprehended with the spatial recognition humans perceive. In truth, no answer can explain these extra dimensions in satisfactory terms, nor can the existence of these extra dimensions be verified experimentally. These extra dimensions seem to be a convenient way to make the mathematics work out.

Therefore, why is string theory so popular if it has not yet predicted any experimental result? Currently, gravity is the only fundamental force that has not been described quantum mechanically. One possible reason is that it is the weakest of all the forces (strong, weak, and electromagnetic), and these other forces have been "quantized." String theory is one attempt to unify gravity (that is, general relativity) and quantum mechanics, and this accounts for its popularity. If string theory is successful, a byproduct may be a unification of all the fundamental forces, a"theory of everything."

— Dean White