UNIVERSITÄT LEIPZIG

Experimental Physics IV IPSP

Bonus Problem Set

Problem 32: 0 points

Look up the solution for the bound state for the δ-potential well (Problem 26). Now, assume a double δ-potential

$$V(x) = -g\left(\delta\left(x+\frac{d}{2}\right)+\delta\left(x-\frac{d}{2}\right)\right).$$

Use simple physical arguments[1] and an ansatz to obtain a qualitative solution for this problem.

Problem 33: 0 points

Show, that the annihilation of an electron and a positron into a single photon in free space ($e^-e^+ \rightarrow \gamma$) violates the energy and/or momentum conservation.

How many photons do you need (at least) for this decay if the spin of the electron and positron are

a) anti-parallel ↑↓ ?
b) parallel ↑↑ ,

Use this to explain why positronium ("atom" which consists of an electron and positron) has two different lifetimes ($\tau_1 \approx 140\,\mathrm{ns}$, $\tau_2 \approx 125\,\mathrm{ps}$). Which annihilation corresponds to τ_1 and τ_2, respectively?

[1] John Archibald Wheeler's First Moral Principle: *Never make a calculation until you know the answer. Make an estimate before every calculation, try a simple physical argument (symmetry! invariance! conservation!) before every derivation, guess the answer to every puzzle.*