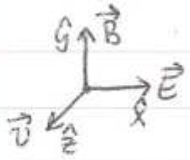
Homework #1 Solutions

Griffiths 1.1 (14 points)



this arrangement of perpendicular fields creates opposing forces

for a positive particle, the forces are:

(for a negative particle, the forces are switched)

for the particle to be undeflected, the magnitude of the two forces should be equal

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B}) = 0$$

$$= q(E\hat{x} + vB(-\hat{x})) \rightarrow qE\hat{x} = qvB\hat{x} \rightarrow$$

$$\boxed{v = \frac{E}{B}}$$

the force due to a magnetic field alone provides centripetal acceleration

$$\vec{F}_B = q\vec{v} \times \vec{B} = \frac{mv^2}{R} \rightarrow \boxed{\frac{q}{m} = \frac{v}{BR}}$$

or, using $v = E/B$,

$$\boxed{\frac{q}{m} = \frac{E}{B^2 R}}$$

Griffiths 1.3 (14 points)

the minimum momentum of an electron in the nucleus is set by the uncertainty in its position

$$\Delta x \Delta p \geq \frac{\hbar}{2} \rightarrow \Delta p = \frac{(1\times10^{-34}\ kg\,m^2/s)}{2(10^{-15}\ m)}$$

$$\boxed{p = 5\times10^{-20}\ kg\,m/s}$$

this is plugged into the equation for energy

$$E^2 = m^2c^4 + p^2c^2$$

$$E = \sqrt{(9.1\times10^{-31}\ kg)^2(3\times10^8\ m/s)^4 + (5\times10^{-20}\ kg\,m/s)^2(3\times10^8\ m/s)^2}$$

$$= 1.5\times10^{-11}\ J = \boxed{100\ MeV}$$

the figure shows virtually no electrons from beta decay over 20 keV, so it is impossible for them to be from the nucleus

Griffiths 1.10 (12 points)

the particles to unambiguously survive are:

$$\boxed{K_1^*,\ K_1,\ \omega,\ \rho,\ \eta}$$

the K_1^* is now called K^*, and K_1 is now ϕ

a more complete chart is also posted

meson	mass	status	exotic	meson	mass	status	exotic
π	138	π		ρ	755	$\rho(770)$	
K	496	K		ρ_2	780	$f_0(600)$?	
K_3	1630	dead	yes	ρ_1	720	$f_0(600)$?	
χ_2	1340	$f_0(1370)$?		ψ_4	760	dead	yes
κ_3	1275	$f_1(1285)$?		K_1^{**}	730	dead	
K^{**}	1260	$K_1(1270)$?		δ	645	dead	
f	1253	$f_2(1270)$?		α	625	dead	
K_5^*	1150	dead	yes	ψ_3	597	dead	yes
χ_1	1045	$a_0(980)$?		ζ	556	dead	
κ_2	1040	dead		η	549	η	
κ_1	1020	$\phi(1020)$		φ_2	520	dead	
ψ_5	990	dead	yes	ψ_2	440	dead	yes
K_1^*	888	$K^*(892)$		φ_1	395	dead	
φ_3	885	$\eta'(985)$?		ψ_1	330	dead	yes
ω	781	$\omega(782)$		ω_{ABC}	317	dead	