Midterm 2 Dez Reed

1) Std Model +3

spin 0
H Higgs

Quarks

spin ½ { e, μ, τ
spin ~~½~~ ½ { ν_e, ν_μ, ν_τ
Leptons

γ
g
W
Z
spin 1
Bosons (gauge)

u c t
d s b
spin ~~½~~ ½

2) W and Z bosons are massive, while the γ is not. +1
strong force?

3) 2 ways for $WZ \rightarrow \ell\nu\nu\nu$ +2

Decays one of 4 quarks * ~~3 colors~~ * 3 generations = 36 quark decays

$\frac{2 \text{ decays}}{38 \text{ decays}} = \frac{1}{19}$ as approx rate of $\ell\nu\nu\nu$ decay

4) We know from class that a W decays as $\ell\nu \approx \frac{2}{17}$ br, ? $\frac{2}{9}$ +1

Assuming the Ws do not influence each other through some spooky action

$\frac{2}{17} \cdot \frac{2}{17} = \frac{4}{17^2}$ br

$Z \rightarrow \ell\ell$ should happen about ½ the time so br is $\frac{1}{4}$ for $ZZ \rightarrow \ell\ell\ell'\ell'$? $\frac{2}{21}$

Then the total of signalling events is

$\frac{4}{17^2} \cdot 20\% + \frac{1}{4} \cdot 3\% = \frac{4}{17^2 \cdot 5} + \frac{3}{400} \approx \frac{8}{400} = 2\%$ of events

Ranking?

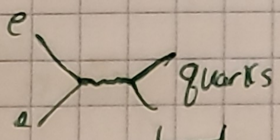
5) a) synchrotron radiation energy loss → helped with better magnets/ larger ring size +3

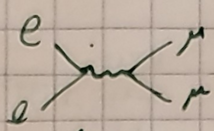
b) even worse synchrotron radiation

6) a) $R(E_{CM}) \equiv \sigma(ee \to jets)/\sigma(ee \to \mu\mu)$ changes

+2

$ee \to jets$





$ee \to \mu\mu$

$3 \cdot 2 = 6$ possibilities

$3 \times 3 \times Q^2$

1 way

$< 2m_{charm}$: $\frac{6}{1}$ $> 2m_{charm}$: $\frac{9}{1}$ since extra gen means 3 new decays

Sketch?

7) a) both interact with tracking detectors. μ, e are of different mass so we expect μ to keep more momentum as it interacts +3

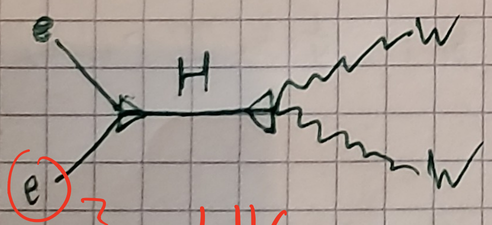
b) both hit the ionizing calorimeter at the end; photon not tracked until it hits.

8) Hadronic. Harder to track position before calorimeter. +1

9) $X \to \mu\mu$, since the tracking will be steadier and we'll understand trajectory/momentum better. +1

10) With difficulty. We have to figure out where we're missing some KE that we wouldn't be without losing the ν, but a ν is tiny. +1

11) a)



? LHC

b)

+0

12) $H \to ee$, on the grounds that it happens way more often +1

less often

13) +0

14) a) A particle breaks symmetry when its Lagrangian's sign is wrong relative to the potential term and so it selects a value of ϕ that rests on a nearby 0-point (like the toy model from lecture). This is "spontaneous symmetry breaking" in that a symm. Lagrangian will see particles forced to pick a side rather than act symmetrically.

b) Why the weak ~~force~~ is chiral (notices parity)

c) Electrons from W-decay all share a handedness even though w/o breaking they would be even-split.

+2