

FINAL EXAM PHY 2408

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TAKE HOME EXAM.

START TIME: APRIL 25 9:00

END TIME: APRIL 28 12:00

HAND-IN EXAMS IN MP-803

THERE ARE 5 QUESTIONS WORTH 20 POINTS EACH

→ do the exam by yourself

→ use only course books (see page 3 of lecture 1) and course notes

* → provide detailed calculations

QUESTION #1

CALCULATE THE WIDTH OF THE TOP QUARK

→ YOU CAN NEGLECT FERMION MASSES
(BUT NOT M_{top} !)

QUESTION #2

(2)

CALCULATE $\sigma(e^+e^- \rightarrow Z^0H)$

→ THIS "HIGGSSTRAHLUNG" PROCESS WAS USED TO SET THE CURRENT HIGGS MASS LIMITS AT LEP II

QUESTION #3

CONSIDER THE ELASTIC SCATTERING OF NEUTRINOS OFF OF ELECTRONS: $\nu_e + e^- \rightarrow \nu_e + e^-$

A) LET θ_e BE THE ANGLE OF THE ELECTRON WITH RESPECT TO THE NEUTRINO BEAM. GIVE AN EXPRESSION FOR $\sin^2 \theta_e$ IN TERMS OF m_e , T_e , E_ν (T_e IS THE ENERGY OF THE ELECTRON IN THE FINAL STATE)

B) COMMENT ON HOW WELL THE INCOMING NEUTRINO DIRECTION CAN BE RECONSTRUCTED IF THE NEUTRINOS COME FROM THE SUN OR A SUPERNOVA AND HAVE ENERGIES $\sim 7-15$ MEV. SUPPOSE THAT T_e MUST BE > 5 MEV FOR YOU TO DETECT THE ELECTRONS.

QUESTION 4

(3)

- A) CALCULATE $\Gamma(\gamma \rightarrow \mu\nu)$
B) CALCULATE $\Gamma(\gamma \rightarrow \pi\nu)$

NOTE: $\mathcal{L}_{\text{eff}} = \frac{G_F}{\sqrt{2}} V_{ud} [\bar{d}\gamma^\mu(1-\gamma_5)u] [\bar{\nu}\gamma_\mu(1-\gamma_5)\nu]$

$$M = G_F V_{ud} F_q^* q^\mu \bar{\nu}_i \gamma_\mu (K) \gamma_\mu (1-\gamma_5) \nu_j(p)$$

WHERE 1 USED: $\langle \pi(q) | \bar{d}\gamma^\mu \gamma_5 u | 0 \rangle = i\sqrt{2} q_\mu F_\pi$
 $q = p - k$

QUESTION 5

WE DISCUSSED IN CLASS THE PROCESS $e^+e^- \rightarrow q\bar{q}$ STARTING FROM SCRATCH, SHOW THAT:

$$\frac{d^2\sigma}{dx_1 dx_2} = \frac{4\pi\alpha^2}{3s} \cdot 8e_q^2 \cdot \frac{ds}{2\pi} \left[\frac{x_1^2 + x_2^2}{(1-x_1)(1-x_2)} \right]$$

→ PROVIDE A DETAILED DERIVATION

→ MANY OF THE CALCULATION'S STEPS ARE IN HALZEN - MARTIN

— END OF EXAM —