

Title: Particle Physics 6

Date: Jun 08, 2006 11:40 AM

URL: <http://pirsa.org/06060011>

Abstract:



The illustration shows a window at night with a bright light shining through the panes. A person in a blue dress is looking out the window, and a small orange bucket is on the floor in front of the window.

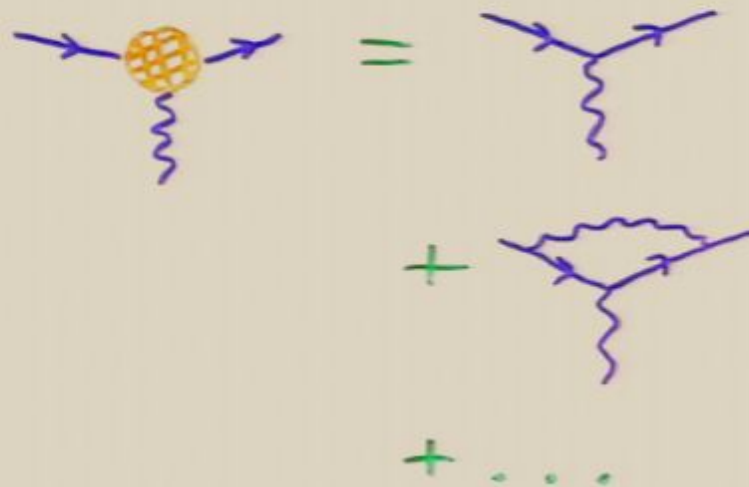


"Sure been a heap more work for ME around here since those Biologists got granted research time on the ol' Supercollider..."

STANDARD
MODEL

↓ (usually)

PERTURBATIVE
Q.F.T.



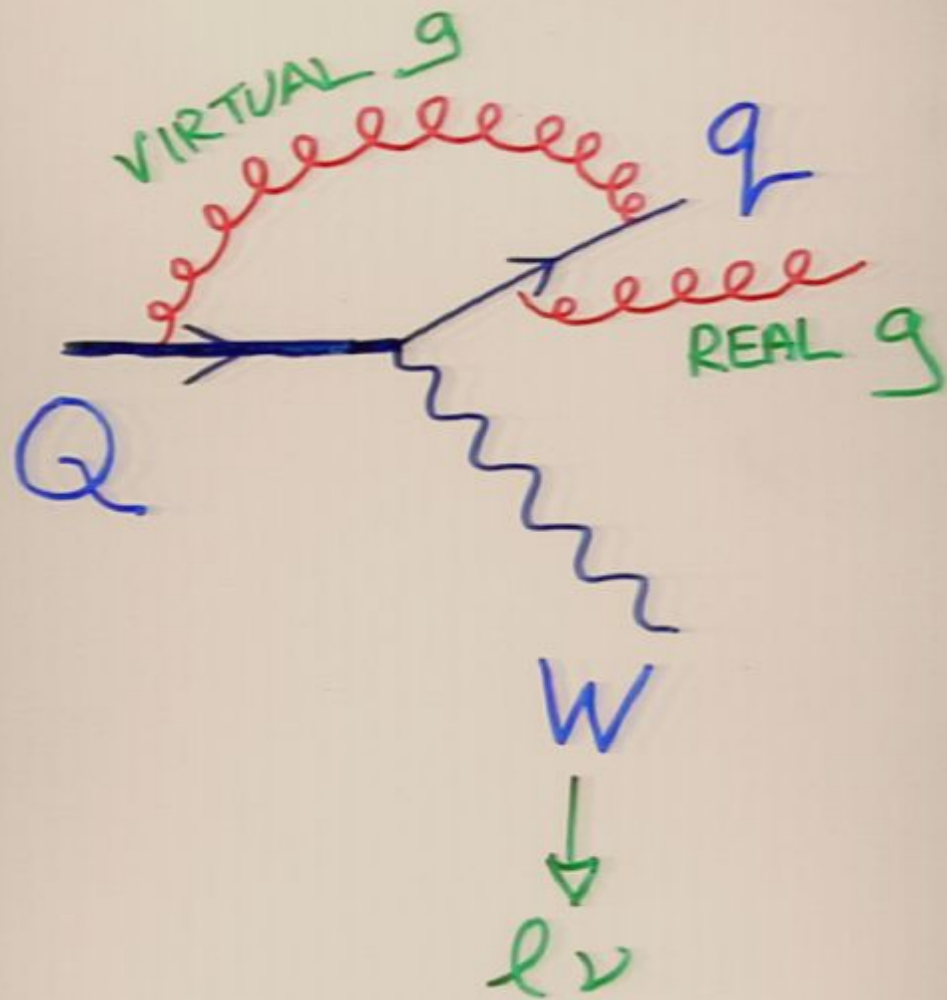
MOTIVATIONS

1 - THEORY SUPPORT FOR
EXPERIMENT
(E.G. CKM MEASUREMENTS)

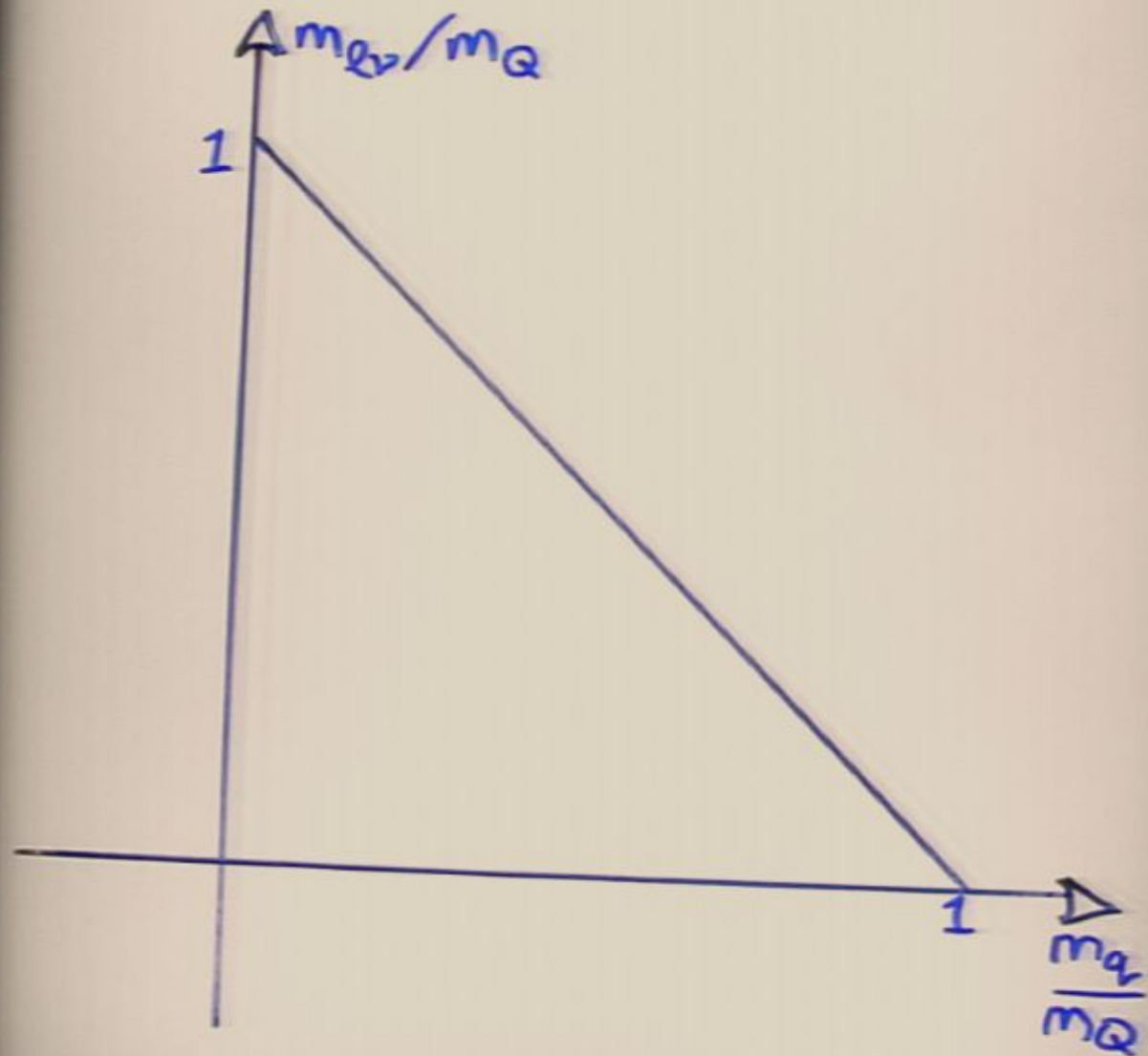
2 - NEW PHYSICS?

3 - STRATEGIC,
MATHEMATICAL,
& COMPUTATIONAL
ADVANCES

+Q : D



KINEMATIC TRIANGLE



PROBLEM:

CALCULATIONS
WITH EXACT

m_q & m_{ν}

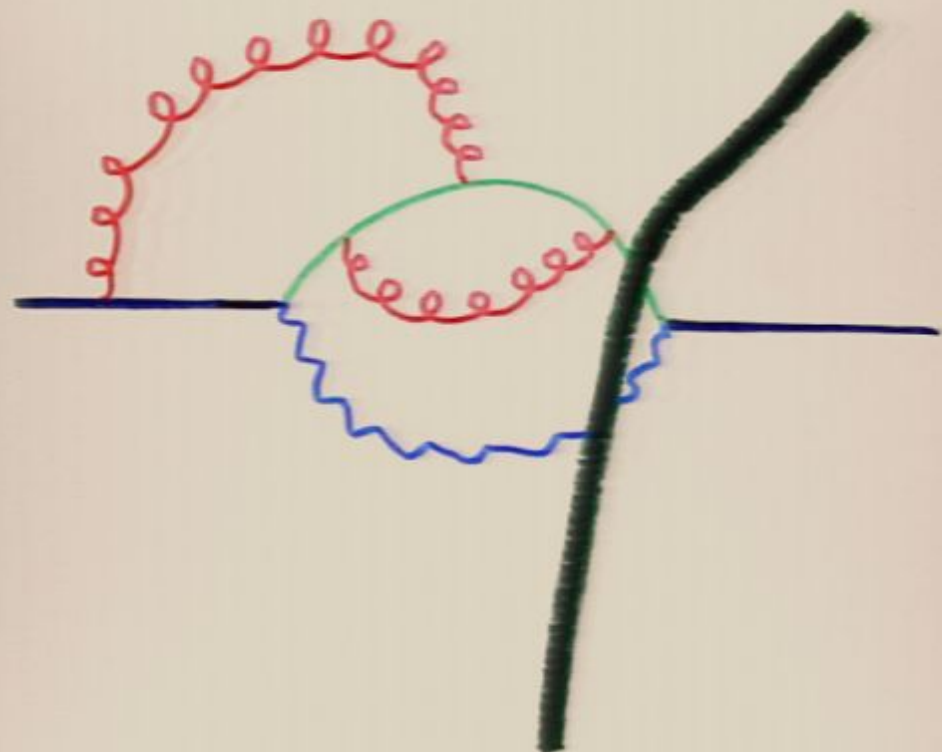
DEPENDENCE

ARE NOT

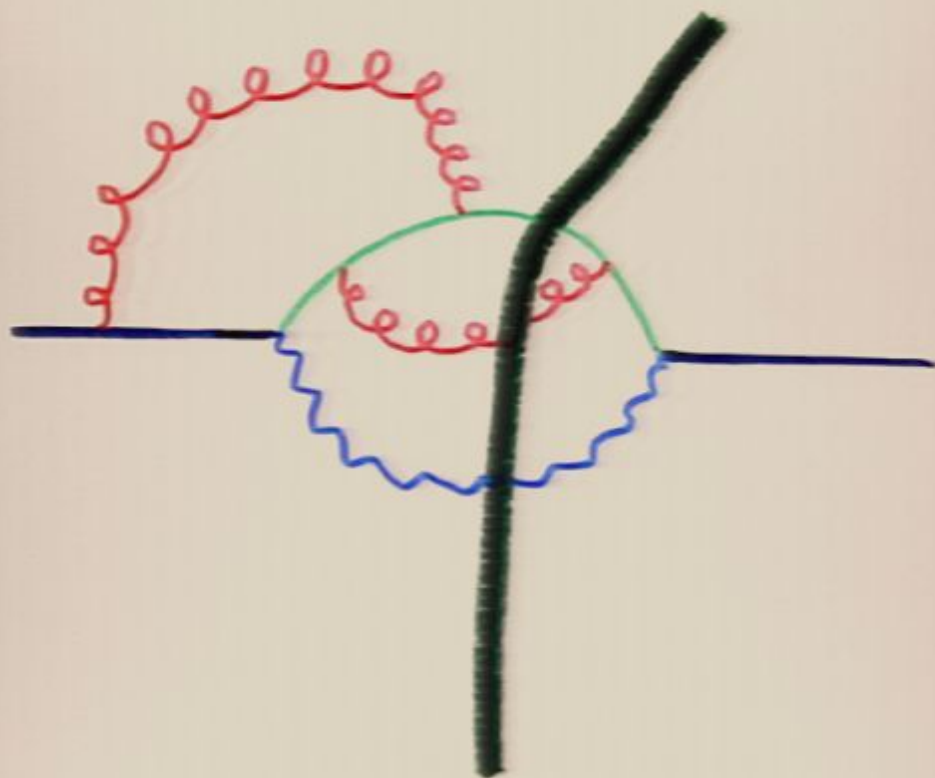
FEASIBLE

AT $O(\alpha_s^2)$

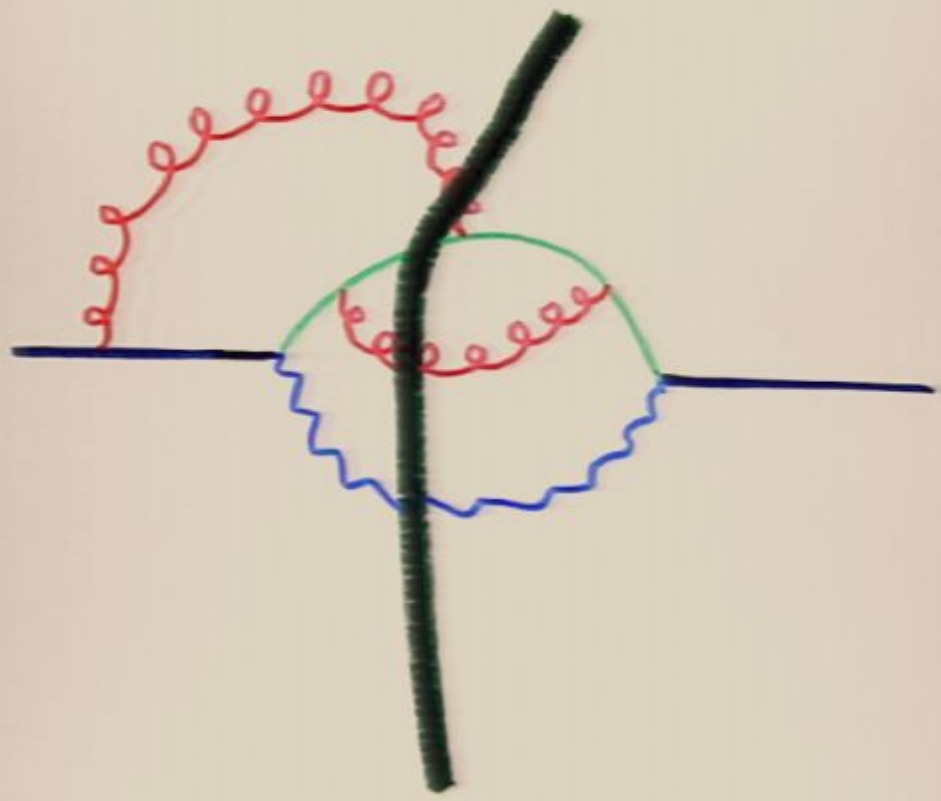
CUTS



CUTS



CUTS



FEYNDMAN RULES



LOOP INTEGRALS

E.G.

$$D = 4 - 2\epsilon$$

$$\int \frac{[d^D k_1][d^D k_2]}{(k_1^2 + m_w^2)[(k_1 + p)^2 + m_q^2]}$$

x

$$\frac{[(k_1 + k_2 + p)^2 + m_q^2][(k_2 + p)^2 + M_Q^2] k_2^2}{}$$



ASYMPTOTIC EXPANSIONS

$$\int \frac{[d^D k_1][d^D k_2]}{(\dots)}$$

→ → → → → "REGIONS"

E.G. $k \gg m$



$$\frac{1}{k^2 + m^2} \rightarrow \frac{1}{k^2} - \frac{m^2}{k^4} + \frac{m^4}{k^6} - \dots$$

⇒ SINGLE-SCALE
INTEGRALS

SAMPLE RESULT

$$\Gamma(b \rightarrow cW^*) = \frac{G_F |V_{cb}|^2 m_b^3}{8\sqrt{2} \pi}$$

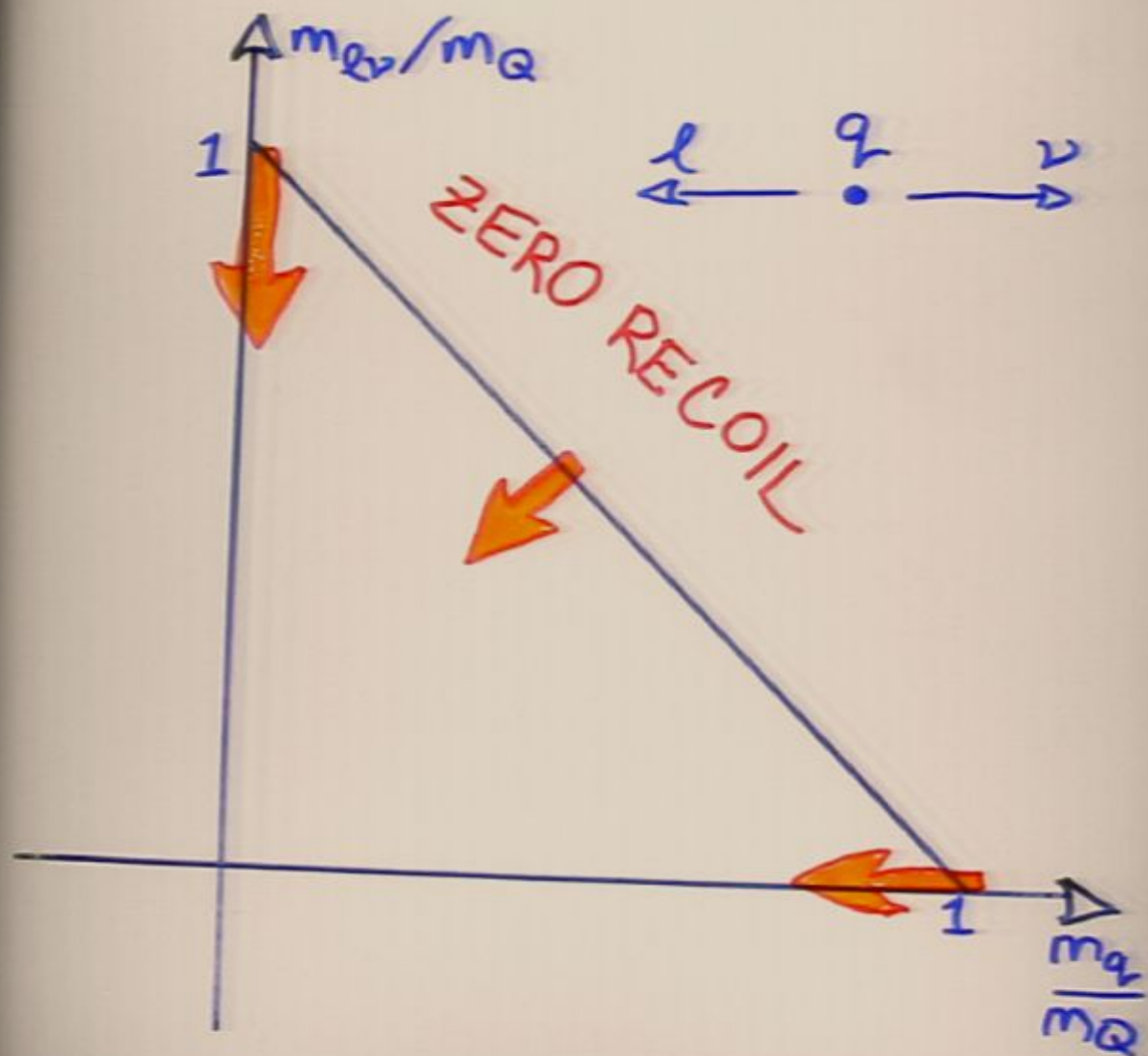
$$\times \left[X_0 + C_F \frac{\alpha_s}{\pi} X_1 + C_F \left(\frac{\alpha_s}{\pi} \right)^2 X_2 + \dots \right]$$

$$X_0 = (1 - \rho^2)^3$$

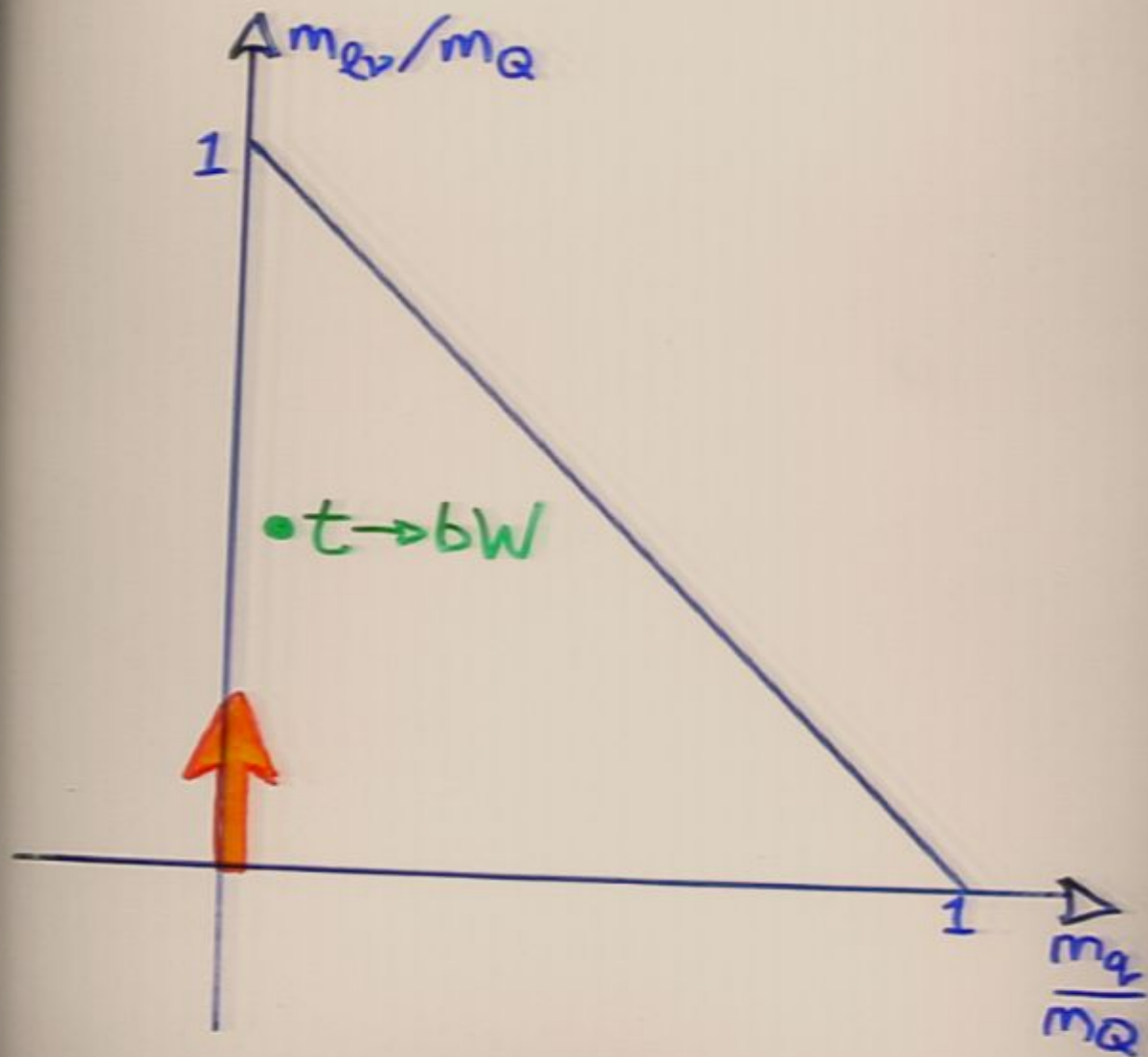
$$\rho \equiv \frac{m_c}{m_b}$$

$$X_1 = \left(\frac{5}{4} - \frac{\pi^2}{3} \right) + \left(-\frac{11}{4} + \frac{\pi^2}{3} - 9 \ln \rho \right) \rho^2 \\ + \left(\frac{1}{4} + \frac{\pi^2}{3} + 6 \ln \rho \right) \rho^4 + \dots$$

KINEMATIC TRIANGLE



KINEMATIC TRIANGLE



OTHER
APPLICATIONS
(BESIDES $t \rightarrow bW$)

$$b \rightarrow s\gamma \quad (\text{EM DIPOLE})$$

$$b \rightarrow u\ell\nu$$

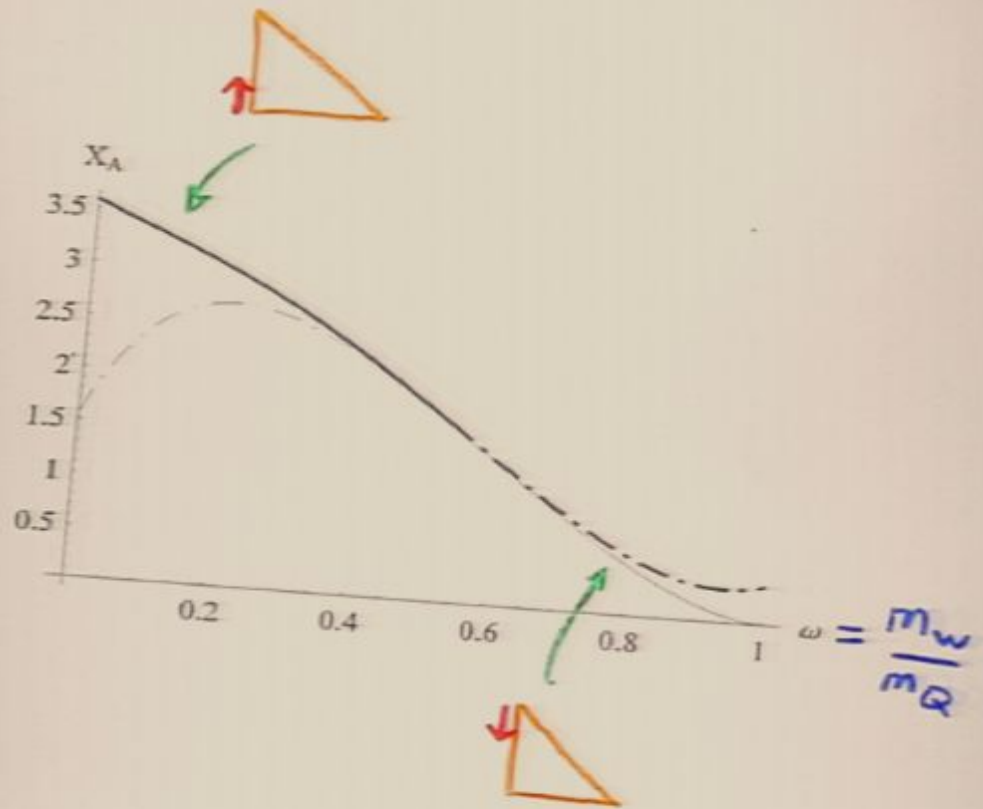
$$\mu \rightarrow e\nu\bar{\nu}$$

OTHER
APPLICATIONS
(BESIDES $t \rightarrow bW$)

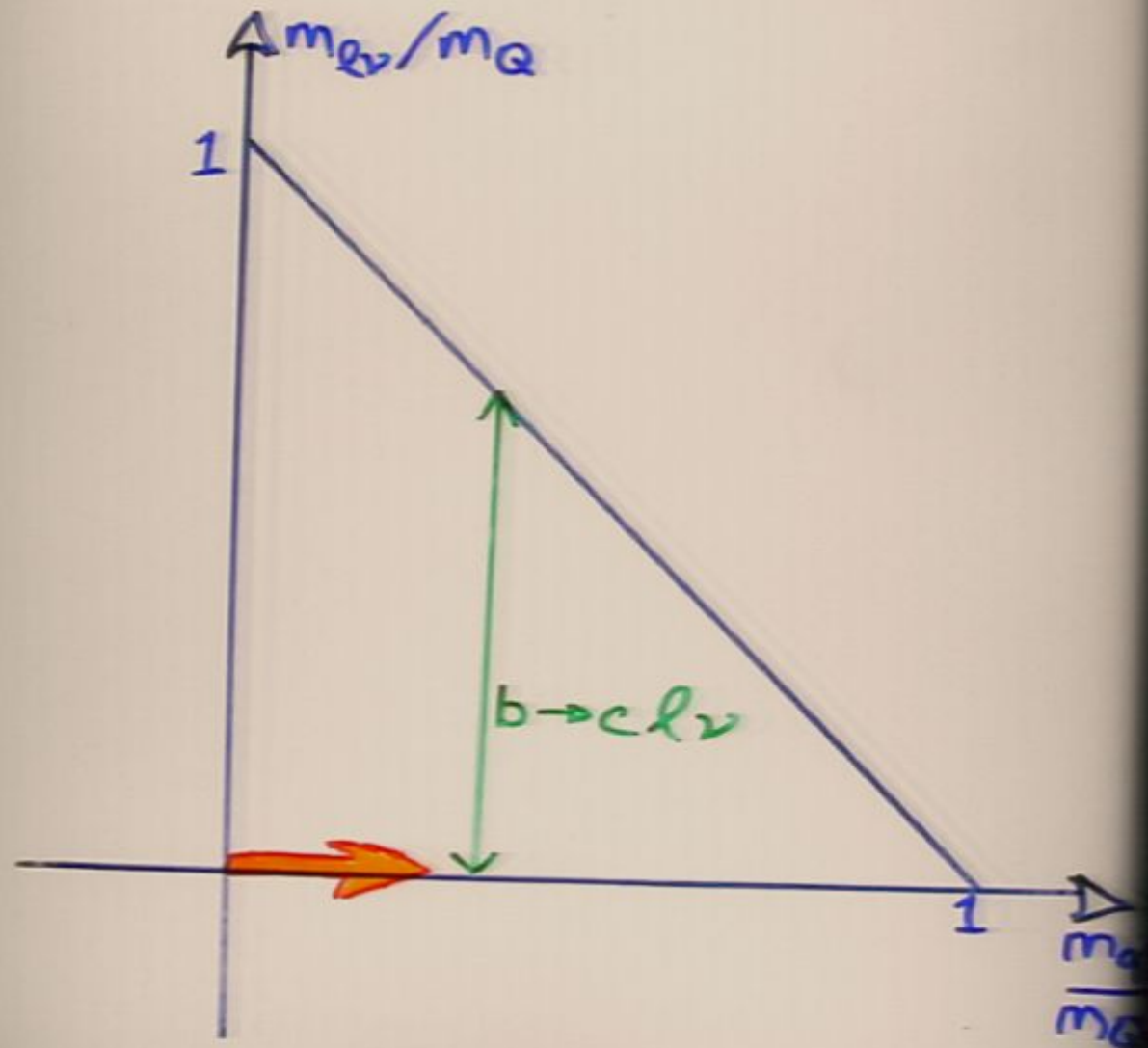
$$b \rightarrow s\gamma \quad (\text{EM DIPOLE})$$

$$b \rightarrow u\ell\nu$$

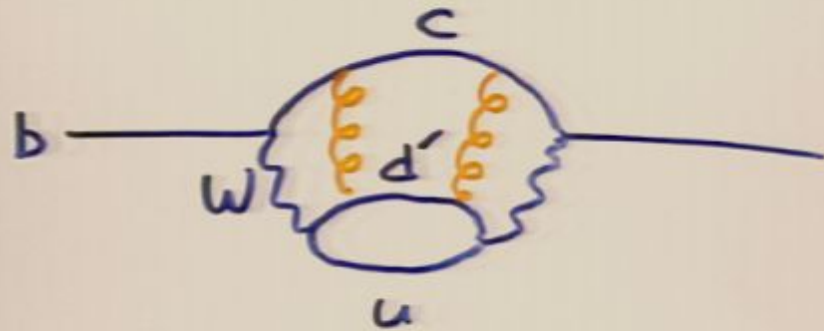
$$\mu \rightarrow e\nu\bar{\nu}$$



KINEMATIC TRIANGLE



NON-LPTONIC b DECAYS

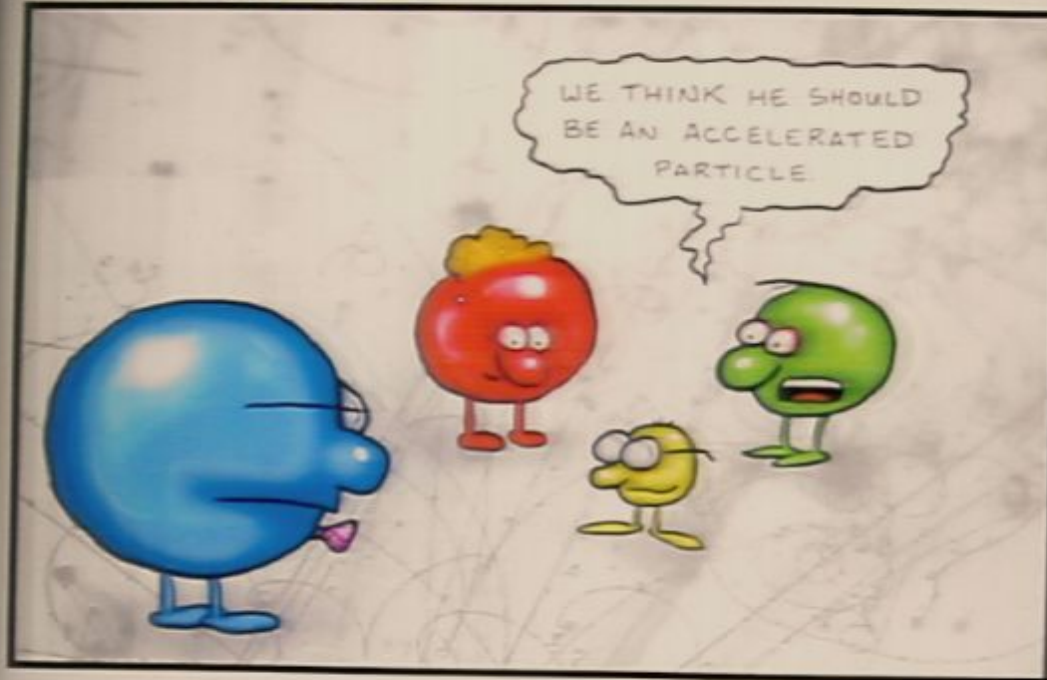


QCD ENHANCEMENT
RESOLVES DISCREPANCY
WITH EXPERIMENT

SUMMARY

SUBSTANTIAL PROGRESS
IS BEING MADE IN
 $O(\alpha_s^2)$ QCD CORRECTIONS
TO HEAVY QUARK DECAYS

DOCTOR FUN



Education at its most basic level