Modern Physics (PHY 3305) Lecture Notes

HomeworkAssignment010

SteveSekula, 3 May 2010 (created 27 April 2010)

no tags

Expectations for the quality of your handed-in homework are available at http://www.physics.smu.edu/sekula/phy3305/homework.pdf. Failure to meet these guidelines will result in loss of points as detailed in that document. This assignment covers material from Harris Ch. 12.1-12.7. It is worth 100 points.

HARRIS *CH12-10* (10 Points)
HARRIS *CH12-12* (10 Points)
HARRIS *CH12-18* (10 Points)
HARRIS *CH12-20* (10 Points)
HARRIS *CH12-27* (20 Points)
SS-13 (40 Points)

Problem *SS-13*: Top Mesons

A "resonance" occurs when two (or more) fundamental particles exchange force carriers and compose a bound state. Resonances can be long or short-lived, depending on the nature of the interactions. The top quark has a mass of $173.1\ \mathrm{GeV}/c^2$.

1. What is the approximate lifetime of the top quark?
2. Imagine you have an experiment capable of producing a top quark and an anti-matter top-quark ($t\bar{t}$) in such a way that once produced they are moving back-to-back, away from one another, each with a speed of 0.86c (roughly speaking, this is the case in the Tevatron at Fermilab). Given the lifetime you computed in Part 1, and given their relative motion, is it possible for the $t\bar{t}$ system to form a bound state (a top meson)? To answer this, let us define the minimum condition for a bound state to form to be that a gluon, emitted from one top quark at the speed of light, reaches the other top quark before either of them decays.