129A HW # 9 (due Dec 1)

1. Using a luminosity of an e^+e^- collider $\mathcal{L} = 10^{31}$ cm^{-2} sec^{-1} and center-of-momentum energy $\sqrt{s} = 60$ GeV, calculate the number of events per hour for the final states $\mu^+\mu^-$, $u\bar{u}$, $d\bar{d}$, and all hadrons (the sum of $u\bar{u}$, $d\bar{d}$, $s\bar{s}$, $c\bar{c}$ and $b\bar{b}$). (Assume the dominance of s-channel photon exchange process. In reality, the Z-boson exchange is also important, but you don't need to include it.)

2. The confining linear potential.

(a) Identify the lightest mesons with $S = 0$, $I = 0$ and $J^P = 1^-$, 2^+, 3^-, and 4^+ in the booklet. Plot them with their mass squared in GeV^2 along the horizontal and their spin the vertical axes.

(b) Identify the lightest mesons with $S = 0$, $I = 1$ and $J^P = 1^-$, 2^+, and 3^- in the booklet. Plot them with their mass squared in GeV^2 along the horizontal and their spin the vertical axes. Also find the lightest mesons with $I = 1$ and $J^P = 0^-$, 1^+, and 2^-, and plot them together with the others.

(c) Identify the lightest mesons with $S = 1$, $I = 1/2$ and $J^P = 1^-$, 2^+, 3^-, and 4^+, and plot them. Also find the lightest mesons with $S = 1$, $I = 1/2$ and $J^P = 0^-$, 1^+, and 2^-, and plot them.

(d) Using the semi-classical analysis of a relativistic particle in the linear potential

$$H = cp + \frac{1}{\alpha'} r, \tag{1}$$

argue that there is a linear relation beween the spin $J = rp/\hbar$ and mass squared $(H/c^2)^2$. Here, the parameter α' has a dimension of Length/Energy and is called the string tension. You can use the natural unit $\hbar = c = 1$.