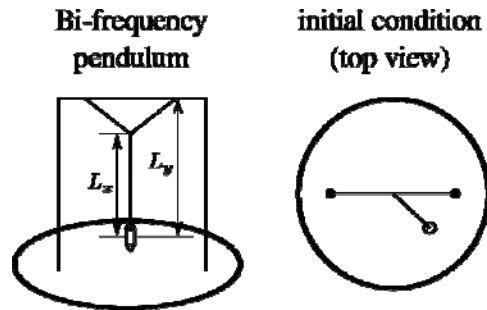


Homework # 5; due Thursday, October 7

Reading: Chapter 4 of Griffiths

19. A neutral kaon K_0 is prepared at time $t=0$. What is the probability of finding this particle in the form of K_0 at some later time t assuming that the particle is free? The other state we can find the particle in is K_0 -bar. What is the probability of this as a function of time? Neglect CP violation. Write analytical expressions in terms of the mass difference Δm between K_L and K_S and the respective decay rates of these particles. Plot the probabilities using the specific values from Problem 18 (or look them up).
20. Discuss the analogy between the neutral kaon system and the [Zel'dovich bi-frequency pendulum](#), see figure below. Explain which physical quantities correspond to each other in these systems. Is the analogy complete?



21. Parity nonconservation due to the neutral weak interaction manifests itself in atomic transitions. For example, for the highly forbidden one-photon decay of unpolarized excited hydrogen

$$|2S\rangle \rightarrow |1S\rangle + \gamma,$$

the emitted photons have a preferred circular polarization. The effect is larger for deuterium, due to its larger weak charge. For deuterium, the degree of circular polarization of the photons is $\approx 2 \cdot 10^{-4}$. As it turns out, while P-invariance is violated, the symmetry is almost restored by performing the combined transformation of spatial inversion and *charge conjugation*, C (this transformation changes matter into antimatter). So far, the only examples of CP-violation have been found in the decays of neutral K- and B-mesons, and for the purpose of this problem, we will assume that CP is a good symmetry.

The question is: if hydrogen preferentially emits right-circularly polarized (R) photons, what is the sign of the preferred circular polarization for antihydrogen?