DECAYS IN QFT - WS 2012/2013

Sheet 4 **23/11/2012**

Exercise 1: Breit-Wigner (6 points = 1 + 3 +2)

Consider an unstable state $|S\rangle$ described by the spectral function

$$d_S(x) = \frac{N}{(x-M)^2 + \Gamma^2/4} \tag{1}$$

1. Determine N.
2. Determine the Zeno time τ_Z. Why is the result expected? Recall that: $\tau_Z = \left(\left\langle H^2 \right\rangle_S - \langle H \rangle_S^2\right)^{-1/2}$.
3. Determine through an explicit calculation the survival probability $a(t)$.

Exercise 2: Breit-Wigner with cutoff (6 points = 2+ 4 + 0)

Consider an unstable state $|S\rangle$ described by the spectral function

$$d_S(x) = \frac{N}{(x-M)^2 + \Gamma^2/4} \theta\left(\Lambda^2 - (x-M)^2\right) \tag{2}$$

1. Determine N.
2. Determine the Zeno-time τ_Z. Comment the result.

Exercise 3: Something is wrong (4 points)

Consider the following identities:

$$e = e^{1+2\pi i} = \left(e^{1+2\pi i}\right)^{1+2\pi i} = e^{1+4\pi i - 4\pi^2} = e^{1-4\pi^2} \to e^{-4\pi^2} = 1???? \tag{3}$$

What did it go wrong?

Exercise 4: Change of coordinates (4 points)

Consider the Lagrangian

$$L_x = \frac{1}{2} m \dot{x}^2 - V(x,t) \ . \tag{4}$$

Perform the change of coordinate $y = x - \frac{1}{2}at^2$. In term of the new variable y the system is described by the new Lagrangian

$$L_y = \frac{1}{2} m \dot{y}^2 - U(y,t) \ . \tag{5}$$

Determine $U(y,t)$.