

## Exercices and questions for lecture 5

1.- Compute the integral appearing in (201).

2.- Prove (203).

3.- Prove that in the non-relativistic limit (203), that is  $c \rightarrow \infty$ , agrees with (201).

§ 4.- Compute the integral (208) when  $m = 0$ .

5.- Prove by direct calculation equation (219). You have to take into account that for a scalar field  $\pi(x) = \dot{\phi}(x)$  and the canonical commutation relation, as well as some properties of the Dirac  $\delta$  function and its derivatives.

§ 6.- Investigate whether  $\theta(x^0 - y^0)D(x - y)$ , with  $D$  as defined in eq. (204) satisfies

$$(\square + m^2)D(x - y) = -i\delta^4(x - y). \quad (243)$$

7.- Write the Dyson propagator in terms of  $D(x - y)$ .

8.- Prove that

$$\{\psi(x), \bar{\psi}(y)\} \quad (244)$$

vanishes for space-like separations.

9.- Starting from the expression

$$S_F(x - y) = \theta(x^0 - y^0)S_+(x - y) - \theta(y^0 - x^0)S_-(y - x), \quad (245)$$

and the expressions for  $S_+$  and  $S_-$ , derive the expression for the Feynman propagator in momentum space (234).

10.- Attempt to derive (242) by direct mode insertion in  $\langle 0|A_\mu(x)A_\nu(y)|0\rangle$ . Which problems do you encounter?