

$$[P_m, A(x)] = i \partial_m A(x) = i \frac{\partial A(x)}{\partial x^m}$$

$$\langle p' | [P_m, T(A(x_1) A(x_2))] | p \rangle$$

$$= (P'_m - P_m) \langle p' | T(A(x_1) A(x_2)) | p \rangle$$

$$= \langle p' | \theta(x_1^0 - x_2^0) [P_m, A(x_1) A(x_2)] + \theta(x_2^0 - x_1^0) [P_m, A(x_2) A(x_1)] | p \rangle$$

$$= \langle p' | \theta(x_1^0 - x_2^0) \left[i \frac{\partial}{\partial x_1^m} A(x_1) A(x_2) + A(x_1) \left(i \frac{\partial}{\partial x_2^m} A(x_2) \right) \right] + \theta(x_2^0 - x_1^0) \left[\left(i \frac{\partial}{\partial x_2^m} A(x_2) \right) A(x_1) + A(x_2) \left(i \frac{\partial}{\partial x_1^m} A(x_1) \right) \right] | p \rangle$$

$$= \langle p' | \theta(x_1^0 - x_2^0) \left(i \frac{\partial}{\partial x_1^m} + i \frac{\partial}{\partial x_2^m} \right) A(x_1) A(x_2) + \theta(x_2^0 - x_1^0) i \left(\frac{\partial}{\partial x_1^m} + \frac{\partial}{\partial x_2^m} \right) A(x_2) A(x_1) | p \rangle$$

So since

$$\left(\frac{\partial}{\partial x_1^m} + \frac{\partial}{\partial x_2^m} \right) \theta(x_1^0 - x_2^0) = 0, \quad \text{we get}$$

$$(P'_m - P_m) \langle p' | T(A(x_1) A(x_2)) | p \rangle$$

$$= i \left(\frac{\partial}{\partial x_1^m} + \frac{\partial}{\partial x_2^m} \right) \langle p' | T(A(x_1) A(x_2)) | p \rangle$$

So

$$\langle p' | T(A(x_1) A(x_2)) | p \rangle = e^{i(p-p') \cdot (c_1 x_1 + c_2 x_2)} F(x_1 - x_2)$$

where $c_1 + c_2 = 1$.

So the Fourier transform of such a time-ordered product is

$$\int d^4x_1 d^4x_2 e^{-ik_1x_1 - ik_2x_2} \langle p' | T(A(x_1)A(x_2)) | p \rangle \equiv G(k_1, k_2)$$

$$= \int d^4x_1 d^4x_2 e^{-ik_1x_1 - ik_2x_2 + i(p-p')(c_1x_1 + c_2x_2)} F(x_1, x_2)$$

Let $y = x_1 - x_2$, so $x_1 = y + x_2$

$$G(k_1, k_2) = \int d^4y d^4x_2 e^{-ik_1(y+x_2) - ik_2x_2 + i(p-p')(x_2 + c_1y)} F(y)$$

$$= (2\pi)^4 \delta^4(p - p' - k_1 - k_2) \int d^4y e^{iy(p-p')c_1 - ik_1y} F(y)$$

In general,

$$\int d^4x_1 d^4x_2 \dots e^{-ik_1x_1 - ik_2x_2 - \dots - ik_nx_n} \langle p' | T(A(x_1) \dots A(x_n)) | p \rangle$$

$$\propto \delta^4(p - p' - k_1 - k_2 - \dots - k_n)$$

This expresses conservation of momentum

$$[Q, A_a(x)] = -q_a A(x)$$

$$(q_b - q_a) \langle p'_b | T(A_1(x_1)A_2(x_2)) | p_a \rangle$$

$$= \langle p'_b | [Q, T(A_1(x_1)A_2(x_2))] | p_a \rangle$$

$$= -(q_b + q_a) \langle p'_b | T(A_1(x_1)A_2(x_2)) | p_a \rangle$$

So charge is conserved:

$$(q_b - q_a + q_1 + q_2) \langle p'_b | T(A_1(x_1)A_2(x_2)) | p_a \rangle = 0$$