

Quantum Field Theory I: Quiz 3

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We simply compute

$$\begin{aligned}\langle \mathbf{p} | \varphi(x) | 0 \rangle &= \int \frac{d^3 \mathbf{k}}{(2\pi)^3 2E_{\mathbf{k}}} \langle \mathbf{p} | a(\mathbf{k})^\dagger | 0 \rangle e^{ik \cdot x} \big|_{k^0=E_{\mathbf{k}}} \\ &= \int \frac{d^3 \mathbf{k}}{(2\pi)^3 2E_{\mathbf{k}}} \langle 0 | a(\mathbf{p}) a(\mathbf{k})^\dagger | 0 \rangle e^{ik \cdot x} \big|_{k^0=E_{\mathbf{k}}} \\ &= \int \frac{d^3 \mathbf{k}}{(2\pi)^3 2E_{\mathbf{k}}} (2\pi)^3 2E_{\mathbf{p}} \delta(\mathbf{p} - \mathbf{k}) e^{ik \cdot x} \big|_{k^0=E_{\mathbf{k}}} = e^{ip \cdot x} \big|_{p^0=E_{\mathbf{p}}}\end{aligned}\tag{1}$$