Frequently asked questions QUANTUM ELECTRONICS
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Module 5: Frequently asked questions:

1. 1. Q: Are the creation and destruction operators Hermitian?

2. Q: What is the difference between a number state $|n\rangle$ with n = 100 and a coherent state $|\alpha\rangle$ with α = 100?

3. Q: Is the single photon in a state described by $|1\rangle$ localized in space or time?

4. Q: In the case of quantum mechanical analysis of a beam splitter why should we consider the incidence of vacuum from the unused port of the beam splitter?

5. Q: What is the difference between the following two two mode states:

$$|\psi 1\rangle = |3\rangle_i |3\rangle_j \text{ and } |\psi 2\rangle = \frac{1}{\sqrt{2}}\left[|3\rangle_i + |3\rangle_j\right]$$

Answers of module 5 FAQs:

A 1 : A: No they are not Hermitian operators. On the other hand the Quadrature operators are Hermitian.

A2: A number state with n = 100 has precisely 100 photons having a zero value of the expectation value of the electric field. On the other hand, a coherent state with α = 100 there is finite probability of finding any number of photons and the average number of photons in this state is 100. Also the expectation value of electric field in this state resembles a classical electromagnetic wave.

A3: A: No, the single photon described by the given single mode state is not localized in space or time. A photon can be approximately localized by considering a multimode single photon state by superposing single mode states.

A4: A: In order to obtain the correct commutation relations between the output annihilation and creation operators, it is necessary to consider the incidence of vacuum from the unused port also.

A5: A: The first state is a product state of modes *i* and *j* while the second is a superposition state of modes *i* and *j*. You can show that both the states are eigen states of the total photon number operator. At the same time the first state is also an eigenstate of the photon number operator of modes *i* and *j* while the second state is not an eigenstate of the photon number operator of modes *i* and *j*. the number of photons in the first state is 6 while that in the latter state is 3.