

**Question:** *Quantum beam splitters.*

We know that classical light input into a beam splitter comes out 50:50. We have argued that the output in the left and right arm can be described by the operator equation for the annihilation operators,

$$\begin{aligned} b_L^o &= \frac{1}{\sqrt{2}} (b_L^i - ib_R^i) \\ b_R^o &= \frac{1}{\sqrt{2}} (-ib_L^i + b_R^i) \end{aligned} \quad (1)$$

where I have chosen phases to correspond to a conventional beam splitter, but can take other values in general.

Calculate the output *state* (not operator) for an input state with exactly a single photon in the left beam. Calculate the output state for an input state with exactly two photons: one on the left beam and one on the right. Does this agree with the classical expectation?