Umeå University
Department of Physics
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Växelverkan
Quantum Optics
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Assignment 3

To be submitted on May 11, 2010

Consider a beam splitter with reflection coefficient R and transmission coefficient T. Let 1 and 2 be the input arms and 3 and 4 be the output arms. Calculate the quantities $\langle n_4 \rangle$, Δn_4, and $\langle n_3 n_4 \rangle$, for each of the input states

(a) One photon in each arm, $|\text{in}\rangle = \hat{a}_1^\dagger \hat{a}_2^\dagger |0\rangle$.

(b) An entangled state, $|\text{in}\rangle = \frac{1}{\sqrt{2}}(\hat{a}_1^\dagger + \hat{a}_2^\dagger)|0\rangle$.
(In the course of the calculation, show that $(R^*T)^2 + (RT^*)^2 = -2|R|^2|T|^2$.)

(c) A coherent state in each arm,

$$|\text{in}\rangle = e^{-\frac{1}{2}|\alpha|^2 + \alpha \hat{a}_1^\dagger} e^{-\frac{1}{2}|\beta|^2 + \beta \hat{a}_2^\dagger} |0\rangle.$$

The solution should be submitted to Emil Lundh (`lundh@tp.umu.se`) no later than May 11, 15:00. If the solution is submitted electronically, I will only accept platform independent formats (pdf strongly recommended!). Answers on paper are of course also accepted.