Beam splitter

September 25, 2016

Taking into account the definition of the transfer matrix of a beam splitter defined in the reference [1]

$$\begin{pmatrix} r_{13} & t_{23} \\ t_{14} & r_{24} \end{pmatrix} \tag{1}$$

Where r_{ij} and t_{ij} are the reflection and transmission coefficients of the beam splitter. We choose the following relations:

$$|r_{13}| = |r_{24}| = |r|, \tag{2}$$
$$|t_{14}| = |t_{23}| = |t|, \tag{3}$$
$$r_{13} = |r|e^{\phi_{13}}, \tag{4}$$
$$r_{24} = |r|e^{\phi_{24}}, \tag{5}$$
$$t_{14} = |t|e^{\phi_{14}}, \tag{6}$$
$$t_{23} = |t|e^{\phi_{23}}, \tag{7}$$
$$|r| = |t| = \frac{1}{\sqrt{2}}, \tag{8}$$
$$\phi_{13} = \phi_{14} = \phi_{23} = 0, \tag{9}$$
$$\phi_{24} = \pi. \tag{10}$$

Assuming the previous relations we obtain the beam splitter matrix presented in (11).

$$\frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \tag{11}$$

References

[1] Rodney Loudon. *The quantum theory of light.* OUP Oxford, 2000.