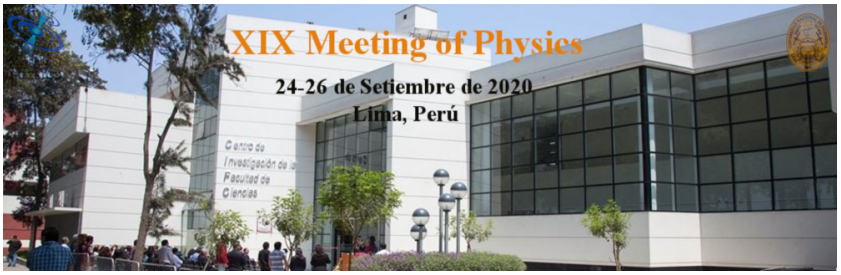

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Classical and quantum mechanical interpretations of lossless beam splitters

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Classical and quantum mechanical models of a beam splitter are addressed, including the cases where there are one or two input source(s) of light resulting in two consequent output beams. In the classical case we invoke the conservation of energy to derive a 2×2 matrix M_{bs} which transforms the electric fields. In the quantum mechanical case we invoke conservation of probability to show that the transformation operator $\widehat{M_{bs}}$ from the input space to the output space must be unitary. We find that the matrix representation of $\widehat{M_{bs}}$ in the occupation-number space is identical to the classical transformation M_{bs}. This formalism is applied to describe the inner workings of a Mach-Zedner interferometer. Additionally, we justify the necessity of the quantum mechanical interpretation by examining strictly quantum mechanical phenomena such as single-photon interference.

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