Wide-field SU(1,1) interferometer: supplementary material

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This document provides supplementary information to “Wide-field SU(1,1) interferometer,” https://doi.org/10.1364/OPTICA.6.001233. We present the simulation based on [1] for the visibility of the degenerate SU(1,1) interferometer in the case of unbalanced gains. The visibility is close to ideal even for a strong unbalance of the two amplifiers.

1. VISIBILITY OF THE SU(1,1) INTERFEROMETER

We derive from [1] the expression for the visibility $V$ of an unseeded degenerate SU(1,1) interferometer. Assuming single-mode operation and direct detection at the output we obtain

$$V = \frac{\sinh^2(G_1 + G_2) - \sinh^2(G_1 - G_2)}{\sinh^2(G_1 + G_2) + \sinh^2(G_1 - G_2) + 2 \left( \frac{1}{\mu} - 1 \right) \sinh^2 G_2}.$$  

(S1)

with $G_1$ and $G_2$ being, respectively, the gain values of the first and of the second pass amplifier and $\mu$ being the transmission of the elements before the second pass amplifier. In the case of perfect transmission and high gain ($G > 1$), the term with $G_1 - G_2$ is much smaller than the one with $G_1 + G_2$. Therefore, strongly different gains do not affect too much the visibility of the interferometer.

Fig. S1 shows the visibility as a function of the gain values $G_2$ and $G_3$ in the particular case of $\mu = 95\%$, as realized in the experiment. The visibility exceeds 98% within a broad region, even if there is a great unbalance.

We obtained high visibility in the experimental setup as well with $G_1 = 2.1 \pm 0.3$ and $G_2 = 3.3 \pm 0.3$, as confirmed by the plot in Fig. 2 (a) of the main text.

**Fig. S1.** Visibility simulated for the single-mode SU(1,1) interferometer as a function of the gains of the first and second amplifiers. The losses between the two amplifiers are assumed to be 5%, as in the experiment. The effect of the amplification/de-amplification of the first pass radiation is close to ideal even for the case of the two gains being unbalanced.
REFERENCES