An experimental method for efficiently measuring radial coherence

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Abstract: In the present work we demonstrate an efficient experimental technique for measuring the two-point cross-spectral density of a monochromatic field averaged over the azimuthal degree of freedom, representing the radial spatial coherence of the field.

Coherence refers to correlations between field vibrations at two separate points in degrees of freedom such as space, time, and polarization. In the context of space, coherence theory has been formulated between two transverse positions which can be described either in the cartesian coordinates or in the cylindrical coordinates. When expressed in cylindrical coordinates, spatial coherence is described in terms of azimuthal and radial coordinates. The description of spatial coherence in the radial degree of freedom has been formulated only recently [1].

In the context of space, coherence theory has been formulated between two transverse positions and is referred to as transverse spatial coherence. When expressed in cylindrical coordinates, the spatial coherence can be expressed in terms of radial and azimuthal coordinates. In the azimuthal coordinate, a measure of coherence based on averaging over the radial coordinate has been particularly suitable for several experiments [2-3], such as for instance the angular Schmidt spectrum of entangled two-photon fields. More recently, the theory of coherence has been formulated for radial variables. In particular, in Ref. [1] it is defined a measure of coherence based on averaging over the azimuthal variables. Just as the angular degree of coherence provides information on the OAM spectrum, the radial degree of coherence can be used to get the radial mode spectrum [1,4].

In the present work, we demonstrate an efficient experimental technique for measuring radial coherence, and we report measurement of radial coherence of different types of radially partially coherent optical fields.

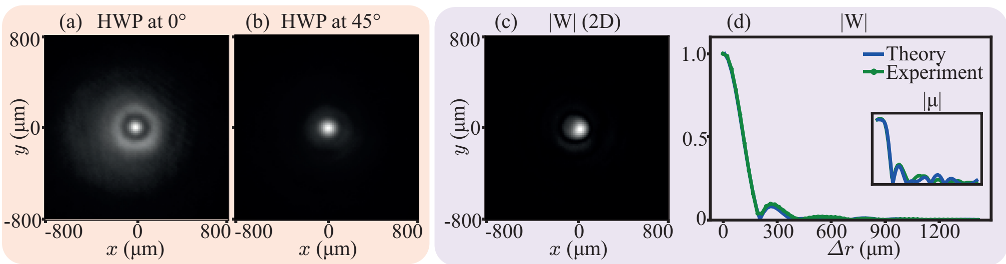

Fig. 1 Radial cross-spectral density function for incoherent mixture of 11 LG modes (p = 0 to p = 10). (a) The recorded interferogram for HWP at 0°. (b) The recorded interferogram for HWP at 45°. (c) The 2D radial cross-spectral density function W obtained by taking the difference of the recorded interferograms in (a) and (b). (d) One-dimensional cut of the plot of the cross-spectral density function W. The inset shows the degree of coherence function μ

The radial degree of freedom in combination with the angular degree of freedom can be leveraged for providing very high-dimensional single-photon states for quantum information applications.

References

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