Spontaneous emission from active dielectric microstructures

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Variable coherence in determining the scattering parameters of diffuse media using laser speckle

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We demonstrate the application of a variable coherence laser source for determining the scattering parameters of a diffuse medium and the potential for imaging spatially dependent scatter. A key concept in this work is the ability to acquire a well-defined coherent light by frequency modulating a tunable laser (with a center wavelength of 532 nm) at a low-repetition rate to create interference fringes. This allows for an in situ measurement and the adaptation of beam coherence to the target of interest, which we show is critical in obtaining accurate results.

The spatially stationary statistics described by the contrast ratio, which we have previously shown, can be used to extract material parameters using light of fixed coherence by varying the material thickness. The correlation and cross-correlation matrices with the scattering data from a Dallron TDL (1550 nm) have been separated in the speckle background by the diffuse medium in a transmission geometry. The speckle contrast statistics in the scattered field were measured, with the results shown in Fig. 1. The theoretical fits were obtained using an approximate linear theory for the diffuse media.

To demonstrate the sensitivity of the specific contrast ratio to scattering variables, we have performed a number of experiments to collect angular data [3]. This data shows a sensitivity varying contrast ratio which can be used to reconstruct photon travel times [4]. In the image in Fig. 2, the contrast ratio between the homogeneous and heterogeneous medium. Lighter displays represent a higher contrast than in the homogeneous case, and darker shades represent a lower contrast ratio. In Fig. 2(b), we can see a ratio of higher contrast ratio corresponding to the localized extinction of scattering (shown by a model in the inset). In Fig. 3(b), we can use a ratio of lower contrast ratio due to the localized bremsstrahlung emitted by a free atom. The distribution of the information is shown for the 500 nm bandwidth used in Pigs. 2(a) and 3(a), demonstrating the importance of the source coherence.

Fig. 1: Contrast ratio data as a function of laser wavelength for two different angular spectra. The spatially correlation data, and the dependence on laser wavelength. The top and bottom curves are for the homogeneous scattering medium, which is 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick. The contrast ratio is shown for the 500 nm wavelength with a contrast ratio of 1 cm thick.

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Spontaneous emission from active dielectric microstructures.

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Spontaneous emission is one of the key factors that determine the noise properties of photonic devices and the pump power threshold of lasers. The spontaneous emission in dielectric microstructures (cavities, photonic crystals, optical waveguides, etc.) can be strongly correlated by the dependence of the emission rate on the location and polarization of the emitters in the structure [1]. This paper addresses the methods of quantifying the correlation functions at the local rate of spontaneous emission in active microstructures. For passive structures the spontaneous emission may be estimated by expanding the radiation field in power-orthogonal modes normalized to unity energy, and using the Fermi Golden Rule. This approach was used in [2] for calculating the position dependence of spontaneous emission in passive photonic crystals. However, for active microstructures the rate equations is problematic, and it is more convenient to express observable quantities in terms of the field amplitudes and optical gains. The total rate of spontaneous emission is given by:

\[ \Gamma = \sum_j \int d^2 r \int d^2 r' \rho_{ij}(r, r') \chi_{ij}(r, r') \delta(r - r') \]

where \( \rho_{ij}(r, r') \) is the spontaneous correlation function and \( \chi_{ij}(r, r') \) is the emission field in terms of the transverse current. For materials with gain the emission can be derived from the solution to the homogeneous wave equation and the adjoint wave equation.

As an example we show in Fig. 1, in polar coordinates, the distribution of spontaneous emission going into radiation modes from an active optical fiber. The distribution is shown for the fiber in the center of the fiber core and at the edge of the fiber core, respectively. The optical fiber has the core effective index 1.45, cladding effective index 1.43, core radius 2 μm. The emission wavelength is 1600 nm. The emission rate \( \Gamma_{ij} \) is for dipoles with orientation along the fiber axis, \( \Gamma_{ij} \) is the sum of radiation rates for dipoles with orientation perpendicular to the fiber axis, and \( \Gamma_{ij} \) is the sum of these two emission rates.

The presentation will include an analysis of the effects of gain on the radiation pattern and the rate of radiation into the guided modes of active optical fibers.

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