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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 variable coherence laser speckle to measuring parameters of a diffuse medium and the potential for imaging spatially dependent scatter. A key concept in this work is the ability to generate a world-convenient power by frequency modulating a visible laser. When (with a center wavelength of 680 nm) at a rate much faster than the integration time of the detector. The sim for a right measurement and the adoption of beam coherence in the factor of water, which is shown in relation to obtaining beam sensitivity. The results are essentially independent of the modulated rate, which we have been observed to use for various materials using this method. The results, for example, are not dependent on the scattering direction or distance. Light stimulation reduces the number of scatterers, and faster modulation rate may be used as an approximation of the true rate for the diffusing media used in Fig. 1. The theoretical model was obtained using an appropriate laser’s lifetime for the diffusion model.

To validate the possibility of using variable coherence to analyzing random media, we have performed a number of experiments with a laser in an optical fiber. The results here show a model of scattering, which can be used to approximate photon transmission. The right diagram shows a result that is comparable to the left one in the homogenous case, and faster modulation rate may be used as an approximation of the true rate for the diffusing media used in Fig. 1. The theoretical model was obtained using an appropriate laser’s lifetime for the diffusion model.

References

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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 microresonators (cross-clamped, photonic crystals, optical waveguides, etc.) can be sorted external by controlling or engineering due to the dependence of the emission rate on the location and orientation of the modes in the structure [1,2]. This paper addresses the methods of quantifying spontaneous emission in dielectric microresonators, which enable calculations of the rate of spontaneous emission in active microresonators.

For passive microresonators, the spontaneous emission may be derived by expanding the radiation field in power-conjugate modes normalized to one quantum of energy, and using the Fermi Golden Rule. This approach was used in [2] for calculating the dependence of spontaneous emission in passive photonic crystals. However, for active materials the rate requires a more sophisticated treatment, and it is more convenient to express the total spontaneous emission in terms of the field operators and in terms of the number of spontaneous emission events.

The total rate of spontaneous emission in given by

$$\Gamma = \frac{2\pi \hbar}{\hbar} \sum_{m} \left| \langle \Phi | J_{m}(\mathbf{r}, \mathbf{\mathbf{p}}) | \Phi \rangle \right|^2 \delta(E - E_{m}(\mathbf{r}, \mathbf{\mathbf{p}}))$$

where $$\Gamma$$ is the generating current, and $$\langle \Phi | J_{m}(\mathbf{r}, \mathbf{\mathbf{p}}) | \Phi \rangle$$ is the classical transverse Green's tensor that determines the electric field in terms of the transverse current. For materials with gain the rate can be derived from the solution to the homogeneous wave equation and the adjoint wave equation.

As an example, we show in Figure 1, in polar coordinates, the distribution of spontaneous emission going into radiation modes from an active optical fiber. The distribution is shown for the sum of the center of the fiber core and at the edge of the fiber core, respectively. The fiber also shows some radiation in the core radiation. The optical fiber has a core radius of 1.5 microns. The core radius is on the order of 2 microns. The emission wavelength is 1550 nm. The emission rate $$\Gamma_{m}$$ is for spheres with orientations along the fiber axis. $$\Gamma_{m}$$ is the sum of radiation rates for spheres with orientation perpendicular to the fiber axis, and $$\Gamma_{m}$$ is the sum of the two emission rates.

The presentation will include an analysis of the effects of gain on the radiation pattern and the noise induced by the guided modes for active optical fibers.

References