Phase Fluctuations in Scattered Radiation

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Fluctuations in scattered radiation are of considerable practical and theoretical interest [1]. Perhaps due to the prevalence of direct detection systems at optical wavelengths, as well as the relative difficulties encountered in phase sensitive systems, phase statistics and correlations would appear to have received considerably less attention than corresponding results for intensity. Freund and Kessler obtained the phase autocorrelation of a complex Gaussian field from the two-point joint density [2], a calculation that Middleton had performed in earlier investigations [3]. As noted by Sebbah et al., [4], the results from these investigations are applicable to the wrapped phase, or phase modulo 2π, and not the unwrapped phase that can take on arbitrary values. However, there are instances when the variance of the unwrapped or cumulative phase is of most interest, such as characterizing transit times in diffuse waves [5], wavefront sensing and interferometry [6]. In this talk we present unwrapped or cumulative phase results following scattering from one-dimensional phase screens and extended random media. Analytical results are obtained in weak and strong fluctuations regimes, which provide a benchmark for numerical simulations that allow insight under all fluctuation conditions.

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