Scattering of partially coherent waves incident upon rough surfaces

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Waves which have been propagated through multiple scattering environments are in general partially coherent. Examples are waves in a turbulent medium, randomly distributed scatterers or waves propagated over rough surfaces. When these partially coherent waves are incident upon rough surfaces, the scattering characteristics depend not only the rough surface characteristics, but the coherent length of the incident wave. Formulations of the problem are made making use of the stochastic spatial transform of the incident and the scattered waves. This is similar to the use of the Wigner distribution and the transition operator. The Wigner distribution of the incident wave produces the Wigner distribution of the scattered wave. The Wigner distribution is a generalization of the conventional specific intensity of the radiative transfer theory with equivalent flux and the average intensity.

We consider rough surfaces with small perturbations where the Rayleigh hypothesis is applicable. The incident wave is expressed with the Gaussian correlation function. The scattered intensity depends on the rough surface rms height, the surface correlation distance, and the coherence length of incident wave. If the incident coherence length is increased and becomes greater than the surface correlation distance, the scattered wave approaches that of a plane wave incidence. If the incident coherence length is decreased and becomes smaller than the surface correlation distance, the scattered wave approaches that of isotropic scattering. This work is a part of the general problem of scattering by discrete objects in the presence of random media and rough surfaces with space-time inhomogeneous incident waves, which may be useful for remote sensing of objects in random media and determination of the medium characteristics.