Multiple Scattering Effects on Radar Cross Section (RCS) of Objects in Random Media Including Backscattering Enhancement and Shower Curtain Effects

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When an object is in a random medium, the conventional theory gives the apparent radar crosssection (RCS) of the object, which is reduced from the RCS in free space due to the scattering and absorption effects of the random medium. This reduction is represented by the optical depth of the medium. However, this does not include multiple scattering effects.

In this paper, we present a multiple scattering theory of RCS in a random medium using scalar fields. We consider Dirichlet objects. We assume that the size and the surface radius of curvature of the object are greater than a wavelength; therefore, the Kirchhoff approximation is applicable. Also, we make use of the parabolic equation approximation for propagation, which should be applicable to many practical problems in microwave and optical scattering in the atmosphere and the ocean, as well as optical scattering in biological media. The medium is characterized by the Gaussian and Henyey-Greenstein phase functions.

The formulation is based on the use of the circular complex Gaussian assumption. Making use of the stochastic Green's functions, RCS is expressed as the surface integral over the object. It consists of three terms. The first is the coherent component, the second represents the correlation between the coherent and incoherent components, and the third is the diffuse component. It includes the fourth-order moments, which are decomposed to the second-order moments by circular complex Gaussian assumption. It includes two effects: backscattering enhancement and shower curtain effects. Both phenomena have been discussed recently, but have not been included in most RCS studies.

As an example, we consider a square conducting plate for the object. The shower curtain effect shows that RCS is greater when the random medium is close to the transmitter. The backscattering enhancement effect shows that RCS is increased if the correlation between the incident and scattering waves is included. The angular dependence of the RCS shows that RCS becomes insensitive to the angular variation of the object as the optical depth increases.