
Generalized Snell laws for rough interfaces

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Abstract

In this talk, we revisit the problem of reflection and transmission of waves through a rapidly oscillating rough interface with general mixing properties. Under the paraxial (parabolic) scaling, the specular and speckle (diffusive) components of the reflected and transmitted waves can be precisely characterized. The scenario of a critically scaled interface will be presented, where the amplitudes of the interface fluctuations and the central wavelength are of the same order. When the correlation length of the interface fluctuations is smaller than the beam width, homogenization phenomena occur, and we will illustrate how the rough interface can be approximated as an effective flat interface, leading to deterministic specular cones. However, this scenario also results in the formation of broader cones (speckle cones) containing speckle patterns. We will present two-point correlation functions for these speckle patterns and a central limit type theorem, demonstrating that these patterns can be modeled as Gaussian random fields. This framework allows us to identify generalized Snell's laws for refraction and transmission, influenced by an effective scattering operator at the interface.

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