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ASYMPTOTIC ANALYSIS OF RADIATIVE TRANSFER EQUATION WITH RANDOM EXTINCTION COEFFICIENT

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ABSTRACT. Radiative transfer in a medium with a spatially random extinction coefficient is considered in the scattering dominated, weak absorption limit. Using a Karhunen-Loeve spectral expansion to represent an arbitrary second-order random process and applying an asymptotic scaling in terms of the Knudsen number to the equation of transfer, a rigorous interior and boundary layer analysis is performed. We show that at lowest order the angle integrated intensity for each realization satisfies a nonrandom diffusion equation with a diffusion coefficient dependent only on the mean extinction coefficient. That is, regardless of the statistical properties of the fluctuations in the extinction coefficient, the angle integrated intensity is a deterministic quantity to lowest order. While not an unexpected result given the assumed scaling, the asymptotic analysis explicitly reveals the different rates of convergence of the mean scalar intensity and the scalar intensity for each realization. These observations are shown to be consistent with results from numerical solution of the random transport equation.