AN ANALYTICAL APPROACH TO THE MEAN FIELD PROBLEM OF STATISTICALLY PERIODIC DISTRIBUTIONS OF INFINITELY LONG CYLINDERS

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Remote sensing from agricultural crops has been an area of research for a long time. Unlike natural vegetation canopies, agricultural canopies like corn are generally aligned in rows. This aligned row structure of the canopy sometimes poses problems in interpreting the data acquired by remote sensing instruments. Several studies have been made in modeling the effects of the row structure of the canopy, however, the general tendency is to use simple models that ignore these effects. Studies that consider the row structure either idealize the canopy and assume it to be periodic or investigate the effects by Monte Carlo simulations. This study is an attempt to develop analytic tools to analyze such canopies with row structures.

In order to analyze and understand the effects of row structure on the mean field, we consider a simple canopy of randomly distributed infinitely long cylinders. In this canopy model, an ideal canopy is a two dimensional periodic lattice with each cylinder placed at a lattice point. A real canopy, on the other hand, is a disordered canopy where the cylinders are randomly displaced from their ideal canopy positions. It is assumed that the probability densities of the displacements of the cylinders are identical and are nonzero over a finite region R. We will refer to such a random distribution of cylinders as statistically periodic. Analytical expressions are derived for the propagation of the mean field through this statistically periodic distribution based on the Foldy approximation. In this approach however, we do not assume a uniform distribution in conjunction with the Foldy approximation as is generally done in the literature. In the presentation we will show that under the Foldy approximation, the mean field experiences a periodic dielectric medium. Furthermore, the shape of the dielectric is identical to the shape of the region R, and the dielectric permittivity is determined by the distribution properties. The ability to construct an equivalent periodic problem for the statistically periodic problem of the mean field is of great value since there is a rich literature on periodic structures.

Analytical results are compared with Monte Carlo simulations for a finite section of statistically periodic distributions of infinite cylinders. The results show excellent agreement in most cases. A discussion of the possible limitations of the analytical results will be given.

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