"Imaging Systems Modelling"

Electromagnetic scattering theory is fundamental to understanding the interaction between electromagnetic waves and inhomogeneous dielectric materials. The theory unpins the engineering of electromagnetic imaging systems over a broad range of frequencies, from optics to radio and microwave imaging, for example. Developing accurate scattering models is particularly important in the field of image understanding and the interpretation of electromagnetic signals generated by scattering events. To this end there are a number of approaches that can be taken. For relatively simple geometric configurations, approximation methods are used to develop a transformation from the object plane (where scattering events take place) to the image plane (where a record of some measure of the scattered field is taken). The most common approximation is the weak scattering approximation which ignores the effect of multiple scattering interactions and the first part of this lecture investigates the use of this approximation for electromagnetic imaging systems modelling. When scattering interactions become progressively more complex (e.g. multiple scattering from random media), the applications of deterministic scattering theory becomes difficult to use in practice. Consequently the inverse scattering problem can become ill-posed. For this reason, a number of other approaches are considered which include developing statistical models for the scattered field itself rather than the scatterer. This seminar investigates the use of diffusion based models for solving the inverse scattering problem when strong scattering processes occur. We then extend this approach and consider the intermediate case by modelling the scattering processes using a fractional diffusion equation. Finally, a low frequency scattering theory is presented which leads to the proposition that light and other high frequency electromagnetic wavefields can be weakly diffracted by a low frequency scattered field. This leads to a new interpretation of gravity gravitational lensing which is investigated through the question as to why Einstein rings, observed in the visible spectrum, are blue?

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