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Towards a q-dependent optics

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The response of matter on a temporally and spatially varying electromagnetic field at a certain point and a certain time depends on the field strength prior to this time at places close to this point. Hence the material parameters become a function of frequency ω and wavevector q, in general.

While the frequency dispersion is common knowledge and widely utilized, spatial dispersion is usually disregarded. However, it is crucial in many metamaterials and inhomogeneous matter. The definition of effective optical parameters by any of the classical effective medium approximations becomes deceptive.

We will discuss the theoretical background, the relation of spatial dispersion and magnetoelectric effect (bianisotropy), for instance. The novel method of Mueller-matrix spectroscopic ellipsometry allows us to map the complete q-dependent optical response. Experiments of toy models such as a metallic-dielectric nanostructures and split-ring-resonator array demonstrate the power of this method and elucidate the rule of spatial dispersion.

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