Light-generated atomic density waves and the coupled field-medium state of light in dielectrics

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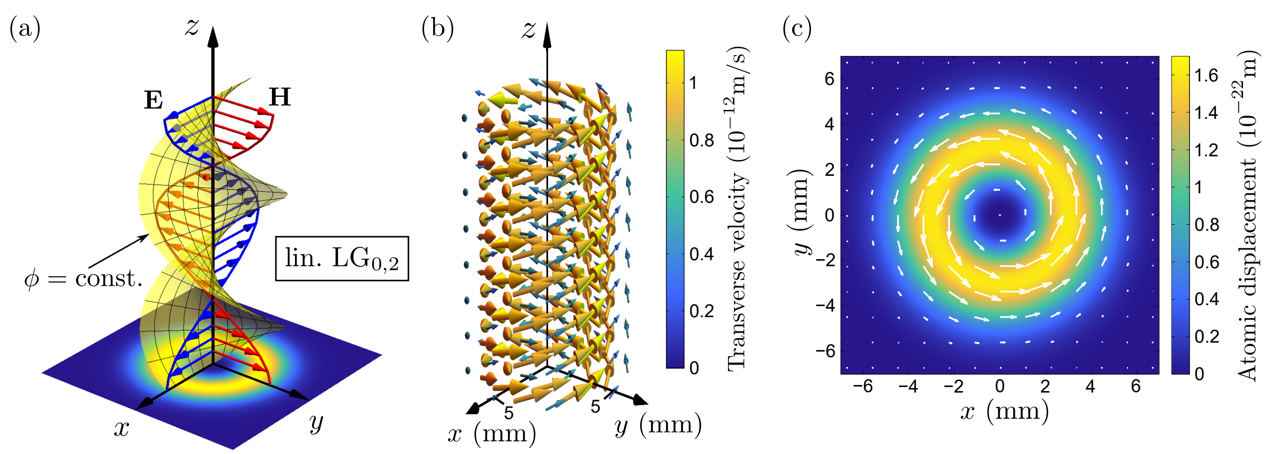
Recently, the generation of elastic waves by light reflected from a mirror foil on a dielectric has been quantitatively measured by Požar *et al.* [1]. The discovery of Požar *et al.* is a special case of a much more general phenomenology of atomic density waves that are generated when light is partially reflected and partially transmitted through a dielectric. Fundamental and unified understanding of the dynamics of these atomic density waves, including sound waves and light-driven atomic mass density shock waves, is possible by the mass-polariton (MP) theory of light developed by us recently [2–7]. The MP theory combines the optical and elastic forces on equal footing and enables solving the dynamical equation for the atoms in a dielectric.

In this seminar, we review the foundations of the MP theory of light. We elaborate the classical field-theoretical background of the energy-momentum tensor of the MP theory [6,7], including its relation to the conservation laws, Lagrangian densities, the Lorentz transformation of the energy-momentum tensor components, and the form-invariance of the field and the atomic mass density wave equations. We also discuss the challenges that must be overcome to be able to experimentally measure the mass transferred by the field-driven atomic mass density shock waves. In particular, we consider the effect of reflections, absorption, the breakdown threshold irradiance of the material, and the relaxation effects by elastic waves.



Atomic mass density shock wave vortex generated by a Laguerre-Gaussian laser beam in silicon [4].

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