

Preface

This book discusses how, in random media, light dramatically changes electron–electron interaction. Despite Coulomb repulsion, the effective interaction demonstrates attraction, even under strong pumping. Light (both coherent and natural) acts like an optical motor, transporting electrons in a direction opposite to that of the electric force direction: electric current flows against bias and static polarization is aligned in opposition to the applied electric field. The uncommon electron transport increases the initial perturbations and is the foundation of the light-driven structuring of a matter. This structuring belongs to the class of self-organization phenomena of open dissipative systems and exhibits a number of fascinating properties.

Light pushes electrons into spatially ordered macroscopic bunches observed in fused silica under ArF-laser irradiation. It carves material balls with fixed diameters equal to 2 microns and throws them out of the ablation crater. Moderate light intensity drills material, forming long channels that align with the wave vector and drill diameters can be as small as 2 microns, while the beam spot is a few millimeters.

Bicolor excitation causes orientational ordering in random media. We monitored the induced transformation by measuring the emerged second harmonic signal. The orientational ordering has been used for all optical poling of glasses. Light treatment prepares phase-matched grating of second-order nonlinear susceptibility and provides effective second harmonic generation. All optical poling was performed in bulk materials and fibers.

We give numerous examples of spatial, orientational and temporal ordering, and we present theoretical and experimental evidence of several kinds of light-driven self-organization. Ordering induced by natural light gives us an idea of how the life on Earth may have come about. The light-driven self-organization might have been the first, prebiotic stage in the chain events that gave rise to life.

We discuss electron acceleration driven by petawatt laser pulses. Particles are accelerated by an electric field of plasmon, generated by the laser. The laser wakefield electron accelerator opens new horizons in light-mediated manipulation by matter.

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