Few- and Half-Cycle Electromagnetic Pulses

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Progress in obtaining increasingly shorter electromagnetic pulses [1] has brought to the forefront the question of the properties of extremely short, few- and half-cycle pulses. In this field, many concepts familiar in nonlinear optics are no longer valid, and new approaches to the physics and description of extremely short pulses are required. In this report, primarily based on the review [2] and a number of recent publications [3-9], and starting from the rigorous Maxwell's equations of electrodynamics, the general properties of the field structure in such pulses are revealed, including the conservation rule of their key characteristic — the electric pulse area $\vec{S}_E = \int_{-\infty}^{+\infty} \vec{E}(\vec{r},t)dt$, where $\vec{E}$ is the electric field strength and t is time. We show that the electric area of extremely short pulses determines the efficiency of their interaction with classical and quantum micro-objects, as well as the efficiency of electron-positron pair generation upon the collision of counter-propagating pulses. A number of methods for generating few-cycle and unipolar (with non-zero area) pulses are presented, particularly in quantum wells, along with techniques for controlling their shape. Finally, possible applications of extremely short pulses in the holography of rapidly changing objects, in the induction of dynamic gratings in media, and informatics are discussed.

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