Abstract of the bachelor's work

**«Geometric optics correction of initial conditions for propagation of tightly focused laser radiation»**

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For the aims of propagation equations, the focusing of the laser radiation is usually described as a quadratic phase increment across the beam [M. B. Vinogradova et al. “Wave Theory”, Moscow, Nauka, 1979 (in Russian)]. This approach is valid for paraxial propagation and thin lens, but not for tight focusing, when the length of the beam waist exceeds the thickness of the focusing element (or the "depth" of parabolic mirror) [Opt. Express 23, 31240 (2015)]. In present work, we derive analytically the initial conditions to serve with non-paraxial vectorial propagation equations for the tight focusing case. Derivation is based on the geometrical optics transfer of the electric field from the focusing element to the initial plane with consideration of finite thickness of the element and large propagation angles. In contrast to the commonly used expressions, both phase and amplitude of the incident field are changed during this routine. With the developed initial conditions applied to the various focusing surfaces, the non-paraxial vectorial propagation equations provide the same electric field distribution (both for transverse and longitudinal components), as the one provided by vectorial diffraction integral, which is the exact solution of Maxwell equations. The developed initial conditions were applied for the simulations of terahertz (THz) emission under tight focusing (numerical aperture of 0.08) of two-color femtosecond pulse into air. The angular-frequency distribution of THz radiation has a conical structure with the divergence of 50° in the range up to 15 THz. With propagation, two rings are formed in the range of >10 THz as well as the bright on-axis maximum with the intensity equal to the rings’ one.