resonance absorption and higher harmonic generation in INHOMOGENEOUS laser-produced plasma [[1]](#footnote-1)\*)

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In the well-known phenomenon of plasma resonance (transformation of electromagnetic waves into plasma waves) in the vicinity of the critical density of an inhomogeneous plasma [1], relativistic nonlinearity is already manifested at nonrelativistic laser intensities due to a significant electrostatic field increase in the resonance region. Therefore, the widely used theory of harmonic generation by plasma resonance [2, 3] should be revised. In Refs [2, 3], based on the assumption of weak nonlinearity, the harmonic spectra are calculated in the framework of perturbation theory in terms of the laser field amplitude and are characterized by an exponentially fast decay in the harmonic intensity with increasing harmonic number [3].

 In the present work, an analytical theory for the higher harmonic generation at nonrelativistic laser intensity in an inhomogeneous plasma, taking relativistic effects in the vicinity of plasma resonance into account, is constructed. Using the renormalization group symmetry method, the nonlinear structure of the resonantly amplified electric field and the electron velocity in the vicinity of the critical plasma density was found [4] and the nonlinear current, which is the source of the electromagnetic field emitted from the plasma into the vacuum, was calculated. Formulas determining the efficiency of harmonic generation are obtained, and the spectral and angular characteristics of radiation are studied [5]. Two effects in the restructuring of the emission spectra relative to the nonrelativistic case were discovered - flattening of the spectral curve and its modulation. Both effects are the result of the phase modulation of relativistic plasma oscillations in the vicinity of the critical plasma density. The manifestation of these effects depends on the characteristic scale of the plasma inhomogeneity: a significant flattening of the spectral envelope is observed at relatively sharp density gradients, and spectrum modulation – at smoother gradients. We have shown that the higher harmonic generation is most effective near the breaking of plasma waves with inhomogeneity gradients $L=20λ-40λ$, where $λ$ is the laser wavelength. Under such conditions, slowly decaying power spectra with intensities $I\_{n}∝n^{-α},α>1$ are formed, where $n$ is the harmonic number. Moreover, this picture already occurs at laser intensities $I\_{0}$, which are quite low by modern standards (for example, for a neodymium laser $I\_{0}=10^{16}-10^{17}W/cm^{2}$). This work was supported by the Russian Foundation for Basic Research, grant No. 18-32-00406 mol\_a.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/It/ru/CL-Metelskiy.docx) [↑](#footnote-ref-1)