Enhancement of quasi-stationary magnetic fields via of the plasma density profile in the regime of relativistic self-channeling

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This work investigates a novel approach to enhancing quasi-stationary magnetic fields generated via the inverse Faraday effect during the self-channeling of circularly polarized laser radiation at relativistic intensity. We generalize a previously established method [1] for constructing self-consistent, stationary, axisymmetric laser-plasma structures to the case of transversely inhomogeneous plasma density distributions.

To circumvent discontinuous solutions encountered in prior work [2], we introduce a small regularization parameter with the physical meaning of temperature. This method describes filaments formed during the relativistic self-focusing of circularly polarized radiation [3, 4].

As a result, the generated axial magnetic field increases by more than an order of magnitude compared to the homogeneous case and becomes comparable in magnitude to the magnetic field of the laser wave. This opens a path toward achieving teragauss-level quasi-stationary fields at laser intensities of $10^{26}\ W/cm^2$.

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[3] Kim A, Tushentsov M, Cattani F, Anderson D and Lisak M 2002 *Physical Review E* **65** 036416

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