Self-guiding of electromagnetic beams in degenerate relativistic electron-positron plasma of gamma-ray sources

Nana Shatashvili [a,b] *and Vazha Berezhiani* [b,c]

e-mail: nana.shatashvili@tsu.ge

[a] Department of Physics, Faculty of Exact and Natural Sciences, Javakhishvili Tbilisi State University, 3, Chavchavadze Ave., Tbilisi 0179, Georgia

[b] TSU Andronikashvili Institute of Physics, Javakhishvili Tbilisi State University, Tbilisi 0177, Georgia

[c] School of Physics, Free University of Tbilisi, Tbilisi 0131, Georgia

The existence of soliton-like electromagnetic distributions in a fully degenerate electron-positron plasma was shown in [1] applying relativistic hydrodynamic and Maxwell equations. For a circularly polarized wave, it was found that the soliton solutions exist both in relativistic and nonrelativistic degenerate plasmas and the possibility of plasma cavitation was also shown. In present manuscript we apply the Fluid-Maxwell model of [1] to investigate the possibility of self-trapping of intense electromagnetic pulse in the transparent degenerate electron-positron (e-p) plasma in a limit of narrow pulse to demonstrate the formation of stable 2D solitonic structures in such media. It is shown that dynamics of such beams can be described by the generalized nonlinear Schrödinger equation with specific type of saturating nonlinearity. Existence of radially symmetric localized solitary structures is demonstrated. It is found that stable solitary structures exist for the arbitrary level of degeneracy. We have found the critical power for the self-guided propagation. The results of the given study can be applied to understand the radiation properties of astrophysical gamma-ray sources as well as may be useful to design the future laboratory experiments.

References

[1] V. I. Berezhiani, N. L. Shatashvili, and N. L. Tsintsadze, Phys. Scr., **90** (2015) 068005.