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Extremely Short Optical Pulses and Ads/CFT Compliance

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Abstract. Dynamics of few cycle optical pulses in non-Fermi liquid was considered. Energy spectrum of non-Fermi liquid was taken from the AdS/CFT compliance. Conditions of quasi-particle excitation existence were defined. Non-Fermi liquid parameters impact on the shape of few cycle pulses were estimated. It was shown that extremely short optical pulse propagation in the non-Fermi liquid is a stable pattern. The value of chemical potential has a significant impact on extremely short pulse shape. An increase in initial pulse amplitude does not result in pulse-shape distortions under its propagation in considered medium that is why the non-Fermi liquid can be used in applications inherent in extremely short pulse processing.

Keywords: extremely short pulses; Ads/CFT compliance

The use of the AdS/CFT compliance allowed to achieve essential advances in non-Fermi liquids property investigation [1-3]. As it is well-known the idea of the AdS/CFT compliance between conformal field theory and superstring theory in space-time with dimension greater by one unit lies in the fact that some effective conformal field theory on a “surface” which is a border of a “space” is associated with superstring theory in this “space”. Note that this compliance is namely that constructing the effective theory, which is equivalent to original one in sense of average computation, but gives the possibility to detect several characteristics of conformal theory, for example, such as Green's functions [4], which can be derived from the AdS/CFT compliance [5].

In its turn, among nonlinear optical phenomena upwards the pioneer papers [6,7], specific attention is attracted by so called extremely short light pulses (ESP). Note that ESP are localized in space electric field pulses. Their whole energy is concentrated in a bounded region of space. It can be said that ESP is a natural generalization of well known one-dimensional electromagnetic solitons [8,9] for non-integrable by inverse scattering problem method case. Note that initiation of solutions with localized energy even in one-dimensional case demands to take nonlinearity into account in case of medium which is characterized by dispersion.

Let us begin investigation of ESP dynamics with the fact that we know the dispersion relation E(p) for quasiparticles. Further in construction of ESP propagation model, we will describe electromagnetic field of a pulse by virtue of the Maxwell equations in the Coulomb calibration: $\mathbf{E} = -\partial \mathbf{A}/c\partial t$. Vector potential has the form $\mathbf{A} = (0, 0, A_z(x,t))$. Then to the planar wave front approximation (one-dimensional problem) we have the following expression:

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$$\frac{\partial^2 \mathbf{A}}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 \mathbf{A}}{\partial t^2} + \frac{4\pi}{c}\mathbf{j} = 0 \qquad (1)$$

where ***j*** is current generated by electric field pulse exposure onto quasiparticles. Here we neglect the extremely short pulse diffractive spreads out in directions perpendicular to distribution axis.

The expression for current density ***j***=(0, 0, *j*) may be written as:

$$j_z = q\int d^3 p v_z f \ , \qquad (2)$$

where the group velocity $v_z = \partial\varepsilon(\mathbf{p})/\partial p_z$, $f = f(p_\alpha, s, t)$ is distribution function implicitly dependent upon coordinate, moreover, the distribution function f at initial moment of time coincides with the Fermi equilibrium distribution function.

Energy spectrum of non-Fermi liquid ε(**p**) was taken from the AdS/CFT compliance.

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