Generalized Non – Local Quantum Hydrodynamics and Problems of Atom Structure and Lightning Balls

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The fundamental principles of generalized Boltzmann physical kinetics [1], as a part of non-local physics are delivered. It is shown that the theory of transport processes (including quantum mechanics) can be considered in the frame of unified theory based on the non-local physical description. Schrödinger equation (SE) reduces without additional assumptions to the system of continuity equation and the particular case of the Euler equation with the Bohm potential (Madelung's quantum hydrodynamics). The physical sense and the origin of the Bohm potential are established in the paper [2]. SE is the consequence of the Liouville equation as result of the local approximation of non-local equations.

Generalized Boltzmann physical kinetics brings the strict approximation of non-local effects in space and time and after the transmission to the local approximation leads to parameter of non-locality τ, which on the quantum level corresponds to the uncertainty principle "time-energy". Schrödinger equation is a deep particular case of the generalized Boltzmann physical kinetics and therefore of non-local hydrodynamics. However, SE describes also the evolution of *individual particle* in the form of Madelung's quantum hydrodynamics. It means that generalized hydrodynamic equations (GHE) deliver the possibility of through description of physical system from micro- to macroscopic level [2, 3]. In principal GHE (and therefore generalized quantum hydrodynamics (GQH)) need not in using of the "time-energy" uncertainty relation for estimation of the value of the non-locality parameter τ. Moreover, the "time-energy" uncertainty relation does not produce the exact relations and from position of non-local physics is only the simplest estimation of the non-local effects.

As example the solutions of the system of nonstationary 1D generalized hydrodynamic equations in the self consistent electrical field is considered. The system of GQH consist from the generalized Poisson equation reflecting the effects of the charge perturbations and the charge flux perturbations, two generalized continuity equations for positive and negative species (in particular, for ion and electron components), one generalized motion equation and two generalized energy equations for ion and electron components. Numerous results of calculations are delivered.

The soliton's type of solution of the generalized hydrodynamic equations for plasma in the self consistent electrical field with separated positive and negative components is found.

In comparison with the Schrödinger theory connected with behavior of the wave function, no special boundary conditions are applied for dependent variables including the domain of the solution existing. This domain is defined automatically in the process of the numerical solution of the concrete variant of calculations. From the introduced scales (written in usual notations)

$$u_0, \qquad x_0 = \frac{\hbar}{m_e}\frac{1}{u_0}, \qquad \varphi_0 = \frac{m_e}{e}u_0^2,$$

$$\rho_0 = \frac{m_e^4}{4\pi\hbar^2 e^2}u_0^4, \qquad p_0 = \rho_0 u_0^2 = \frac{m_e^4}{4\pi\hbar^2 e^2}u_0^6$$

only one parameter is independent – the phase velocity u_0 of the quantum object

Fig. 1, 2 displays the typical quantum object placed in bounded region of 1D space, all parts of this object are moving with the same velocity. Figures 1, 2 reflect the following Cauchy conditions (written in Maple notations):

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v(0)=1,r(0)=1,s(0)=1/1838,u(0)=1,p(0)=1,
q(0)=0.999,
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D(v)(0)=0,D(r)(0)=0,D(s)(0)=0,D(u)(0)=0,
D(p)(0)=0,D(q)(0)=0.
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On figures the following dimensionless values are used: r- density $\tilde{\rho}_i$, u- velocity $\tilde{u}$, s- density $\tilde{\rho}_e$, p, q – pressures of ion and electron components correspondingly ($\tilde{p}_i, \tilde{p}_e$), v – self-consistent potential $\tilde{\varphi}$ in quantum soliton, t is dimensionless coordinate in the coordinate system moving along the positive direction of x-axis in ID space with velocity $C = u_0$ equal to phase velocity of considering quantum object $\xi = x - Ct$.

Important to underline that no special boundary conditions were used for all considered cases, then this soliton is product of the self-organization of ionized matter.

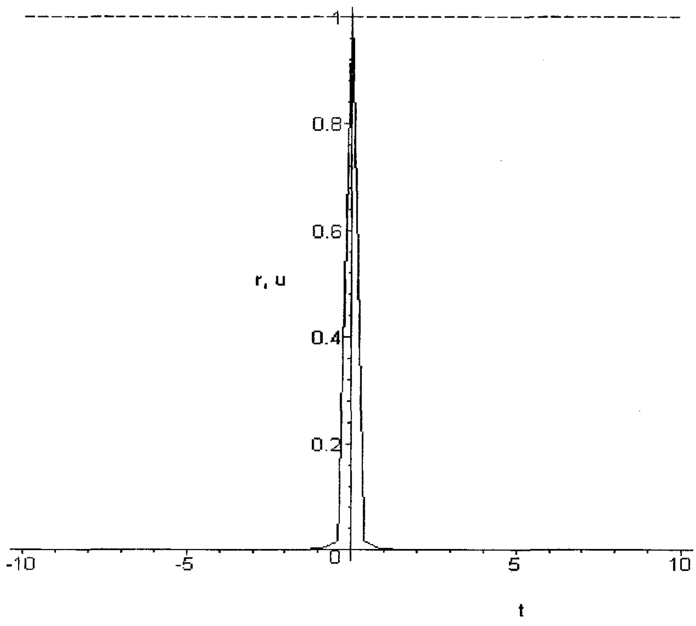

Fig. 1 r - density $\tilde{\rho}_i$, u - velocity $\tilde{u}$ in quantum soliton

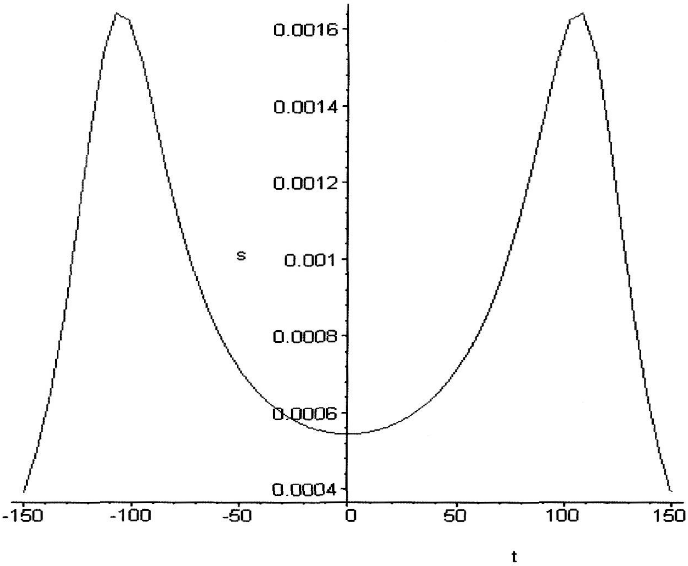

Fig. 2. s - density $\tilde{\rho}_e$ in quantum soliton

The solitons have the character of quantum objects (with the separated *negative or positive* kernel and *positive or negative* shells) if the initial rest pressures of non-local origin for the positive and negative components are not equal each other, and objects reach stability as result of equalizing of corresponding pressure of the non-local origin and the self-consistent electric forces. These effects can be considered also as explanation of the existence of atom structures and lightning balls.

If the initial rest pressures of non-local origin for the positive and negative components are equal each other but the quantum object is moving in the periodic resonance electric field, the mentioned quantum object is the stable soliton. This effect can be significant for nanoelectronics. In this case disappearing of the mentioned field leads to the blow up destruction of soliton. The delivered theory demonstrates the great possibilities of the generalized quantum hydrodynamics in investigation of the quantum solitons.

The usual Schrödinger' quantum mechanics cannot be useful in this situation, because Schrödinger – Madelung quantum theory does not contain the energy equation in principal.

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1. B.V. Alexeev B.V. Generalized Boltzmann Physical Kinetics. (Elsevier, 2004).

2. B.V. Alexeev, Journal of Nanoelectronics and Optoelectronics, Vol. 3,143 (2007).

3. B.V. Alexeev, Journal of Nanoelectronics and Optoelectronics, Vol.3, 316 (2008).