Theory Views of New Experimental Observations of Solitons in Quasi 1D Conductors.

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Physics of solitons in electronic processes was brought to the science of synthetic metals in 1970's through theories of charge density waves (CDW). It was boosted in the 1980's epoch of the polyacetylene and the SSH model. Solitons have reentered in 2000's through the discovery of the ferroelectric charge ordering in organic conductor[1] and via new nano-scale experiments[2,3] in CDW materials. Corresponding dynamical processes - instantons are responsible for subgap transitions leading to a pseudogap formation[4]. We are concerned with Electronic Crystals like Charge Disproportionation and CDWs, while their Wigner forms are also known in nano-wires and expected in doped polymers. Their common property is a deep selftrapping of electrons and their pairs into solitons, polarons, bipolarons. The theory tells[1-4] that here the electronic processes (dynamic - optics, tunneling, kinetic - conductivity, static - doping, field effect) goes on via discommensurations, dislocations, solitons. We shall demonstrate that all these effects appear in contemporary experiments. We shall recall experiments confirming solitons in organic metals, and particularly concentrate upon latest direct observations of microscopic solitons in processes of the coherent interlayer tunneling in inorganic CDWs[2,3]. We shall describe special nano-scale devices were fabricated from the chain compound NbSe3 using focused ion beams[2,3]. Tunneling spectra were drastically refined by working at high magnetic fields. Experiments[2] prove that the internal quantum tunneling of electrons goes through channels of solitons, which might correspond to the long sought special quasiparticle - the spinon. The same experiments give access to reversible reconstruction of the junction via spontaneous creation of the solitonic lattice grid[3]. Its formation shows up through the staircase structure of the subgap tunneling spectrum. Most of tunneling takes place in the cores of the solitonic grid. The resolved tunneling in the normally forbidden subgap region recovers collective quantum processes like coherent phase slips[4].

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