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SEQUENCE FROM MANY SOLITARY ELASTIC WAVES WITH DISCRETE, TWICE DOWNWARD DECREASING, STARTING FROM A SPEED OF SOUND, VELOCITIES EXCITED BY A SINGLE-PULSE IN CONDENSED MATTERS

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*There were explored at standard conditions samples of many materials as Syngle crystal or poly-crystallic (belonging to 4 basic types of crystals), and amorphous, jelly-like and fluids (water and alcohol). Thus some different methods were applied for measuring of a material parameter variations in explored waves. The waves of change of reflection and conduction (WCRC) recorded as with the help of indirect (optical features, conduction, self-IR radiation), and direct measuring of a variation of pressure (by quartz pressure pick-up) and temperature (by the thermocouple). The investigation results were endorsed as team workings with a series of groups in Russia and abroad, and results of the independent publications (after their relevant analysis). So, for example, from the analysis of independent works was clarified, that the excitation of a considered sequence of solitary waves happens not only at action of a laser impulse, but also at pulse of an electron beam action or by shock of a super-sound body. Besides it was clarified, that the slow waves - WCRC-components can be excited at gradual increasing of electron beam intensity or gradual introduction of a static mechanical loading. Though the mechanism of phenomenon yet does not set, but the experiments display, that its nature is **different from the sound wave** mechanism. The point is that the temperature dependence of WCRC velocity in the case of a series of explored materials is **inverse** of similar dependence of a sound velocity in the same material in investigated temperature range.*

Introduction. Experimentally established since its finding in 1992 [1] 3-dimensional many components soliton-like wave structure presents a new variety of transfer phenomena in condense matter (see review in [2]). The mechanism of this wave structure is not known yet. It was temporally (up to its mechanism understanding) called Wave of Changing of Reflection and Conduction (WCRC). N.Zabussky suggested the title “multi dimensional wave structure of the soliton-type” for it. Our goal now in experimental work - do not loose the most general, qualitative properties of WCRC important for adequate mechanism development.

The most important WCRC properties and its discussion. One can find here the list of in our opinion the most important WCRC properties as withdrawn from many experimental results for different materials.

1. Excitation conditions. WCRC is excited by a *single* IR laser (or electron beam) -pulse with a threshold ~10 kW/cm$^{2.}$ or by mechanical shock of corresponding strength. Up to last years all the experiments were fulfilled with IR laser pulse excitations [2]. Later on it start to be clear that e-beam produce WCRC excitation [4] in massive Cu-sample. Typically, very homogeneously irradiated 10x10 mm^2 spot on the 3 mm thick wall Cu-tube got the beam energy during ~ 100-200 sec. The rather slow increasing of e-beam density at the beginning (during ~1 sec from 0 to 5 kW/cm^2) correlated in this experimental work with slow velocities of registered WCRC components: U_i ~ 0.01 cm/sec.

Another way of WCRC excitations was found by analysis of Abramova’s group works [5]. Flat shock of Cu-cylinder (35 mm in diameter, 25 or 50 mm long) with 0.8 km/sec moving metal projectile produced excitation of WCRC components with velocities v_l /16, v_l /32, where v_l is longitudinal sound velocity The slow loading by 0.5-8.0 t of Cu-sample (150x100x6 mm^3) showed excitation of WCRC components with U_i ~ 0.2 cm/sec.

2. Discrete values of WCRC component velocities. WCRC consists *of a* series of about 30 solitary *pulses (components)* with propagation velocity U_i of each subsequent pulse decreasing in two times, starting from v_l , so

$$U_i \cong v_l /2^i . \qquad (1)$$

So U_i changed from *km/sec* for $U_o = v_l$ up to *μ/sec*, in the 10^9 range, namely, $v_l \geq U_i \geq U_{30} = 2^{-30} v_l$

This statement supposed to be correct generally although it was concluded [6] on the ground of non systematic, fragmentary data of WCRC velocities measurements. As example, such a data on the excitation of WCRC with $\boldsymbol{i}$= 24-26 was shown for poly-crystal Cu-samples [4] by temperature variations registered by thermocouple, and for single crystal Si-sample – with $\boldsymbol{i}$ = 18 [7]. Then for the same Si-sample the WCRC component excitation with $\boldsymbol{i} \cong$ 10,11,12 and 14 was found from independent heat conductivity measurements made in IGP of RAS by laser flash analysis method [7].

Although the measurements were not systematic it is logically to suppose that for each specified material the regularity (1) will be correct also.

3. The geometrical size of excitation region. The geometrical size (half width of pulse, $\boldsymbol{L}$) of all measured different velocity WCRC components are of the same order, namely, (2÷5) mm. One can write $L_i = U_i\ t_i$, where t_i is the time for WCRC component to pass the detector. Then from experimental fact L_i=const and from (1) it is follow that $t_i \sim 1/U_i \sim (2)^i/v_l$. So it takes more and more time for more later (up to i~30) WCRC components to appear from excitation area of the sample. That times must be very long and it is worth special investigating (our attention to this fact was called by I.L.Fabelinsky).

4. The sign of variations in WCRC. Reversible variation of measured function in WCRC is usually of one sign for investigated material. The sign of registered variation does not changed nor once nor repetitively like at harmonic oscillations. The example of a sigh behavior presents Fig.1 a),b)

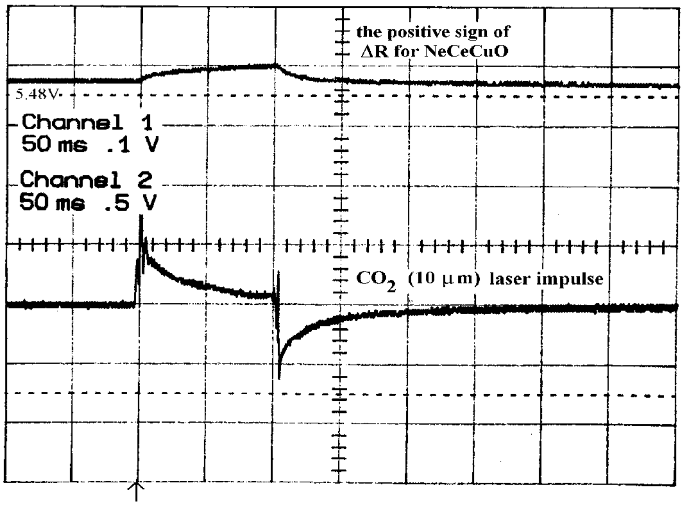

Fig. 1 a).

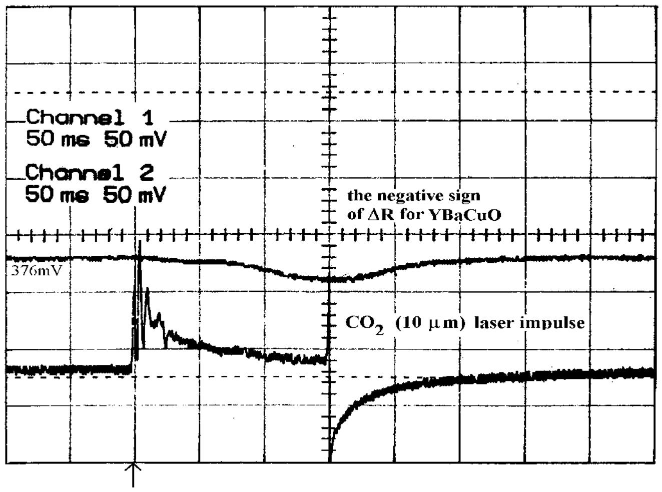

Fig. 1 b).

here (which are Fig.3 a), b) from [8]) where registered ΔR variation has *positive* sign for NdCeCuO - and *negative* sign for YBaCuO (both ceramic HT SC sample were excited by the same IR CO_2 laser pulse). We can note that the reason of different variation sign is not clear and does not follow simple assumptions (see chapter 3 of [9]).

5. Constant value of WCRC velocity. WCRC component velocity $U_i(x)$ is nearly constant when this component propagate trough the sample of different thickness. It was experimentally checked as for single crystals as for poly-crystals like metallic (Cu) or ceramic (HT SC NeCeCuO, YbaCuO) samples. It is out of the question [8] that registered process of WCRC propagation differs from diffusion process in principle.

6. WCRC ability to be effectively reflected. WCRC is *reflected many times* from sample surfaces without changing the sign and with loosing of ~(1÷10)% in velocity at one reflection.

7. WCRC excitation in the very different condense materials. WCRC was registered (with different efficiency) in the very broad collection of condense materials: *Single (or poly-crystals)* of all 4 main crystal types (covalent, ionic, molecular, normal and synthetic metal [2,4,9]); *amorphous solids* [2,9], *polymers* like plexiglas (PMMA) [10] or rubber [11].

8. Temperature WCRC velocity dependence. Temperature WCRC velocity dependence $U_i(T)$ is *opposite to analogous dependence of sound velocity* v_l as it was shown for about 10 different investigated solid state materials [2,12-14]. If to look at fluids, it appears, that a unique fluid is the water (together with its isotopically changed *heavy water*). Water has abnormal, - incremental, - dependence of a speed of sound on temperature at standard atmosphere pressure in an interval of easily accessible temperatures (0-:-70)°C. For all remaining fluids under the same conditions the speed of sound decreases on temperature increasing. It has allowed us to make a following prediction [15] on the ground of investigation results [13] of comparative behavior of temperature dependencies of WCRC and sound velocities for a series of solids (with normal and abnormal dependencies of a speed of sound). « If we will succeed to find in fluids soliton-type excitations inherently similar of objects, which one we found in solids, it is necessary to expect their following properties. The velocity of WCRC components in water should decrease on temperature, whereas for any other fluids (except for a heavy water) it will grow ». In [16] the indicated excitations in water were detected. Later by same method it was exhibited, that, really, according to our prediction [15], the temperature dependencies of slow solitary waves for distilled water and ethanol have appeared opposite. Besides all retrieved quantities of velocities U_i correspond (with values i =19, 20, 21, 22) to a *condensed matter* relation (1) : $U_i = 2^{-i} v_l$, where through v_l the speed of *longitudinal* sound is marked (now it is important, that in liquid there are *only longitudinal* sound waves).

Such experimental results for solids and liquids prove our opinion that WCRC has *another nature* then usual sound waves.

It is interesting that the same velocity behavior follow, by our opinion, from model of topological Frenkel -Kontorova soliton [17], although temperature soliton velocity dependence there was not discussed in their works.

9. Wide set of WCRC velocity measurement methods. Measurements of U_i -values were obtained from variations either of optical constants (reflection ΔR, transmission or absorption) or of the temperature ΔT (measured by IR radiation and thermocouple); or of the pressure Δp; or of the conduction. All this measurements are in agreement each with another: $\Delta R \sim \Delta p \sim \Delta T \sim (10^{-3} \div 10^{-4})$.

Acknowledgments. Author express his gratitude to A.M.Baldin, A.M.Prokhorov for interest to investigation and support; L.V.Keldysh, I.L.Fabelinsky, N.Zabussky, M.I.Rabinovich, L.A.Ostrovskii, P.D.Weidman, A.B.Ezersky - for discussion, V.I.Emel'yanov for theoretical support of investigations, K.B.Abramova, I.P.Scherbakov, A.V.Varava, A.V.Dedov, A.T.Komov, V.S.Konov, V.S.Ral'chenko, A.I.Vlasov for cooperation and experimental data giving, E.N.Lotkova, B.G.Makeev, V.V.Krivov for help in experiments.

This work was sponsored partially by RFBR (Russia), and partially - by government of France, Japan Society for the Promotion of Science, and KIE.

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