Superluminal transmission of the information

And its applications in Communications and Computer

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***Abstract*—**We have proved the superluminal transmission of information is certainly possible in the theory and computer simulation, Meanwhile this paper discussed the contradiction between Special Relativity and superluminal phenomena from three aspects: 1, epistemology; 2, the defects of SR and 3, the special character of SR. Pointed out the superluminal is a natural phenomenon; the velocity of bodies is no matter with the SR. Our results provide the theoretical foundation to develop the superluminal communications and computers, also support all of the discovery of superluminal events.

Keywords*—Superluminal transmission of information; Special Relativity; Superluminal communications and computers; 3z "Time compensator";*

I. INTRODUCTION

Today with the development of INTERNET, the information needs to be exchanged increate rapidly day by day. Meanwhile the development of astronautic Science and interstellar communications also require improving the precision and speed of the remote control and signal detection. All these mean that we still will need to seek a new information transmission technique with higher capacity and speed both in communications and computer area. As we know, any communication and computer system contains two parts: the signal treatment and the signal transmission. Here we will only focus on the signal transmission part. In digital communications era, the information transmission is by virtue of coded pulses; just as traffic, transmission capacity is proportional to the signal speed, thus the transmission capacity and speed convert to the problem of pulse transmission speed. WKD experiment [1] has showed that the light pulse can travel faster than c – the speed of light in vacuum. Recently some scientists are interesting the superluminal transmission of Electro-magnetic in some solid materials. If such a superluminal pulses can be used to transfer information, then the manner of communication and the computer run rate will change dramatically. But according to the conclusion of Einstein in Special Relativity, nothing （including signal）can move faster than the speed of light c [2]; Sommerfeld and Brillouin also said the energy transport velocity v_e must be less than c in a dispersive dielectric [3, p.120]. Here we shall prove all of these conclusions are wrong, and the information can be superluminal transmission certainly.

II. SUPERLUMINAL PROPAGATION OF LIGHT PULSE

A. The velocity V_e of the energy transport can faster than c;

For realizing the superluminal transmission of the information, firstly we have to clarify that if Superluminal Pulse as an information unit is real or virtual. According to the definition of v_e the energy flux density I is defined as the energy passing through a surface of unit area perpendicular to the direction of propagation per second, $I = \omega V_e$ [3,4]. The key problem still is **what is the energy density in medium through which the wave is propagating?** We think that should only be the energy density of the electro-magnetic wave, and the internal energy of media doesn't participate in energy transport. For monochromatic wave we can get [4]

$$v_e = \frac{1}{\sqrt{\varepsilon\mu}} = v_p \tag{1}$$

For the light pulse after considering the interference overlap of monochromatic wave (see section 2.21), we have $v_e \approx v_g$. As we know both the v_p and v_g can larger than c; the superluminal pulse is real and not virtual has also been proved by the fact of that the superluminal pulse is detectable [1].

B. Superluminal propagation of light pulse,

1). Theoretic demonstration,

Supposing the waveform of light pulse is U(r,t), according to the definition, we have**[4]**

$$U(r,t) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} A(\omega)e^{i(\omega t - kr)}d\omega \tag{2}$$

$v_p = \omega/k = c/n$. ignoring absorption and gain and supposing the dispersion that the can cause an additive phase change for each component is linear. Let ω_o is the central frequency, with a refractive index n_0, thus for an arbitrary component frequency is $\omega = \omega_o + \Delta\omega$ with the index $n = n_0 + \frac{dn}{d\omega}\Delta\omega$. Consider the variance of n and ω in equ. (2). Taking a first order approximation, we can get

$$U'(r,t) = \frac{2}{\sqrt{2\pi}}\frac{\sin(t - \frac{r}{c}(n_0 + \frac{dn}{d\omega}\omega_0))\Delta\omega}{t - \frac{r}{c}(n_0 + \frac{dn}{d\omega}\omega_0)} \times \tag{3}$$

$$A(\omega_o')\exp[i\omega_o(t - \frac{r}{c}n_o)] = C(r,t)\exp[i\omega_o(t - \frac{r}{c}n_0)]$$

After reshaping it becomes a new pulse represented by the enveloped function C(r,t), with the peak at

$$t-\frac{r}{c}(n_0+\frac{dn}{d\omega}\omega_0)=t-r/v_g=0 \qquad (4)$$

This peak moves with a velocity of:

$$v_g = c/(n_o+\frac{dn}{d\omega}\omega_0) = \frac{d\omega}{dk}\Big|_{k_0} \qquad (5)$$

Since the dispersion can be positive or negative, so that the group velocity v_g can be less than, equal to or larger than c, even be a negative value. We think the pulse is only a collection of photons or electric field in time and space, and the negative group velocity is faster than infinite. In such condition the Special Relativity is invalid, neither does the addition theorem of velocities

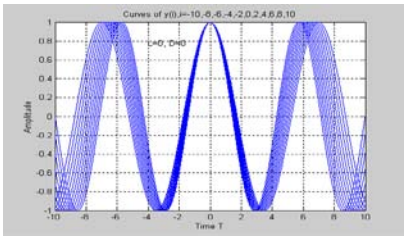
B. Computer simulation.

To prove the correctness of our theoretic calculation, we study the propagation behavior of a pulse consisting of 21 Cosine waves by virtue of computer simulation. The expression is as following

$$Y=\sum_{i=-10}^{i=10} y(i)=\sum_{i=-10}^{i=10} \mathbf{Cos}[\omega(i)(\mathbf{t}-\mathbf{L}\times(\mathbf{no}+i\times\frac{\mathbf{dn}}{\mathbf{d\omega}}\times d\omega)/c)]$$

$$\omega(i)=\omega_0+i\times d\omega \qquad i=-10:10 \qquad (6)$$

Taking the parameters as ω_0= 1， $d\omega = 1\times10^{-2}$, n_0 = 1, c = 1. For different D=dn/dω the calculating results are shown in fig. 1-3. We can see that in dispersing medium the behavior of pulse propagation is different from that of each individual component. The simulation results fully reveal the characters of group velocity. When dispersion changes, the group velocity also changes accordingly. Let the original pulse position be at L = 0.



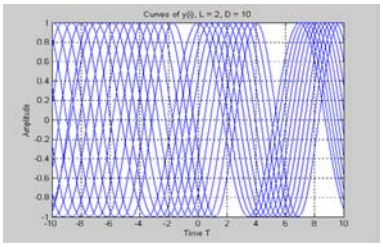


Fig.1, 21 cosine waves and their propagation

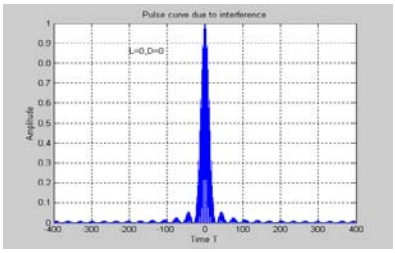
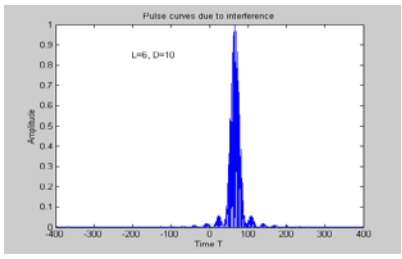
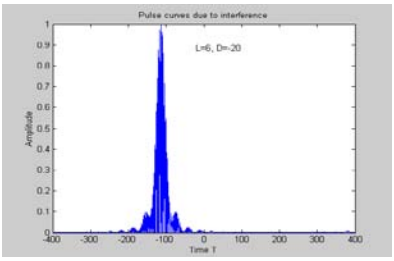
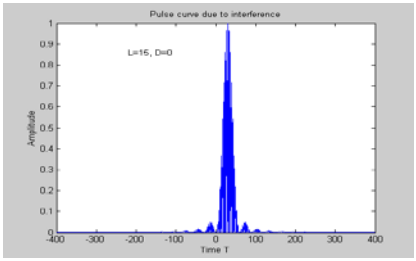
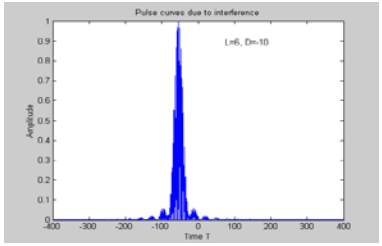


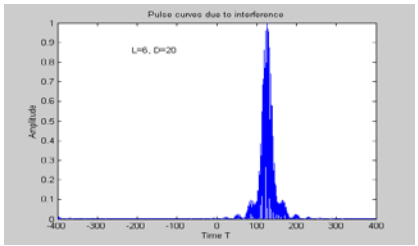
Fig.2, Light pulse compounded with 21 cosine waves











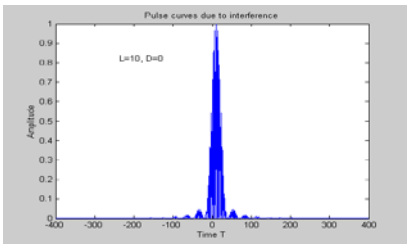


Fig.3. Propagation of light pulse in medium with different dispersion.

The arriving time of the pulse to position L = 6 is varies with media parameters (Fig. 3). Put the values of L, D = dn/dω，c and ω_0 in equ.(6), calculated value t coincides with that shown in fig.3. When $v_g < 0$, the arriving time is negative, and the output pulse leaves before input pulse reaches, the time advance occurs. It means the negative v_g is faster than infinite, since for an infinite velocity we can only get t = 0. For example, when D= -10, we get time t = -54; and D = -20, t = -114. These results show in fig. 3. We also proved that the amount of time advance is proportional to distance L. When D= 0, the transmission velocity of light pulse is determined by phase velocity v_p. These simulation results also show that the pulse can broaden, deform, and even split. If put A(ω) in equation (12), we also can study the propagation of any light pulse by computer simulation. Here we have to say the dispersive force is a kind of magical force.

The simulation results affirm the rationality of our point of view and calculation. The results show that the behavior of light pulse is different from that of its components. Each component has the phase and energy transport velocity c/n(ω), but the velocity of the pulse resulting from interference overlay of all components is the group velocity v_g. The difference between those two velocities rests on the dispersion, and sometimes, this difference can be as far apart as heaven and earth;

III. BRIEF DISCUSSION ABOUT THE CONTRADICTION BETWEEN SUPERLUMINAL PHENOMENON AND SR.

Most people think that the superluminal propagation of light pulses violates the conclusion of the Special Relativity (SR) and is impossible. Here we shall address this question from three aspects:

1, Epistemology;

2, the defect of SR;

3, the character of SR,

A. Epistemology Difference between Relativity and Classical mechanics

1). Objective epistemology: external world exist objectively and independent of our observation. All of the bodies in the external world constitute an **objective world** are independent of the observation. Physics, mathematics, classical mechanics, quantum mechanics etc. all belong to this epistemology category. These subjects are dealing with objective or real law of variance or movement of body (of course not all bodies). All of these subjects recognize the Superluminal phenomena. This is the reason of that classical and quantum mechanics conflict with the Relativity.

2), Subjective (or visual) epistemology: the existence of bodies around us is recognized due to that we receive a signal from them on retina and produce a vision sense, i.e. we recognize the bodies through the observation. Since the value of light velocity is limited, signal from body to eyes need a certain time $\Delta t = L/c$. For a moving body, when you have seen, it has left original position by a distance of

$\Delta L = \vec{v}\Delta t = \vec{v}L/c$,(or $\Delta L = \int_0^{\Delta t} \vec{v}dt$), here v is moving velocity. The object you seen is only an image of such body (Δt ago). For example, the sun you seen is the image of 2.5 minute ago. In such case all these discussions only refer to the image of body, and not the body itself. All images seen by us constitute a **virtual world**. In this kind of epistemology, the observer is at the center of all events, and all observed results are relative. Astronomy and Relativity both belong to the Subjective (visual) epistemology - the observed result depends on the observer. This is why such theory is called as Relativity and it study the visual law of body motion, so that can be called as visual subjects also, and its research always bound with light velocity. Because the value of light velocity is limited, the visual law is different from the real law of body motion. The larger the velocity and the farther the distance, the more is the difference.

B, The defect of SR and Confusion caused by Lorentz transformation.

1. A very important result of Lorentz transformation is contraction of ruler, and retardation of clock in moving system [5,6], there are some strangeness in such situation. Suppose we have two systems A(x,y,z.) and $A'(x', y', z')$ with relative motion velocity v. Form the Lorentz transformation

We can get

$$x_2' - x_1' = (x_2 - x_1)\sqrt{1-(v/c)^2}; \quad t_2' - t_1' = (t_2 - t_1)/\sqrt{1-(v/c)^2}. \quad (7)$$

And from its reverse transformation, we also can get

$$x_2 - x_1 = (x_2' - x_1')\sqrt{1-(v/c)^2}; \quad t_2 - t_1 = (t_2' - t_1')/\sqrt{1-(v/c)^2}. \quad (8)$$

An observer in system A sees the ruler contraction and clock retardation in system A', but for other observer in system A', the ruler contraction and clock retardation also happen in system A. which one is correct?

2. Addition theorem of velocity.

$$u = \frac{u' + v}{1 + \frac{u'v}{c^2}} \quad (9)$$

The question is that here v is the relative velocity of two system, but u and u' is the velocity in different system. According to Lorentz transformation, the units of time and length are different in two systems, and the velocities, with different time and length units in different systems, are different as well. How can we put them together to plus or minus? Who can do that? We think perhaps the formula (9) should change its name and called as the corresponding theorem of velocity. i.e. the velocity u in system A corresponds to a velocity u' in system A' - they have different units and are different quantity. Between them, there only has a corresponding relation.

3. The principle of light invariance is incorrect.

Einstein had a famous thought if you follow a light beam go forward look at another light beam it still travels with c, that is the rudiment of the invariance of light velocity, but the interference of two light beam shows this thought is not correct, also violates the principle of all observation result is relative. We think the light velocity depends on the situation of the observer and isn't invariable.

We still can list more questions in SR that means some contents and conclusions of SR may incorrect.

C. Specific character of the SR.

The core of SR is Lorentz transformation that got from so called the time space invariance

$$x^2 + y^2 + z^2 - (ct)^2 = x'^2 + y'^2 + z'^2 - (ct')^2 \quad (10)$$

In our opinion this formula isn't suitable for visual mechanics since it violates the relativity of the light velocity, but it valid under this hypothesis let the interval of events [7] in two vacuum system equal, both sides in equ. (10) corresponds different system and observer. On the other hand for the real visual mechanics only one observer has, the time space invariance should be

$$x^2 + y^2 + z^2 - (ct)^2 = x'^2 + y'^2 + z'^2 - (c't')^2 \qquad (11)$$

In different system the light velocity is different certainly, since c ≠ c', from equ.(11) can't deduce the Lorentz transformation, so that Lorentz transformation is not the time-space quantities transformation of real visual mechanics, that corresponding to Galileo transformation. The valid condition for formula (10) has to change as the interval of event invariance. So that SR is a methodology and not a universal truth. Its prerequisite is v < c, since If v >c, the x, y, z will be imaginary. Therefore we said by using SR to deny the superluminal phenomena is reasonable, also SR is not suitable to discuss the superluminal problems; we have said the superluminal is a natural phenomenon, the velocity of electro-magnetic wave (include pulse) is determined by the electro-magnetic properties of the transmission media and the character of the body motion determines its velocity and all velocities of body depend the situation of the observer as well as no matter with the SR.

Ⅳ. APPLICATIONS

We study superluminal transmission of the information aim at following applications:

1. Raise the operation speed of the computer;
2. Develop the superluminal communications.

As the signal velocity goes up, the capacity of communication system increases accordingly and the computer run rate will raises. We have discussed the possibility of the superluminal communications [8,9]. We think the key measure is to keep the signal travel in a linear transparent **higher** negative dispersion region. Gain-aided technique is one choice of the measures. Our opinion is that the superluminal communication can simplify the communication system, a single channel can transfer several Tbits information, thus avoid multiplexing and de-multiplexing and compensation of non-linearity and dispersion techniques. In our opinion, only after established the superluminal communication system, we can say we have construct the information highway. The superluminal propagation of light pulse in fiber has been observed [10]. In 1997, Nimtz had realized the superluminal propagation of information [11] in barrier. All of these prove the possibility of superluminal communications. Especially since the phenomena of time advance of pulse with negative group velocity (L= v_g t) can make a "time compensator" we call as "3z compensator" to short the time of information transmission for improving the capacity of remote control and telemetry, the superluminal communication technique also create a new way for interstellar communications. The technique of superluminal transmission of information also can be used to raise the computer run rate, some scientists have pay attention to search for the special solid material for realizing the superluminal transmission of electric signal now.

Ⅴ. CONCLUSION

We have study the superluminal transmission of information for more than 10 years in theory. Our research have revealed the theoretic foundation of superluminal propagation of light pulse, and raised the question that the invariance principle of light velocity may be incorrect. The superluminal propagation of the information will be a certainty, but it is still long way to go to make it practical in communication and computer technologies. The first thing we need to do is to find a transparent material with higher linear negative dispersion in fiber communications and new material in computer. We also need to reveal the implication and revise the error in the SR and create a correct and real visual mechanics to fully understand the influence of light velocity on study the law of body (including celestial) motion. We would like cooperate with anyone who interesting such area.

REFERENCE:

[1] L. J. Wang, A. Kuzmich & A. Dogariu; Nature, 406, 277 (2000).

[2] A. Einstein, The principle of Relativity and Its Conclusion, Einstein's Corpus, Vol.2 (Business Press, 1977 Peking). 151. Translated from "Jahrbuch der Radioaktivitat and Electronik", 1907 Vol.4 PP411-462

[3] Brillouin. L, Wave Propagation and Group Velocity, (Academic Press, New York and London, 1960).

[4] Zhang zi hua, Zhang hua an, Study of Superluminal Phenomena and Its influence on Physics and Informatics, 6th annual meeting of photonics of China. Oct. 2008, ZhongQing, Chinese Scientist,

[5] Zhang zi hua: Reshape and superluminal propagation of light pulse in negative dispersion media . Chinese Scientists , 2011, N0.1, p1-7.

Zhang zi hua, Zhang hua an, Cause of superluminal transmission of light pulse and Photon Capture (AOM 2010 OSA-IEEE Topical Conference, Advances in Optoelectronics & Micro/nano-Optics, 3-6 Dec, 2010, Guangzhou, China)

[6] A. Einstein, Relativity, (in Chinese, translated by Yi Hong Bo, Li Zhi Mou), Press of Jiangsu People, 2011, Jan.). A. Einstein; Relativity, (Methuen & Co Ltd，Dec. 1916).

[7] Chen wang Peng et. Handbook of university physics, Science and technology Press of Shang Dong, 1985 Ji Nan China.

[8] Zi Hua Zhang, Special way of Optical Communications —the technique of superluminal communications, (Instrumentation, Measurement, Circuits and Systems I, Springer, 2011) P.145-153.

[9] Zhang zi hua：Is Superluminal communication possible? (科技纵览) IEEE Spectrum 2013.09, p.68.

[10] Zhang L, Zhan L, et al, Superluminal Propagation at Negative Group Velocity in Optical Fibers Based on Brillouin Lasing Oscillation, Phy. Rev. Lett. 107, 093903,(2011).

[11] Nimtz G, Heitmann W. Superluminal photonic tunneling and quantum electronics. Prog Quam Electr, 1997, 21(2), 81~108.