the general science journal

Superluminal motions

Petr Křen © 2016
pkren@cmi.cz

***Abstract**: The mainstream theory claims that superluminal motions are not possible. Nevertheless, it is valid only for fields. Particle superluminal motions can explain more than one could think.*

***Keywords**: superluminal motion, retarded potential, speed of light, parity*

The finite speed of interaction (e.g. speed of light) is a speed of propagation of retarded potential (like the Liénard–Wiechert potential or similar to one in the Whitehead's theory). The periodic motion of sources (charges, masses) generates potential waves propagating with this speed. And the change in this motion corresponds to the radiation.

The acceleration (force) corresponds to the gradient of potential. The potential waves propagate with the speed of interaction and thus they cannot produce superluminal motions (e.g. in electrodynamic accelerators). However, the static potential can because there is not a retardation effect (and it allows stable orbital motions because the Larmor formula is based on the Lorentz factor that is not generally valid and it leads to e.g. the paradox of a charge in a gravitational field - the retarded potential approach is needed for accelerated charges instead of the Lorentz invariance ansatz or the Maxwell equations). We learn in schools that the proper time of an infall to the gravitational “black hole” is finite in the general relativity theory for the Schwarzschild metric (although the coordinate time of infall for a distant observer is infinite - i.e. the observer somewhere outside will receive information of infall via interaction waves (with finite speed of light) within a finite time but the number of periods (defining the time duration by a clock realization) of this information will be infinite (light is swept over gamma ray frequencies) thus observer will deduce infinite time of infall but the real (proper) time is finite - relativistic observational/coordinate limits are not real limits because the concept of observers (observing via variation of radiation) is not generally valid). Also we could see in this solution that speed below the “event horizon” is superluminal in proper units (i.e. it is like the classical solution). The similar transition for an infalling charged electron is the atomic nucleus (observed as stable with neutron skin a few femtometers in size). Almost static potential of nucleus (that is nearly the same as retarded potential in this case) “classically” accelerates infalling electron irrespectively on its relative speed (and the relativistic Lorentzian mass increase could not applied) and it goes through the superluminal boom (“light barrier”). Nevertheless, the current knowledge does not allow a correct description of (strong “stabilization”) mechanisms close to the central “singularity” that cannot be reached. These mechanisms can also produce a residual charge potential that could be linked to the potential of mass (emergent gravitation with the same speed of propagation).

It is known that the potential of charge is isotropic in the rest (i.e. our 3D space is isotropic). It was also shown that the retarded potential is isotropic (the Lorentz factor was introduced by the special theory to preserve isotropicity broken by an increase of potential in transversal directions that could squeeze particle, directionalize spin, decrease cross section and increase stability - however, it depends on the inner structure) with respect to the recent position for the uniform subluminal speed movement [1]. However, we can see in the figure 1 below that a uniform superluminal speed produces anisotropic potential (with a factor analogical to the Mach number) and needs a more general theory. I.e. electric (*v*=0) and “magnetic” (*v*<*c*) interactions conserve parity but the “week” interaction (*v*>*c* of source) do not. Now we can clearly understand why this week interaction is confined in atomic nuclei. Atoms are like galaxies with central sources of “parity violation” (from “the arrow of time”). The changes in potential waves (signals propagating in vacuum at the speed *c*) from charge (“electroweak” interaction) have two forms: electromagnetic radiation (“photons”) from subluminal charges and “weak” radiation (“neutrinos”) from (“tachionic”, causality “breaking”, Lorentz-violating oscillations of) superluminal charges (the half-integer spin/tensor/pseudovector was introduced to distinguish radiation with two involuted shock wave “wings” - conic sides).

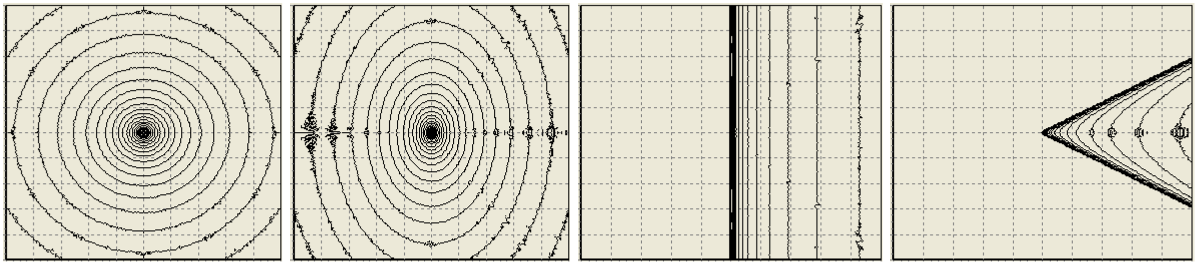

Figure 1: Logarithm of the retarded potential of uniformly moving charge (*v*=0, *v*<*c*, *v*=*c*, *v*>*c*) with its current position in origin [0,0] (the centre of each chart). The charge of particle does not vary in time.

Nevertheless, the subluminal (rectilinear) current (multiple particle/charge beam/ray) does not decelerate (radiate) by itself because each particle is in a symmetrical contribution of scalar potentials from particles ahead and behind while the superluminal current does according to its asymmetry (the rate of deceleration depends on current density - i.e. distances between individual charges - however, the isotropic movements of charges like in a gas do not radiate). However, the circular or accelerated (periodical) rectilinear current (particle beam) radiates also for subluminal currents (total retarded scalar potential is asymmetric along their paths) while single individual particle (charge without current and corresponding magnetic vector potential) do not (stable orbit in field of static charge). I.e. the magnetic vector potential (and the Lorentz gauge) was introduced to simplify expression of potential for sets of charges (with the general unique space and time distribution and thus the vector potential can be equivalently expressed in terms of scalar potentials without gauges) and it cannot be used in all cases ($\vec{A} = 0$ for particle “picture”).

The “quantum” behavior can be introduced e.g. by an “intrinsic” periodic variation of charge in time [2] (like bouncing droplets in fluid hydrodynamic analog) and it could explain e.g. the quantization of orbits. In the case of charge variation, the instantaneous pattern is also asymmetric for subluminal speeds (see figure 2).

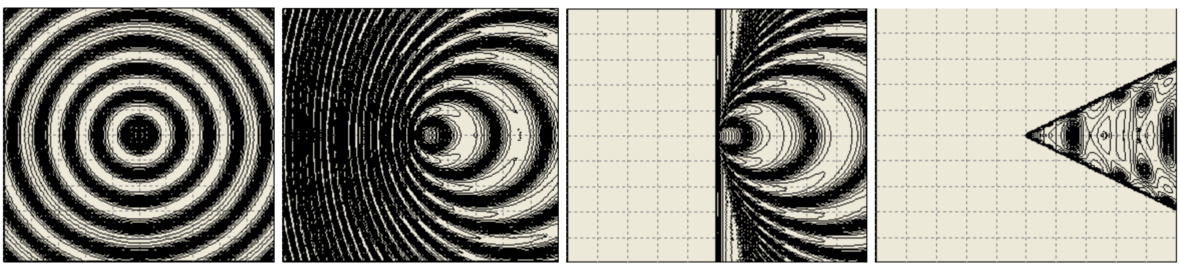

Figure 2: Logarithm of the retarded potential of uniformly moving charge (*v*=0, *v*<*c*, *v*=*c*, *v*>*c*) with its current position in origin [0,0] (the centre of each chart). The charge sinusoidally varies in time (the time with phase of charge in maximum is shown).

The spatial frequency of such potential waves for transversal direction is given by

$$k_T = k_0\gamma = k_0 \Big/ \sqrt{1-\beta^2}$$

where γ is the Lorentz factor. The relation similar to the relativistic Doppler effect we will obtain for directions ahead and behind the oscillating charge:

$$k_+ = k_T\sqrt{\frac{1+\beta}{1-\beta}} \qquad \text{and} \qquad k_- = k_T\sqrt{\frac{1-\beta}{1+\beta}}\,.$$

The standard deviation of gradient of potential (i.e. force) ahead and behind is different (due to different wavelength). Its sudden step change (impulse) located in particle position

$$\Delta k = 2k_T\gamma\beta$$

corresponds to the relativistic linear momentum (using e.g. $hk=mc$). We can also see that this retarded potential is not local for subluminal rectilinear motion (information about wavelength also precedes particles). Thus “strange quantum” effects can be better understood without mystical interpretations.
The subluminal particle collisions can be described classically with the electromagnetic (“photon”) contribution for each particle. This contribution corresponds to electrodynamic acceleration/deceleration ability (individual reference frames of proper classical behavior) by the Lorentz factor and to the retarded potential (or its current) by the wave equation.

$$\sum\left(m_0c^2 + h\nu\right) \rightarrow \sum m \rightarrow \sum \rho_m \rightarrow \sum \varphi_m$$
$$\sum\left(m_0\vec{v} + h\vec{k}\right) \rightarrow \sum m\vec{v} \rightarrow \sum \vec{j}_m \rightarrow \sum \vec{A}_m$$

I.e. it is equation for colliding (or interfering) potentials (fields) and not for particles. The electromagnetic interaction (its waves) has a characteristic velocity factor (the fine structure constant) because the “physics” should be based on numbers (without quantities) [3].
The cosmic ray current density N_j is calculated from observed events using the Lorentz factor. Its observed energy-based spectral density is approximately given as

$$\frac{dN_j}{dE} \propto E^{-3}.$$

We can see that using equation

$$\frac{dE}{dv} = d\,\frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}}\Bigg/dv = E_0^{-2}E^3\,\frac{v}{c^2}$$

we can write the velocity-based spectral density of flux passing through a detector as

$$\frac{dN_j}{dv} \propto v\,.$$

I.e. the most probable (subluminal) velocity of detected particle is *c*. Then the particle density N_ρ in space is approximately constant (however, the real measurement results show that velocities close to *c* are also more probable for particle density than low-speed particles, nevertheless, it also depends on other factors)

$$\frac{dN_\rho}{dv} \propto const.$$

I.e. the (relativistic) particle velocities are "equally" probable in range up to the speed of light *c*. (The rareness of ultra-high-energy rays is given by very narrow range of speeds that corresponds to energies by the Lorentz factor.) It is "surprising" that this spectral density is so flat (what is the mechanism of production of such rays that can explain it?) also for speeds very very close to *c* (for lower speeds) but it could be (suddenly) zero for superluminal speeds (i.e. they does not follow some distribution similar to the Maxwell–Boltzmann distribution of speeds (i.e. normal/Gaussian distribution in 3D) that is derived from more general conditions - Euclidean norms, independence and isotropy). It is also related to the problem with the GZK limit. Nevertheless, the superluminal particles provide weak detection signals instead of electromagnetic ones for subluminal movements of charges. Thus this discontinuity can be resolved. E.g. it can be done by an analogy that the speed of sound is also related to (and is less than) the most probable speed of atoms (i.e. some of them are faster than the corresponding speed of sound).

It should be also noted that superluminal phase and group velocities are possible in (a part of) the focus of Gaussian beam [4]. Thus we can see that the superluminality is not so exotic and it can be understood as supersonic speed in acoustics ("phonons"). I.e. it is theoretically possible (without a conflict with relativistic experiments but not in the agreement with their mainstream interpretations) and it can explain several unresolved problems or axiomatized properties.

[1] R. Feynman: The Feynman Lectures on Physics, 26 - Lorentz Transformations of the Fields, 1964, http://www.feynmanlectures.caltech.edu/II_26.html

[2] P. Křen: Dimensions and Frequency, 2007, http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/1247

[3] P. Křen: Mathematics and languages, 2015, http://gsjournal.net/Science-Journals/Essays-Mathematics%20and%20Applied%20Mathematics/Download/6368

[4] Z. L. Horváth, J. Vinkó, Zs. Bor, D. von der Linde: Acceleration of femtosecond pulses to superluminal velocities by Gouy phase shift, 1996, http://www.ilp.physik.uni-essen.de/vonderLinde/Publikationen/APB96_gouy.pdf