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Special and general relativity according to superfluid quantum space.

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Abstract

By considering vacuum as superfluid quantum space (SQS), all the relativistic phenomena described in special and general relativity are reproducible and explainable thanks to the mere action of gravity, considered as a flow of space quanta which are absorbed by massive bodies (by fermions, on subatomic scale, according to a previous work of mine[1]), suggesting how to merge relativity with QFT. A superfluid reformulation of Einstein's equivalence principle is proposed and several hints in favour of the actual existence of SQS are discussed. Furthermore, the motion of light in vacuum is consequently reinterpreted as motion through SQS, for which mathematical and physical similarities suggest how photon might be described as a special spin-1 phonon occurring in SQS.

1 Photon as phonon through superfluid quantum space.

Light has a central role in Einstein's relativity, as shown by Lorentz factor and Schwarzschild radius:

$$\gamma \equiv \frac{c}{c^2 - u^2} = \frac{1}{\sqrt{1 - \beta^2}}, \quad R_S = \frac{2GM}{c^2}$$

where, in the former, $\beta = \frac{u}{c}$ is the ratio of a body's velocity in uniform motion and the speed of light. The constance and the value of c are due to photon's interaction with vacuum, in our case with superfluid quantum space (SQS). The speed of light is indeed derivable as:

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$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} \quad (1)$$

where ϵ_0, μ_0 can be seen as properties of SQS. Moreover, in the energy eigenvalue of any eigenstate ψ_n , expressed as

$$E_n = (n + \frac{1}{2})\hbar\omega \quad (2)$$

$\frac{1}{2}\hbar\omega$ corresponds to the energy from quantum vacuum. In our case from SQS. If photons actually move through a superfluid, it is then interesting to make a comparison with the speed of sound in a fluid: $a = \sqrt{\frac{E}{\rho}}$, where, by setting $\sigma = 1$ in Young's modulus ($E = \frac{\sigma}{\epsilon}$), we obtain $a = \frac{1}{\sqrt{\epsilon\rho}}$. When ϵ_0 is seen as quantum space's deformability and ρ_0 as its density, we have

$$a = \frac{1}{\sqrt{\epsilon_0 \rho_0}} \quad (3)$$

which is mathematically analogous to (1): this suggests that light really moves through a fluid space, whose quanta, like air's molecules, possess specific properties. Their superfluidity would for instance account for photon's indefinite propagation.

When travelling through a specific medium and at specific temperature, sound has constant speed as light and the motion of the source only determines frequency shift, according to Doppler-Fizeau effect, which for light corresponds to redshift's formula:

$$z = \frac{f_{emit} - f_{obs}}{f_{obs}}.$$

The photon-phonon analogy might be questioned by pointing out that there are at least a couple of fundamental differences between sound and light. The latter doesn't move through a medium and photon is also a particle. But actually, there are no differences, since the medium, in our case, is SQS (currently called quantum vacuum, zero-point field¹) and the dual nature of photon matches that of phonon, which also has both wave and particles characteristics. Analogies with photons have also been encountered in plasmons[16]. Moreover, and this is of central importance, the disproof concerning the existence of a *luminiferous aether*, due to the Michelson-Morley experiment[4], doesn't confute the photon-phonon analogy, since in that case the hypothesis was that of a stationary aether² and - as a result of Earth's motion - of an aether wind which would have influenced light's speed in the experiment. While the present case is very different, as it assumes that Earth - as composed of fermions - absorbs

¹Superfluid quantum space corresponds in my opinion to dark energy, whose negative pressure is due to SQS's expansion, which proceeds since primordial inflation. This would mean that ~68% of energy in the universe is SQS itself.

²proposed by A.Fresnel in 1818

SQS³, which shapes its gravitational field. So, in our case, the aether simply corresponds to the gravitational field. In the Michelson-Morley experiment light had therefore the same speed in both orthogonal directions. At most, when travelling parallel to Earth's surface, it slightly curves downward, according to general relativity⁴, albeit this effect becomes evident only on astronomical distances and for much greater gravitational fields. For this reason, Michelson and Morley concluded that light doesn't need any medium to propagate. Now, SQS - along with the fact that fermions absorb it, producing gravity - might be in a way a plot twist. It is now clear that SQS doesn't need gravitons or other force carriers to explain gravity, as its quantum nature is reduced to space quanta's dynamics, as well as ocean currents don't need anything else than water and fluid-thermodynamics to be described and understood.

Thus, we could actually think of light as a collective, excited state of space quanta (phonon). By considering phonons in a quantum mechanical harmonic chain of N identical atoms (as they were space quanta) whose positions are x_1, x_2, \dots , the potential energy is expressed as:

$$\frac{1}{2}m\omega^2 \sum_j (x_j - x_{j+1})^2 = \frac{1}{2} \sum_k m\omega_k^2 Q_k Q_{-k} \quad (4)$$

where Q_k is a set of N normal coordinates defined as discrete Fourier transforms of the conjugate momenta \prod of x and N , corresponding to the Fourier transforms of the momentum operator p

$$Q_k = \frac{1}{\sqrt{N}} \sum_l e^{ikal} x_l$$

$$\prod_k = \frac{1}{\sqrt{N}} \sum_l e^{-ikal} p_l$$

k_n is the wave number of the phonon and

$$\omega_k = \sqrt{2\omega^2 [1 - \cos(ka)]}.$$

The harmonic oscillator eigenvalues for the mode ω_k are

$$E_n = (n + \frac{1}{2})\hbar\omega_k \quad n = 0, 1, 2, 3, \dots \quad (5)$$

with quantized levels at

$$\frac{1}{2}\hbar\omega, \quad \frac{3}{2}\hbar\omega, \quad \frac{5}{2}\hbar\omega \quad \dots$$

³it seems that a consequence of space quanta absorption carried out by fermions (which are described as superfluid vortices of space quanta themselves) can also bring to the complete unification of the four fundamental interactions and to their more accurate understanding in light of space quanta's superfluid dynamics, leading to the so-called theory of everything [1].

⁴where the angle of deflection is: $\theta = \frac{4GM}{rc^2}$

exactly matching (2), where $\frac{1}{2}\hbar\omega$ is the zero-point energy for phonon and photon, *i.e.* SQS's energy. Indeed, we know that phonons are bosons[13], just like photons, since they are symmetric under exchange $|\alpha, \beta\rangle = |\beta, \alpha\rangle$ and any number of identical excitations can be created by repeatedly applying the creation operator b^\dagger . Phonon hamiltonian (renormalized on the right by putting $\frac{1}{2}\hbar\omega q_k = 0$) is:

$$\hat{H}_{ph} = \sum_k \hbar\omega_k \left(b_k^\dagger b_k + \frac{1}{2} \right), \quad \hat{H}_{ph} = \sum_k \hbar\omega_k b_k^\dagger b_k \quad (6)$$

Photon could be therefore described as a phonon occurring in superfluid quantum space, where the necessary collective excitation is satisfied by space quanta: a discretized amount of these, would form a photon, thanks to a certain degree of compressibility/elasticity of SQS, also supported by the cosmological inflation model and by the subsequent and still ongoing expansion of the universe. Other hints are that, as well as photons, phonons possess wave-particle duality[7][8], can form squeezed coherent states and they can interact via parametric down conversion[14]. Moreover, it would be now evident that light moves at the maximum, possible speed in the universe since nothing can move through superfluid quantum space faster than its quanta themselves, which take advantage of their superfluidity, minimal energy and minimal mass (if they have). Moreover, the fact that c is determined by SQS's deformability (ϵ_0) and density (ρ_0), tells us that no greater compression-deformation may be caused by a moving body than that allowed by SQS's properties, *i.e.* nothing can move faster than, c . By adding these considerations we can state that for any body moving through SQS, we always have $v < c$. Because of superfluidity, a *phonoton* (photon described as a special spin-1 phonon occurring in SQS) can indefinitely propagate - overcoming the limitations of a liquid space which would cause dissipation of light [17] - until it scatters, for instance, with an electron. By considering photon as a phonon in SQS, the photoelectric effect and Compton scattering are still allowed, thanks to its momentum $\frac{h}{\lambda}$, which for analogy is also derivable from phonons' crystal momentum $p_{crystal} \equiv \hbar k = \frac{h}{\lambda}$, where $k = \frac{2\pi}{\lambda}$. Anyway a phonoton doesn't possess crystal momentum, since it doesn't pertain to solid-state physics and photon's momentum $\frac{h}{\lambda}$ directly applies. Pair production is besides allowed and intelligible when electrons are described as vortices of space quanta[1], triggerable by the scattering of discrete space quanta's pulses such as phonotons. But how would the latters carry an electromagnetic field? In an ideal isotropic medium such as SQS, it is plausible that phonons may have spin= 1, as angular momentum transmitted by the emitting particles. Theoretically, since it has been demonstrated how sound waves may spin [19, 20], also phonons moving through a superfluid medium can accordingly spin. This fact could trigger secondary compressive, elastic, harmonic phenomena (as shown in fig. 1.b) - in addition to the main one occurring along the z -axis - which might generate the field.

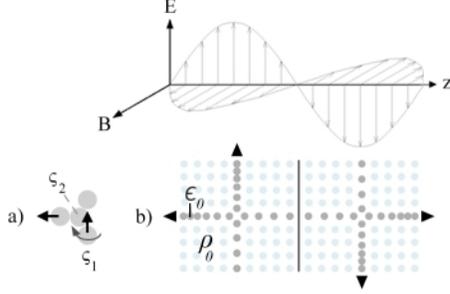


Figure 1: Density (ρ) and deformability (ϵ) of superfluid quantum space allow photon to carry a variable, transverse electromagnetic field (b), where the oscillations of the field are due to harmonic, elastic, orthogonal compressions of space quanta, while the main pulse (photon) is moving along the z -axis. On the left (a) a probable quantum mechanism at the origin of transversality, due to compression and spin.

The EM field would be then generated according to vacuum's permittivity (ϵ_0) and permeability (μ_0), here represented as SQS's deformability (ϵ_0) and density (ρ_0).

As inferable from fig. 1, the equivalence $\epsilon_0 \rho_0 = \epsilon_0 \mu_0$ is placed. Within this framework, SQS's density and deformability indeed determine photon's speed (c) in vacuum (*i.e.* in SQS), but then (3) must equal (1) and the similarity between them becomes an equivalence. To highlight the relationship between photon's electromagnetic field and its total angular momentum, we also see that the latter is related to ϵ_0 , that is - valid the equivalence - to SQS's deformability (ϵ_0):

$$\mathbf{J} = \epsilon_0 \int \mathbf{r} \times (\mathbf{E} \times \mathbf{B}) d^3 \mathbf{r} \quad (7)$$

and deformability is inevitably pertaining to how (mass-)energy is locally distributed, hence the field's oscillation, while photon is travelling in the direction of propagation and its translational velocity is given as $c = \lambda \nu$. Light's EM field would be therefore created by perfectly elastic scattering among the photon and the adjacent space quanta, occurring in the zero-point field (SQS): this would be the underlying quantum mechanism to equation (1). A harmonic perturbation mechanism without energy loss. And it wouldn't be an isolated case: metamaterials have been investigated, in which light moves without energy loss [18]; energy is also conserved in Rayleigh scattering and *a fortiori* when the scattering pertains to the zero-point field (space quanta). Fig. 1(a), shows a possible quantum mechanism at the origin of transversality ($E \perp B$): space quantum ς_1 moves upward against the overlying space quanta: because of both compression and its spin, received from the photon⁵, an orthogonal pulse is generated.

⁵It's assumed that space quanta have no spin.

Phonoton as a discrete pulse of space quanta, along with gravity described as space quanta absorption, may also explain why massless photons are however subject to gravity and why they can't escape from extreme gravitational fields such as those of black holes: according to Schwarzschild radius definition, beyond the event horizon light should travel faster than c . This necessity is obvious when space quanta are absorbed faster than c , a circumstance which may occur since SQS, as a frame of reference, may move at $v > c$ while it is for instance sucked into a black hole.

2 How superfluid quantum space can replace Einstein's curved spacetime.

Superfluid quantum space would be able to reproduce and justify any relativistic effect described in special and general relativity and to unify the cause of clocks' slowdown: gravity only, since speed would simply produce an increase of gravity, giving account of the weak principle of equivalence (between gravitational and inertial mass) from a quantum point of view.

First of all, the simulation of gravity (as far as Newton's universal law of gravitation is concerned) run through a computational fluid dynamic (CFD) approach is proven successful [1] and it seems that such an approach (space quanta absorption effected by massive particles, described as vortices of the same quanta[1]) is also able to describe any other effect related to general relativity's space topology. In fig. 2 space's curvature is compared with quantum space absorption. Since in CFD simulations, to facilitate calculations, space is discretized, the mathematics of tensors used in general relativity

$$\begin{pmatrix} g_{00} & g_{01} & g_{02} & g_{03} \\ g_{10} & g_{11} & g_{12} & g_{13} \\ g_{20} & g_{21} & g_{22} & g_{23} \\ g_{30} & g_{31} & g_{32} & g_{33} \end{pmatrix}$$

may be seen as a discretization of superfluid quantum space, indeed it's conceptually not so different from Cauchy's tensor, used in fluid dynamics,

$$\begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{pmatrix}$$

plus time, as Minkowski spacetime [15] is a combination of Euclidean space and time. However, superfluid quantum space may help to solve more issues, until the unification of fundamental forces. It may moreover pave the way for future antigravity technology, since quantum space (hence its energy) may be technologically more manageable [3] than Einstein's continuous, non quantum, space.

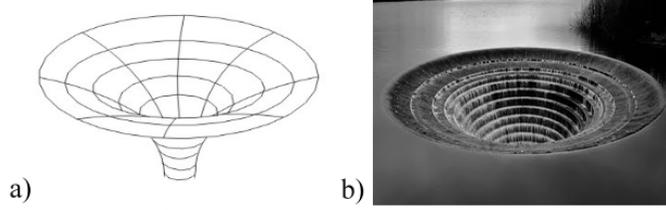


Figure 2: how the presence of a massive body curves spacetime (a) or absorbs it (b), here in analogy with a bell-mouth spillway.

In this approach space deformation is however not necessary (neither of Einstein's spacetime nor of superfluid quantum space): in fluid dynamics, Cauchy's stress tensor indeed applies only to small deformations. What is instead able to replace space curvature is the dynamics of fluids itself: flows in superfluid quantum space, vortices *etc.*, as shown by the aforementioned CFD simulations of Newton's law. From this point of view, gravity is a flow of space quanta, which transport what is immersed in the superfluid quantum space, as a floating object would be sucked into the spillway of fig. 2.b.

In the following images, we see how fluid space may describe the same relativistic effects of general relativity.

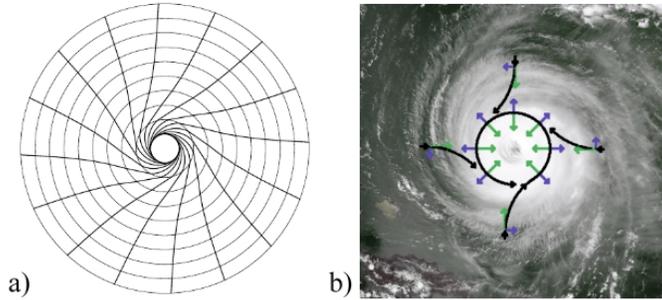


Figure 3: The Lense-Thirring effect according to Einstein's curved spacetime and to fluid dynamics (here an analogy with the Coriolis effect in a cyclone).

Where the gravitomagnetic field related to the Lense-Thirring effect is expressed as

$$B = -\frac{4}{5} \frac{m\omega R^2}{r^3} \cos \theta \quad (8)$$

and the Coriolis force may be written, in some respects, in a similar form:

$$F_C = -2m\omega(\omega R)\mathbf{u}_R \quad (9)$$

Other effects which can be described by fluid dynamics are, for instance, the gravitational lensing:

$$\vec{\hat{\alpha}}(\vec{\xi}) = \frac{4G}{c^2} \int d^2 \xi' \int dz \rho(\vec{\xi}', z) \frac{\vec{b}}{|\vec{b}|^2} \quad (10)$$

with $b \equiv \vec{\xi} - \vec{\xi}'$ where ξ, z are coordinates and $\hat{\alpha}$ is the deflection angle, which in fig. 4.a is determined by vector interaction between light's and space quanta's momenta, here illustrated as water flowing into a spillway. By considering light as special spin-1 phonons, as discussed in §1, if gravity is described as a flow of space quanta, SQS interestingly curves light as wind curves sound. In this case, gravitational lensing would rather mean that light is moving in a superfluid medium (SQS), not that space is curved.

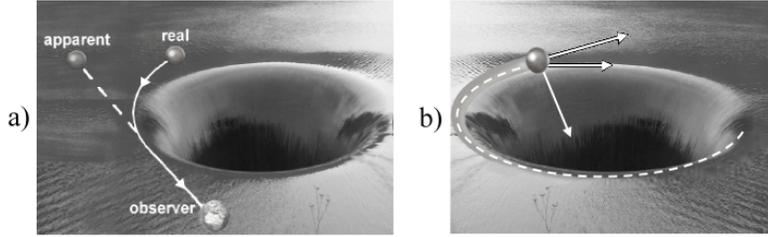


Figure 4: Gravitational lensing (a) and the motion of a satellite (b) according to SQS, here in analogy with a bell-mouth spillway.

Also orbital motion (fig. 4.b) is fluid dynamically explainable, when the description of angular velocity for *any* inverse square law such as that found in the CFD simulations (11)[1]

$$F_a = \int_A (p + \rho(\vec{u} \cdot \vec{n})(\vec{u} \cdot \vec{d})) d\vec{A} \cdot \vec{d} \quad (11)$$

is given as

$$u(\theta) = \frac{\mu}{h^2} - A \cos(\theta - \theta_0) \quad (12)$$

where A and θ_0 are arbitrary constants, h the angular momentum and μ the standard gravitational parameter GM . Beyond this newtonian formula (12), relativistic effects which may occur along with orbital motion, as the aforementioned Lense-Thirring effect, may be likewise described by fluid dynamics, without resorting to curved spacetime.

3 Relativistic mass increase and time dilation according to superfluid quantum space.

Einstein's special and general relativity show how time dilation can be caused by speed and gravity. In this section, I aim to demonstrate how, according to gravity interpreted as a flow of space quanta, these two cases can be reduced to a single one: gravity slows down clocks.

To understand why gravity provokes time dilation, it is first necessary to understand why it produces mass increase. Let's consider the equivalence between gravitational and inertial mass: $m_g = m_i$. According to the quantum space superfluid model[1], gravitational mass is caused by the downward-directed flow of space quanta, which a body is subject to, when it is in a gravitational field, similarly to wind blowing against a body and exerting a force on it. It is therefore obvious that a body's gravitational mass is proportionally related to the gravitational flow (g) acting on it. Now, if also the inertial mass depended on gravity, the issue of mass would be reduced to only two cases: gravitational mass and energy-related mass ($m = \frac{E}{c^2}$). Let's see how through an example. Being in a wind tunnel, where wind blows with velocity u is indistinguishable from moving at the same speed through the atmosphere when no wind is blowing.

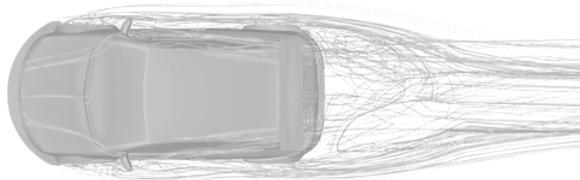


Figure 5: Einstein's equivalence principle reformulated according to SQS. As in this CFD simulation it is impossible to distinguish whether wind is blowing against the car (for instance, if it were in a wind tunnel) with velocity u or the car is moving at that velocity through the air, the motion of a body through superfluid quantum space would similarly cause a gravitational flow acting against it as it were stationary in a gravitational field. This reformulation of Einstein's equivalence principle is also compatible with the principle's strong version.

Once it is clear from a quantum point of view (gravitational flows are composed of space quanta) why inertial mass *is* gravitational mass and why then stronger gravitational flows - acting both in greater gravitational fields and when bodies are accelerated - can increase mass, we can pass to analyze time dilation. It should be pointed out that time is never slowed down: only clocks are. And any clock works thanks to its mechanics, which involves energy and forces. For instance, when considering the case of a mechanical clock, a given amount of energy (from battery, spiral mainspring *etc.*) moves its components producing

a given force which corresponds to a given movement, *e.g.* a tick of the second hand. When the same clock is situated in a stronger gravitational field, the gravitational mass of all its components increases and this means that a greater amount of energy would be necessary to produce greater forces and to keep the tempo. However, since the supplied energy remains the same (and it is now insufficient) the clock slows. This is valid also for caesium clocks, since once the atoms have been launched upwards by laser beams, they fall back down under gravity: they therefore mark time differently in different gravitational fields. Moreover, also cosmic muons are subject to gravity, thus their relativistic velocity (corresponding to greater gravity which they're subject to) is able to lengthen their life. In the formula

$$T_c = T_{g_0} + \frac{g_c}{\epsilon_c} \vartheta = 1s \quad (13)$$

a clock is calibrated to have a period $T_c = 1s$, equal to the period (T_{g_0}) it would have in a gravitational field $g \rightarrow 0$, plus a ratio formed by the gravitational field acting where the clock is calibrated (g_c), *i.e.* where the clock is expected to function, and the energy amount (ϵ_c) which is necessary to contrast gravity and friction forces, so that clock's period exactly corresponds to 1s. While ϑ is a constant expressed in Js^3/m . We see that if the clock was put into a stronger gravitational field, the supplied energy would be insufficient to allow it to tick in the correct way and it would be slowed or even stopped, while in a weaker field it would tick faster.

By stating that time dilation is only a matter of gravity, also for a body moving at constant relativistic velocity in a field $g \rightarrow 0$ (because of the superfluid equivalence principle illustrated in fig.5), a mathematical relationship able to relate speed and gravity is therefore needed. We can start from relating special and general relativity's time dilation. By putting proper time $\Delta t = 1$, we have

$$\Delta t' = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \frac{R_S}{r}}} \quad (14)$$

hence

$$\frac{v^2}{c^2} = \frac{R_S}{r} = \frac{2GM}{c^2 r} = v^2 \frac{1}{c^2} = \frac{2GM}{r} \frac{1}{c^2} \implies v^2 = \frac{2GM}{r} \quad (15)$$

and

$$v = \sqrt{2rg} = \sqrt{2V}. \quad (16)$$

Where V is the gravitational potential ($\frac{GM}{r}$). Dimensional analysis check in the right side confirms: $\sqrt{\frac{L^2 M}{L M T^2}} \equiv m/s$. Thus (16), is the mathematical relationship which links time dilation caused by speed with that caused by gravity. For example, with Earth's radius and gravitational field, we have: $v = \sqrt{2 \cdot r_e \cdot g_e} = 11174$ m/s. This velocity would slow down clocks as much as the gravitational field of Earth, according to the superfluid reformulation of

Einstein's equivalence principle. It is interesting to notice that c doesn't appear in (16), suggesting that the link between the two cases of time dilation is only related to gravity, *Q.E.D.*

To conclude this section, also the relativistic phenomenon of gravitational redshift is explainable according to SQS, since an observer's clock which is located in a weaker gravitational field ticks faster. This means that the observer will measure a longer period of light waves (\Rightarrow redshift). Therefore the following formula

$$\omega_1 = \omega_0 \cdot \frac{\sqrt{1 - \frac{R_S}{r}}}{\sqrt{1 - \frac{R_S}{r'}}$$

where ω_1 is the observed frequency, can still be used also in the superfluid approach. Many hints for the actual existence of a superfluid quantum space, instead of a continuum spacetime, emerge from (1), (2), (3), (5), (6), (11), (16), as well as from the fluid dynamic analogies of general relativity's space topology shown in fig. 2, 3, 4, 5. I wish to point out how it is in my opinion more correct to speak of a superfluid quantum *space* instead of *spacetime*, since quantum superfluidity is a characteristic of space, not of time, and whereas time dilation would be simply due to the action of space quanta's flows (gravity), *i.e.* to quantum space's superfluid dynamics.

4 About Lorentz-FitzGerald contraction.

Relativistic length contraction affects *measurements* taken in two different frames of reference in relative motion, when compared. Not bodies' physical structure (*i.e.* no structural deformation occurs). We know that this relativistic phenomenon can be explained through time dilation and, in this case, it can be reduced to what already discussed in §3. Also the Lorentz-FitzGerald contraction is therefore explainable within the theoretical framework of SQS. Let's consider fig. 6:

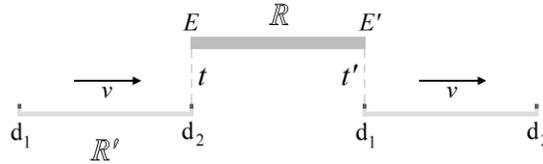


Figure 6: Relativistic length contraction. According to an inertial frame of reference (\mathbb{R}), the length $\overline{EE'}$, detected in the frame \mathbb{R}' , is shorter when measured, since in a moving frame Lorentz factor has to be considered: $l_{\mathbb{R}'} = v \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}}$.

Be \mathbb{R} an inertial frame of reference and \mathbb{R}' a frame moving with velocity v . Length $\overline{EE'}$ is measured in both frames by considering Δt as the difference

$t' - t$, between the instants in which detectors d_2, d_1 respectively align with E, E' . The two measurements (according with \mathbb{R}) are:

$$l_{\mathbb{R}} = v\Delta t \quad \text{and} \quad l_{\mathbb{R}'} = v \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\text{since } \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} > \Delta t \quad \implies l_{\mathbb{R}} > l_{\mathbb{R}'}$$

As clocks tick slower in $\mathbb{R}' \Rightarrow \Delta t$ is shorter in that frame, as well as the measured length $\overline{EE'}$.

Conclusions

All relativistic effects, both of special and general relativity, as well as GR's space topology may be ascribed to gravity, explained as space quanta absorption effected by massive bodies (*i.e.* by fermions, on a subatomical scale[1]) within the concept of a superfluid quantum space. Four statements concerning what we might call *superfluid relativity* may be inferred from this work:

1. Velocity causes mass⁶ increase when a body moves through SQS (*i.e.* always), according to the superfluid reformulation of the equivalence principle, as discussed in §3. Lorentz factor still applies, since SQS's properties don't allow anything to move at or over the speed of light.
2. Time dilation can be explained through clocks' gravitational mass increase, both when they're stationary in a gravitational field and when they're moving through SQS, still according to the above mentioned principle.
3. Length contraction can be explained through time dilation and it only affects measurements/observation, *i.e.* no structural changement occurs in the moving bodies⁷.
4. All the relativistic effects due to curved spacetime can be explained through the dynamics of SQS.

Finally, the fact that the constant c (referring to Lorentz factor and Schwarzschild radius) is still necessary in superfluid relativity is due to SQS's properties (here described by the parameters ϵ_0 and ρ_0), which don't allow bodies to achieve greater velocities than that of a superfluid pulse of space quanta, *i.e.* of a photon, described as a spin-1 phonon occurring in SQS.

As far as this theory's predictions are concerned, they essentially coincide with those of special and general relativity, making it difficult to experimentally verify the reasons for switching to the superfluid approach. On the other hand a correct quantum theory of gravity and relativity - that we need to recompose an old puzzle, to unify the fundamental forces and to pave the way for future

⁶as passive gravitational mass

⁷Cosmic muons' mean lifetime is extended rather by time dilation due to their velocity through SQS, as no structural contraction of physical space actually occurs.

technology implementations - can't disprove Einstein's relativity but has to predict and unify all known and verified relativistic phenomena and, first of all, to explain gravity from a quantum point of view, which - in my opinion - derives from space's quanta, not from graviton or analogous force carriers. But after all, this work and the superfluid model of particles and fundamental interactions show how also other force carriers such as photon and gluon may take shape from space quanta, as well as fermions, described as vortices (topological defects) of SQS . Thus, a single fundamental particle might eventually remain in the standard model: the quantum of space. When it will be there.

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