

Interconnecting Quantum Mechanics with Relativity

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Abstract : A physically real wave associated to any moving particle and propagating in a surrounding material medium was introduced by Louis de Broglie. He proposed the physical concepts of wave - particle duality of matter & the presence of matter waves & these concepts gave rise to an entirely 'new physics' known today as 'quantum mechanics'. In 1927 , the experimental proof of matter waves was given by Davisson & Germer . Both relativity and quantum theory, the two pillars of fundamental physics, are co-related in this paper to make them also explain the physical phenomena they describe. A few years after de Broglie's insight into the wave nature of matter, Schroedinger was able to make his famous equation for the development of matter waves . Einstein had realised that matter was spherical and spatially extended and thus the electron was not a point particle, but rather, a structure of space.

Doppler effect in matter waves on the basis of wave structure of matter (WSM) has been studied previously & in the present work an attempt has been made to connect the quantum theory with the relativity. The SRT time dilation , length contraction , relativity of mass and energy equivalence formulas are derived from wave structure of matter concepts. Before the WSM, there had been no known physical reason for the theoretical mass increase of relativity. Dirac's work was a clue that they are connected because spin, relativity, and QM were joined in Dirac's work, albeit theoretically. The WSM now reveals their simple physical connection - Doppler effects.

Keywords: Doppler shift , Matter waves , Wave structure of matter (WSM) , Quantum Mechanics (QM), special relativity theory (SRT)

1. Introduction :

In 1842 Christian Doppler first proposed his theory of the Doppler effect [1], which has been supported by experimental data for all situations except the relativistic considerations. The Doppler effect of matter waves occurs in a similar way & the equation for frequency shift for Doppler effect of IN-waves & OUT-waves has been shown in previous work [2].

One of the most exciting & revolutionary theories in Physics is Einstein's Theory of Relativity. The theory predicts several effects such as time dilation, length contraction and relativistic mass increase[3]. These effects occur most noticeably to objects that travel at very high speeds, or are subjected to high accelerations. These effects are real - not just predictions and have been verified, by experiments, to a great degree of accuracy. Even then, many people have great difficulty believing that the effects actually occur. The SRT was not readily accepted in it's early days & Einstein had to face lot of criticism. If the cause of the effects could be visualized, and explained, they would be much easier to understand, and believe.

Although the first hypothesis of Einstein's relativity theory regarding the constancy of the speed of light between reference frames has been verified experimentally, his second hypothesis of relativity is still being challenged by many experiments. Relativity connects space & time ,matter & energy ,electricity & magnetism-links that are crucial to our understanding of the physical universe. .

This essay will demonstrate that the interconnection between relativity & QM follows in an obvious manner from consideration of Doppler shift of de Broglie waves based on WSM.

The wave structure of matter has been successful, not only in explaining the basic laws, but also in interconnecting quantum mechanics with relativity. The same consideration has been considered.

2. Wave structure of matter:

The dual particle-wave nature of matter has long been a paradox in physics. It is supposed that the accepted view of physicists is that there is some mysterious principle of wave-particle duality and that it is impossible to understand quantum physics with realistic models. It is now seen that particle consists entirely of a structure of spherical waves whose behavior creates their particle like appearance [7].

According to WSM proposed by Dr. Milo Wolff, a particle is represented by spherical standing wave or a space resonance. According to this, a particle is nothing but a superposition of two identical concentric spherical waves, the IN - wave & the OUT - wave travelling in radially opposite directions to form a spherical standing wave. The wave which travels inwards is called IN- wave & the wave travelling outward is called OUT-wave. The particle may be considered to be located at the wave center. The IN-waves arrive from all the other matter in the universe & interfere with the OUT- waves leaving the wave center to form spherical standing waves. Thus each particle is a pair of IN- & OUT-waves, the inward wave converging to center & then become outward wave. Every particle depends for its IN-wave on all other particles in the universe & this explains that all matter in the universe is interconnected. Thus every particle in the universe owes its presence to every other particle in the universe [7]. Particles therefore do not exist; they are local manifestations of real scalar quantum waves.

We see it is wrong to imagine each particle as one pair of IN- and OUT - waves, because one pair cannot exist alone. We have to think of each particle as inextricably joined with other matter of the universe. Although particle centers are widely separated, all particles together are one unified structure. Thus, we are part of a unified universe and the universe is part of us.

The origin of the mysterious quantum spin of the electron and other charged 'particles' is shown to be a result of the Wave Structure of Matter (WSM). Spin is a spherical rotation in quantum space of the inward quantum waves of an electron at the electron wave-center to become the outward waves. The WSM spin agrees completely with the theoretical spin derived by Dirac (1929), and shows the physical origin of his Dirac Equation. An electron is a pair of waves, one converging, one diverging that form a continuous resonant structure in space. The wave amplitudes of the electron are exactly opposite to those of the positron. Rotation of an in-coming wave is 720° at the center and transforms in-waves to out-waves. The resulting spin = $\pm h/4\pi$. Superposition of an electron and a positron causes annihilation since all amplitudes are opposite.

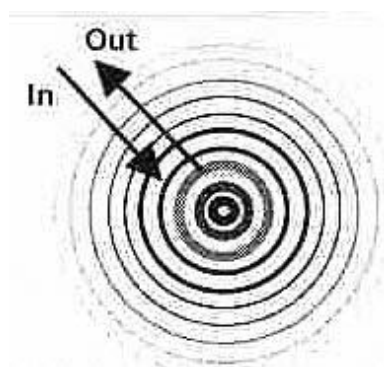


Figure 1. The spherical waves of the electron or positron.

3. Doppler shift in matter waves :

WSM describes the particle as a standing wave comprised of spherical IN- wave & OUT- wave , that reflect at the combined standing wave nodes. The IN -wave becomes an OUT-wave at reflection & vice-versa The OUT- wave of one particle may be the IN -wave for some another particle & vice-versa. The spherical IN-&OUT- waves interact with all other wave center particles in the universe. Since the WSM theory describes a particle as a combination of an IN-wave and an OUT-wave, both waves will need to be classically Doppler shifted to see how the interaction brings about the effects predicted by SRT.

When one spherical standing wave is moving relative to another , then the apparent frequency as seen by the other is different from the actual frequency .This can be called as Doppler effect of matter waves. Thus when two spherical standing waves are in relative motion , Doppler shifts of IN- & OUT- waves are obtained.

The relativistic Doppler shift for two photons formed by intermodulation of IN waves & OUT waves , which is the same as relativistic Doppler shift of light waves , is given by

$$f_{p2} = f_{p1}[(1 + v/c) / (1 - v/c)]^{1/2} \quad \text{Eq.1}$$

where f_{p1} is the photon frequency by IN-wave intermodulation & f_{p2} is the photon frequency by OUT-wave intermodulation.

4. Principles of SRT from WSM:

a) Time Dilation :

Time dilation is the apparent slowing of time of a relativistically moving body with respect to a body in a different reference frame i.e. a moving clock ticks more slowly than a clock at rest. The frequency shift due to Doppler effect of matter waves is given by eq.(1) [2]

The apparent frequency of the IN-wave at the wave centre is given by

$$f_{0\text{ in}} = f_{\text{in}} (1 + v/c) \quad \text{Eq.2}$$

The mean frequency seen by a wave center is given by:

$$f_{0\text{mean}} = (f_{0\text{inlead}} f_{0\text{inlag}})^{1/2} \quad \text{Eq.3}$$

where $f_{0\text{inlead}}$ is the IN-wave frequency seen at the wave center in the direction of motion, while $f_{0\text{inlag}}$ is the IN-wave frequency seen in opposite direction of motion.

Using classical Doppler shift shown above and the opposite shift for the lagging side, the mean frequency for the moving body is:

$$f_{0\text{mean}} = [f_{\text{in}} (1+v/c) f_{\text{in}} (1-v/c)]^{1/2} \quad \text{Eq.4}$$

If the body is at rest with respect to the observer, then the mean frequency is given by:

$$f_{\text{mean}} = f_{\text{in}} \quad \text{Eq.5}$$

Eqn(4) can be simplified by substituting Eqn 5 to get:

$$f_{0\text{mean}} = f_{\text{mean}} (1 - v^2/c^2)^{1/2} \quad \text{Eq.6}$$

Considering that all events in a wave center are timed by the IN-wave seen from the universe & knowing that time is reciprocal of frequency ,we arrive at the following relation from eq.(.6).

$$t = t_0 (1 - v^2/c^2)^{-1/2} = t_0 \gamma \quad \text{Eq.7}$$

t is the time interval measured on clock in motion relative to an observer and t_0 is the proper time interval measured & $\gamma = (1 - v^2/c^2)^{-1/2}$ is Lorentz's factor.

This is the time-dilation relation of relativity, which shows that time dilation is based on the Doppler shift of the in-wave seen by a moving body. The time dilation follows in an obvious manner from Doppler shift of matter waves.

b) Length Contraction:

The wavelength of the IN and OUT-waves may be considered as the measuring standard for length measurements, and wavelength is inversely proportional to frequency, so the mean wavelength seen by a wave centre is

$$\lambda_{0\text{mean}} = \lambda_{\text{mean}} (1 - v^2/c^2)^{-1/2} \quad \text{Eq.8}$$

so Eqn. (8) can be used to show that the length contraction relation is:

$$l = l_0 (1 - v^2/c^2)^{1/2} = l_0 \gamma^{-1} \quad \text{Eq.9}$$

where l is the apparent length of a moving body with respect to a stationary observer and l_0 is the length of the body from the observer's reference frame.

This is the length contraction relation from relativity which also follows in an obvious manner from Doppler shift of matter waves.

c) Relativity of mass:

Since the WSM shows us that matter is simply waves, the wavelength of matter waves depending inversely on mass ($\lambda = h/mv$) & hence the frequency of matter waves depends directly on mass of the particle, therefore from a different reference frame, mass dilates equivalently to the mean frequency shift, based on this same mean frequency dilation factor from Eqn(6):

$$m = m_0 (1 - v^2/c^2)^{-1/2} = m_0 \gamma \quad \text{Eq.10}$$

where m is the apparent mass of a moving body with respect to a stationary observer and m_0 is the mass of the body from the observer's reference frame.

Using the kinetic energy equation from classical mechanics, we find the kinetic energy of the IN and OUT-waves of a moving wave center to be:

$$E = \frac{1}{2} m v_{\text{in}}^2 + \frac{1}{2} m v_{\text{out}}^2 \quad \text{Eq.11}$$

where v_{in} is the IN-wave velocity, v_{out} is the OUT-wave velocity. Since both waves travel at the speed of light c , and the OUT-wave travels in the opposite direction as the IN-wave

$$v_{\text{in}} = c \quad \text{and} \quad -v_{\text{out}} = c \quad \text{Eq.12}$$

Therefore Eqn (11) becomes:

$$E_0 = m c^2 = \gamma m_0 c^2 \quad \text{Eq.13}$$

which is Einstein's famous mass - energy equivalence equation .

5. Conclusion

The basic laws of SRT follow from the classical Doppler shift of matter waves from WSM in an obvious manner & the principles of relativity come out as a direct consequence of the wave structure of matter . These simple conceptual derivations take a lot of the mystery out of SRT by presenting WSM with explicit mechanisms that produce the same results as Einstein. The derivations are also further verification that the WSM is an important theory in that it ties together SRT and quantum mechanics (QM) with a physical model for matter and energy exchange that satisfies the requirements of both of these major fields of physics, without alienating any of the experimental proof that made both older theories so strong.

The relativity theory is interconnected with QM & the link being WSM , no doubt but precisely the Doppler shift of matter waves based on WSM is the link that interconnects relativity with QM. Thus relativity follows from WSM & comes out as one of the properties which can be attributed to wave nature of particles. We can have confidence that the Wave Structure of Matter is the true physical reality of the universe. It may be considered now that the effects of relativity may be arising from the WSM . The derivation shown eliminates Einstein's requirement for the constancy of the speed of light in all inertial frames.

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