the general science journal

# Brain and Consciousness Processing of a Quantum Energy-Time Event

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The Uncertainty principle is one of the fundamental concepts of quantum mechanics. This principle defines a relationship between the uncertainties of a particle's momentum (Δp) and position (Δx). These uncertainties are related by the following expression

$$\Delta p \Delta x \geq h \quad \ldots (1)$$

where $h$ is Planck's constant (= 6.63 × $10^{-34}$ *J sec*). Besides $h$ (the absolute maximum), these two relations include the reduced Planck's $\hbar$ (= $h/2\pi$ = 1.05 × $10^{-34}$ *J sec*) and $\hbar/2$ (the absolute minimum), depending on the case.

There is another form of Heisenberg's uncertainty principle for simultaneous measurements of the energy and time during a quantum energy-time event (hereinafter referred to as a QM-ET event). In equation form,

$$\Delta E \Delta t \geq h \quad \ldots (2).$$

where ΔE is the uncertainty in energy and Δt is the uncertainty in time of this event. This means that within a time interval Δt, it is not possible to measure energy precisely; there will be an uncertainty ΔE in the measurement. This time interval may be the amount of time it takes to measure a change in energy of the event.

The average reaction time to a visible light stimulus in humans is around 250 *msec*. So, for an observer, the total time to acknowledge the QM-ET event is about 250 *msec*, depending on their capability. In this particular case, Δt would be a parameter with a fixed value opposing the Principle of uncertainty.

By using a highly sophisticated observation device, we can shorten Δt considerably. However, this shortening depends on its two important characteristics: its response time and dead (or resolving) time. The response time is the time that the detector takes to form the signal after the arrival of a particle. The dead time is the minimum period that must elapse after the detector has detected a particle. Simply speaking, the shortest time interval necessary for the above detector to register a single QM-ET event is approximately equal to the sum of its response and dead time. Therefore, by using this detector, we can shorten Δt considerably, but still, it would be a parameter having a fixed value, which mainly depends on the device response and dead times. Consequently, it implies that the energy-time form of the Uncertainty principle requires some rethinking.

Let us consider a particle of the rest mass m traveling along the x-axis with a non-relativistic speed $\upsilon$ [$\leq 0.1\ c$, where $c$ ($\approx 3 \times 10^8\ m\ sec^{-1}$)] is the speed of light]. It takes the time $\Delta t$ to cover the distance $\Delta x$ or

$$\Delta x = \upsilon \Delta t \quad \ldots (1).$$

Its (kinetic) energy is

$$E = 1/2 m\upsilon^2 \quad \ldots (2).$$

The change of energy for the time interval $t_2 - t_1 = \Delta t$ or the position interval $x_2 - x_1 = \Delta x$ is

$$\Delta E = 1/2m(\upsilon_2^2 - \upsilon_1^2)$$

where $(\upsilon_2 - \upsilon_1)$ is the corresponding change in speed. The term $(\upsilon_2^2 - \upsilon_1^2)$ can be written as the product $(\upsilon_1 + \upsilon_2)(\upsilon_2 - \upsilon_1)$ so

$$\Delta E = 1/2m(\upsilon_1 + \upsilon_2)(\upsilon_2 - \upsilon_1) = m\upsilon_{av}\Delta\upsilon$$

where $\upsilon_{av} = 1/2(\upsilon_1 + \upsilon_2)$ is the average speed. As $\upsilon_{av} = \Delta x/\Delta t$ and $\Delta p = m\Delta\upsilon$, we get

$$\Delta E\Delta t = \Delta p\Delta x.$$

As we concluded above, the energy-time uncertainty needs some rethinking, but this equation implies that the momentum-position uncertainty also needs some rethinking.

Moreover, in our previous paper [2], we stated that $\Delta E\Delta t$ and $\Delta p\Delta x$ cannot be equal. We see this is not true for a particle moving at a non-relativistic speed in one dimension. Therefore, in other quantum mechanical cases, $\Delta E\Delta t \neq \Delta p\Delta x$. We guess?

Finally, differentiating eqn. (2) and after combining with eqn. (1) we have

$$dEdt = md\upsilon dx.$$

As the momentum of the particle $p = m\upsilon$, its first derivative is

$$dp = md\upsilon.$$

Combining this equation and eqn. (3), we have

$$dEdt = dpdx.$$

In our communication [2], we stated that „the mathematical derivative first order cannot be applied in any mathematical approach to the Heisenberg uncertainty principle". This is often the case in textbooks and other publications of elementary quantum physics. However, this is not true for a particle moving at a non-relativistic speed in one dimension. As an example, we pointed to the author's work in which he applied the first derivation [3]. As can be concluded from the above, the pointing was wrong.

## References


[1] P, I. Premović, *Is the Universe eternal and infinite*? The General Science Journal.

[2] P. I. Premović, *The energy-position and the momentum-time uncertainty expressions*. The General Science Journal.


**This Δt is an outer time, in the sense of Aharanov and Bohm [1]. [1] Y. Aharanov and D. Bohm, *Time in the Quantum Theory and the Uncertainty Relation for Time and Energy*. Phys. Rev., 122, 1649-1658 (1961).**