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What Is The Matter With de Broglie Waves?

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Abstract:

The wave-particle duality of photons, as hypothesized by Einstein, was well accepted by the early 1920's. De Broglie's bold hypothesis in 1924, that all matter likewise has a wave-particle duality added further fuel to the fire in the development of Quantum Mechanics. It seared into the minds of physicists the wave-particle duality of Nature. Needless to say, this counter intuitive and bold assertion mystified the World beyond any sensible comprehension by common sense. The question often asked by ordinary people is "what is the matter with de Broglie waves'? We provide just this answer in this short paper.

Introduction:

Following earlier work [Refs. 1-13], in this short paper we show how de Broglie waves come about and what they really mean. We show the 'matter' of de Broglie's waves to be the 'prime physis' quantity 'eta' that has naturally also appeared in all our other results. Fundamental to all these mathematical results is this 'prime physis' quantity 'eta' that appeares in all previous papers [Refs. 1-13]. In terms of 'eta', we have been able to define other physical quantities and mathematically derive Basic Law. In this paper we expand this formulation of basic physics to include our treatment of de Broglie waves.

In earlier work, starting with η as the prime physis quantity, undefined and undefinable, we defined the following:

Note: Since our only aim is to show the essential play of ideas, for simplicity of exposition we will restrict all our derivations to just one spacial dimension x and to time t.

Definitions: For fixed $\left(\vec{\mathbf{x}}_{\mathbf{0}}, t_0\right)$ *and along the x-axis for simplicity,*

Prime *physis* : η

Energy: $E = \dfrac{\partial \eta}{\partial t}$

Momentum: $p_x = \dfrac{\partial \eta}{\partial x}$

Force: $F_x = \dfrac{\partial^2 \eta}{\partial x \partial t}$

Temperature: $\mathcal{T} = \left(\dfrac{1}{\kappa}\right)\dfrac{\eta}{\tau}$ where κ is a scalar constant and τ is duration of time

Entropy: $\Delta S = \dfrac{\eta \nu}{\mathcal{T}}$

The following Basic Law can be mathematically derived using the above definitions:

Conservation of Energy and Momentum: $\vec{\nabla} \eta = \left\langle \dfrac{\partial \eta}{\partial x}, \dfrac{\partial \eta}{\partial t} \right\rangle$

Newton's Second Law of Motion: ***F = ma***

The Quantization of Energy Hypothesis:	$\Delta E = nh\nu$
Planck's Formula for blackbody radiation:	$E_0 = \frac{h\nu}{e^{h\nu/kT} - 1}$
Energy-momentum Equivalence:	$\boldsymbol{E = pv}$
Average Energy:	$\boldsymbol{E_{av} = kT}$
Kinetic Energy:	$\boldsymbol{K.E. = \frac{1}{2} mv^2}$
The Uncertainty Principle:	$\boldsymbol{\Delta E \Delta t > h}$
Schroedinger's Equation:	$\frac{\partial \psi}{\partial t} = H\psi$
Entropy–time Relationship:	$\boldsymbol{\Delta S = k\nu\Delta t}$
The Second Law of Thermodynamics:	***"All physical processes take a positive duration of time to occur"***
Boltzmann's Entropy Equation:	$\boldsymbol{S = k \ln\Omega}$

De Broglie Waves:

For η_0 and $\Delta\eta = (\eta - \eta_0)$, the ratio $\frac{\Delta\eta}{\eta_0}$ defines the " % change from η_0". We can consider this to be a "cycle of change" with η_0 taken as the basis for that change. Thus, over a distance Δx, the ratio $\frac{\Delta x}{\Delta\eta / \eta_0}$ expresses the "distance per cycle of change". We define the quantity $\lambda = \frac{\Delta x}{\Delta\eta / \eta_0}$. We have, $\lambda = \frac{\Delta x}{\Delta\eta / \eta_0} = \frac{\eta_0}{\Delta\eta / \Delta x} \to \frac{h}{\partial\eta / \partial x} = \frac{h}{p_x}$ and this, of course, is the de Broglie "wavelength". Note that here we have used the definition of momentum above, $p_x = \frac{\partial\eta}{\partial x}$, and have taken the arbitrary basis η_0 to be Planck's constant h, this being the smallest amount of η that can be measured by our measurement standards. (Note: we show elsewhere [7] that h is the standard of measurement for Kelvin temperature *T)*.

Consider next, for a duration of time Δt, the ratio $\frac{\Delta\eta / \eta_0}{\Delta t}$. This ratio expresses the "cycles of change per time". We define the quantity $\nu = \frac{\Delta\eta / \eta_0}{\Delta t} = \frac{\Delta\eta / \Delta t}{\eta_0} \to \frac{\partial\eta / \partial t}{h} = \frac{E}{h}$, and this of course is the de Broglie "frequency". Note again that here we have used the definition of energy above, $E = \frac{\partial\eta}{\partial t}$, and have once again taken the arbitrary basis η_0 to be Planck's constant *h.* Note that these definitions above make no assumptions regarding η or give any special physical meaning to any of the quantities used. Certainly, we have not used 'matter' or any properties of 'matter'. All the results are mathematical expressions using the undefined quantity η .

From the above, as a consequence we have that $\lambda \nu = \dfrac{dx}{dt}$, which is velocity of 'propagation of η ', v.

In summary, we have

$$\lambda = \frac{h}{\partial\eta / \partial x} = \frac{h}{p_x} \quad , \quad \nu = \frac{\partial\eta / \partial t}{h} = \frac{E}{h} \qquad \text{and} \qquad \lambda\nu = \frac{dx}{dt} = \text{v} \text{ , the velocity of 'propagation of } \eta \text{ '.}$$

The Exponential of Energy:

In an earlier paper, "A Time-Dependent Local Representation of Energy" [3], we considered that the energy at a point x be represented by a simple exponential, $E(t) = E_0 e^{\nu t}$, where E_0 is 'intensity' and ν is 'frequency'. We have shown that using such representation, *Planck's Formula is a mathematical tautology that describes the interaction of energy* [2]. The above results now provide a justification for that representation of energy.

The ratio $\dfrac{\Delta\eta / \eta_0}{\Delta t}$ above expresses "cycles of change per unit of time". But this same ratio also expresses "% change per unit of time". If we were to consider 'continuous change', we then have that $\eta = \eta_0 e^{\nu t}$. Since $E = \dfrac{\partial\eta}{\partial t}$, differentiating w.r.t. t we get, $E(t) = \eta_0 \nu\, e^{\nu t}$ and since at $t = 0$, $E = E_0$, we have that $E_0 = \eta_0 \nu$. Thus,

Time-dependent Local Representation of Energy: $\quad E(t) = E_0 e^{\nu t}$

and also: $\quad E_0 = \eta_0 \nu$

References:

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[4] **The Temperature of Radiation** by Constantinos Ragazas (2010)

[5] **Prime 'physis' and the Mathematical Derivation of Basic Law** by Constantinos Ragazas (2010)

[6] **"The Meaning of 'psi' "! An Interpretation of Schrodinger's Equation** by Constantinos Ragazas (2010)

[7] **"Let there be h"! An Existence Argument for Planck's Constant** by Constantinos Ragazas (2010)

[8] **Entropy and 'The Arrow of Time'** by Constantinos Ragazas (2010)

[9] **The Interaction of Measurement** by Constantinos Ragazas (2010)

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[11] **The Photoelectric Effect Without Photons** by Constantinos Ragazas (2010)

[12] **The Metaphysics of Physics** by Constantinos Ragazas (2010)

[13] **Stocks and Planck's Law** by Constantinos Ragazas (2010)