Prime *physis* and the Mathematical Derivation of Basic Law

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Abstract: In another paper we derived Planck's Law and showed that it is an exact mathematical identity that describes the interaction of energy. In that derivation the quantity η , the 'accumulation of energy', played a prominent role. This quantity was defined as a time-integral of energy, while energy was the primary quantity. In this note we consider instead that η is the primary physical quantity (prime *physis*) and define in terms of it energy, momentum and force. From these we go on to mathematically derive such basic laws of Physics as Conservation of Energy and Momentum and Newton's Second Law of Motion. We also make promising connections with the Schrodinger Equation and derive a relationship between energy, mass and velocity. Underlying all this is the conviction that 'measurement' is what connects Mathematics with Physics. It's what makes mathematical derivations relevant to physics. If so, it should then be that all Basic Law of Physics are Mathematical Identities that describe the interactions of measurement. This we are able to show for Planck's Law, Conservation of Energy and Momentum, Newton's Second Law of Motion, and the Quantization of Energy Hypothesis.

Introduction: In another paper we have shown the following mathematical equivalence.

Theorem: $E(t) = E_0 e^{\nu t}$ *if and only if* $E_0 = \dfrac{\eta\,\nu}{e^{\eta\nu/E_{av}} - 1}$ **(1)**

where $\eta = \int_0^\tau E(u)du$, $E_{av} = \dfrac{\eta}{\tau}$ and $E(t)$ is an integrable function

From **(1)**, assuming a time-dependent local representation of energy $E(t) = E_0 e^{\nu t}$ where E_0 is the intensity and ν is the frequency of radiation, and assuming at equilibrium (when average energy at the 'sensor' = average energy of the 'source', i.e. when $E_{av} = kT$) the 'accumulation of energy' is $\eta = h$, we were able to derive Planck's Formula $E_0 = \dfrac{h\nu}{e^{h\nu/kT} - 1}$.

Basic Law: Planck's Formula is an exact mathematical identity that describes the interaction of energy measurement.

Basic Law: The Quantization of Energy Hypothesis, $\Delta E = nh\nu$ **(see *mathematical derivation*)**

It these formulations, the quantity η , the 'accumulation of energy', played a key role. This suggests that we can make this quantity primary and define the other physical quantities in terms of it. We have,

Definitions: *For fixed* $(\vec{\mathbf{x}}_0, t_0)$ *and along the x-axis for simplicity,*

Prime *physis* : η

Energy: $E = \dfrac{\partial \eta}{\partial t}$ **(2)**

Momentum: $p_x = \dfrac{\partial \eta}{\partial x}$ **(3)**

Force: $F_x = \dfrac{\partial^2 \eta}{\partial x \partial t}$ **(4)**

Mathematical Derivation of Basic Law:

Using the above definitions, and known mathematical theorems, we are able to derive the following basic laws of Physics:

Basic Law: Conservation of Energy and Momentum

The gradient of $\eta\left(\vec{\mathbf{x}},t\right)$ is $\vec{\nabla}\eta = \left\langle \frac{\partial\eta}{\partial x}, \frac{\partial\eta}{\partial t} \right\rangle$. Since all gradient vector fields are *conservative,* we have the *Conservation of Energy and Momentum Law*.

Basic Law: Newton's Second law of Motion

The second Law of motion states that $F = ma$. From definition **(4)** above we have

$$F = \frac{\partial^2\eta}{\partial x\partial t} = \frac{\partial^2\eta}{\partial t\partial x} = \frac{\partial p_x}{\partial t} = \frac{\partial}{\partial t}(mv) = ma$$

since 'mixed partials are equal' and $p_x = mv$,where m is mass and v is velocity

Further Results:

Energy-mass-velocity: $E = \frac{\partial\eta}{\partial t} = \frac{\partial\eta}{\partial x}\cdot\frac{\partial x}{\partial t} = p_x\cdot v = mv^2$ **(5)**

Schrodinger Equation:

This equation in essence, once the extraneous constants are striped, can be written as

$$\frac{\partial\psi}{\partial t} = H\psi \qquad \textbf{(6)}$$

where ψ is the 'state function' , H is the *energy operator*, and $H\psi$ is the energy at *any* $\left(\vec{\mathbf{x}},t\right)$

The definition of energy **(2)** above is for a *fixed* $\left(\vec{\mathbf{x}}_{\mathbf{0}},t_0\right)$,

$$\frac{\partial\eta}{\partial t} = E \qquad \textbf{(7)}$$

where η is 'prime *physis*' ('accumulation of energy') and E is energy at *fixed* $\left(\vec{\mathbf{x}}_{\mathbf{0}},t_0\right)$.

Comparing **(6)** and **(7)** we see that whereas **(7)** is for *fixed* $\left(\vec{\mathbf{x}}_{\mathbf{0}},t_0\right)$, **(6)** is for *any* $\left(\vec{\mathbf{x}},t\right)$. But otherwise the equations **(6)** and **(7)** have the same form and so express the same underlying relationship. Now **(7)** *defines* energy in terms of the more primary quantity η (which can be viewed as 'accumulation of energy') and so we can view **Schrodinger Equation** in essence *defining* energy of the system at *any* $\left(\vec{\mathbf{x}},t\right)$ while the 'state function' (wave function) can be seen to express the 'accumulation of energy' at $\left(\vec{\mathbf{x}},t\right)$. We have,

Basic Law: The 'state function' of a system gives the distribution of the 'accumulation of energy' of the system. The minimum 'accumulation of energy' that can be manifested is Planck's constant ***h***.

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