# The fundamental theorems of Maxwellian dynamics explain entanglement as a nilpotent superposition; an experiment that tests the Copenhagen interpretation is proposed.

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**Abstract:** The question whether all phenomena are of electromagnetic origin has not been answered since Poincaré voiced it. To work towards an answer we adopt a Poincaréan ontology (everything is of electromagnetic origin) and develop Maxwellian dynamics (interactions as nilpotent electromagnetic superpositions) and test it against experience. For this purpose I present a novel set of three simultaneous vector cross-product equations that define generically the Maxwell equations in vacuum, but with expanded analytical capabilities, *e.g.* solitons as 1-D, 2-D and 3-dimensional waves; the latter two propagate on closed curves in space. Here we analyse 1-dimensional solitons (photons) and show that entanglement emerges from the conservation of the nilpotent state required for a two-photon production in atomic cascades. From the insight obtained, I propose adapting the EPR-Bell experiment by introducing asymmetrical polarisation in the first (and earlier) Alice's station. Bob in the second (and later) station uses a symmetrical polariser. The theorems presented here predict that Bob observes an asymmetrical polarisation distribution. Should this prediction be proven experimentally then that would mark an inflection point in the ontology of physics.

**Keywords:** Generic Maxwell Equations, Maxwellian Solitons, Entanglement, EPR Paradox, Bell violation

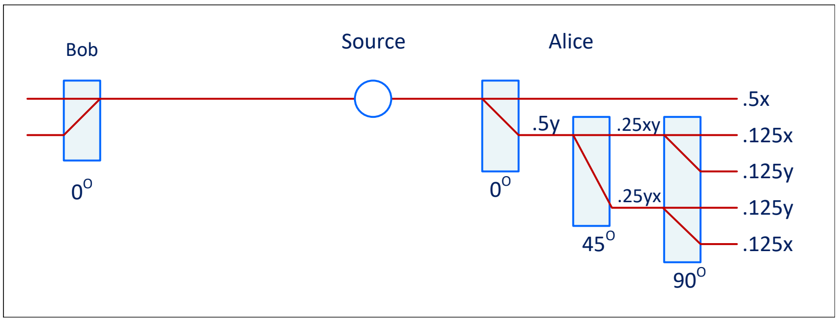


Figure 1: A simple EPR experiment is proposed with no correlation measurements. The birefringent polariser's optical axes are aligned as indicated. The photon source produces circular polarised and entangled photons. This paper presents the motivation for the experiment and predicts that Bob observes a skewed 25:75 polarisation distribution.

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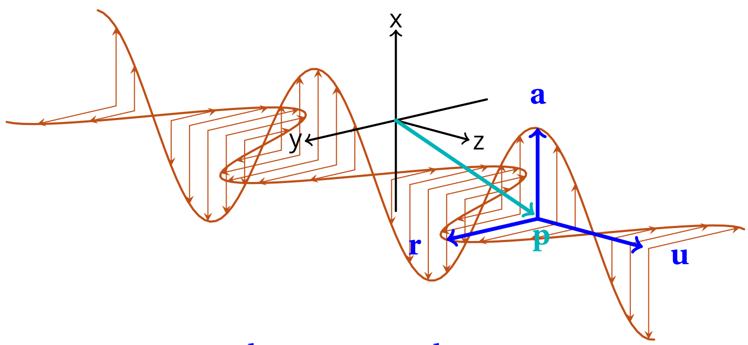
Poincaré's [1] deliberation *"... either everything in the universe would be of electromagnetic origin, or this aspect—shared, as it were, by all physical phenomena—would be a mere epiphenomenon, something due to our methods of measurement"*, is the *urgedanke** that is developed into a Poincaréan ontology which simply states:

> Everything in the universe is described by Maxwellian dynamics and is not influenced by methods of observation. Here, Maxwellian dynamics is the study of interactions as nilpotent electromagnetic superpositions.

* Urgedanke: German n. first or original thought.




$$\mathbf{r} = \mathbf{u} \times \mathbf{a}, \quad \mathbf{u} = \frac{1}{\|\mathbf{a}\|^2}\mathbf{a} \times \mathbf{r}, \quad \mathbf{a} = \frac{1}{\|\mathbf{u}\|^2}\mathbf{r} \times \mathbf{u}, \quad \mathbf{p} = \int \mathbf{u}\,\mathrm{d}t$$

Figure 2: Illustrating the vectors in $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ together with the position vector $\mathbf{p}$ and shown here as one plane of a travelling plane wave.

**Axiom 1 : (Wave)** *Towne [2] defines: The physical condition to be referred to as a wave, is that its mathematical representation give rise to the d'Alembert wave equation, a partial differential equation of particular form*

$$\frac{\partial^2 w}{\partial p^2} - \frac{1}{u^2}\frac{\partial^2 w}{\partial t^2} = 0 \qquad \text{or} \qquad \nabla^2 w - \frac{1}{u^2}\frac{\partial^2 w}{\partial t^2} = 0.$$

**Theorem 1 : (Bimodal Wave Theorem)** *In an Euclidean space, $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ defines the Maxwellian demands on the three orthogonal vectors $\mathbf{u}$ (a velocity vector) and the two domain vectors $\mathbf{a}$ (activation vector) and $\mathbf{r}$ (reactivation vector). Their common origin is defined by the position vector $\mathbf{p} = \int \mathbf{u}\,\mathrm{d}t$. (see Fig. 2) The solutions of the following three simultaneous cross-product equations*

$$\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r}) \xrightarrow{\textit{defines}} \left\{ \langle \mathrm{i} \rangle\ \mathbf{r} = \mathbf{u} \times \mathbf{a}, \quad \langle \mathrm{ii} \rangle\ \mathbf{u} = \frac{1}{\|\mathbf{a}\|^2}\mathbf{a} \times \mathbf{r}, \quad \langle \mathrm{iii} \rangle\ \mathbf{a} = \frac{1}{\|\mathbf{u}\|^2}\mathbf{r} \times \mathbf{u} \right\} \tag{1}$$

*describe bimodal transverse waves, if and only if $\mathbf{u}$, $\mathbf{a}$ and $\mathbf{r}$ are all functions of time and are position independent, and that both $\|a\|$ and $\|u\|$ are constants.*

The bimodal wave theorem describes the continuous self-interactions: $\langle \mathrm{i} \rangle$ activation by $\mathbf{a}$, $\langle \mathrm{ii} \rangle$ wave-vectoring by $\mathbf{a}$ and $\mathbf{r}$, and $\langle \mathrm{iii} \rangle$ reactivation by $\mathbf{r}$. These three interactions describe the mechanism of perpetual self induction which supports the wave action.

Proof: That $\mathscr{M}(\mathbf{u},\mathbf{B},\mathbf{E})$ (1) is a mathematical reformulation of the Maxwell equations is demonstrated as follows: We evaluate the triple vector products $\nabla \times (\mathbf{u} \times \mathbf{a})$ and $\nabla \times (\mathbf{r} \times \mathbf{u})$, which we expand using general vector analytic methods.

$$\begin{aligned}
\nabla \times (\mathbf{u} \times \mathbf{a}) &= \mathbf{u}(\nabla \cdot \mathbf{a}) - \mathbf{a}(\nabla \cdot \mathbf{u}) + (\mathbf{a} \cdot \nabla)\mathbf{u} - (\mathbf{u} \cdot \nabla)\mathbf{a} &&= -(\mathbf{u} \cdot \nabla)\mathbf{a} \\
\nabla \times (\mathbf{r} \times \mathbf{u}) &= \mathbf{r}(\nabla \cdot \mathbf{u}) - \mathbf{u}(\nabla \cdot \mathbf{r}) + (\mathbf{u} \cdot \nabla)\mathbf{r} - (\mathbf{r} \cdot \nabla)\mathbf{u} &&= (\mathbf{u} \cdot \nabla)\mathbf{r}
\end{aligned}$$

because the vectors $\mathbf{u}$, $\mathbf{a}$ and $\mathbf{r}$ are position independent, thus

$$\begin{aligned}
&\mathbf{u}(\nabla \cdot \mathbf{a}) = 0, \quad \mathbf{a}(\nabla \cdot \mathbf{u}) = 0, \quad (\mathbf{a} \cdot \nabla)\mathbf{u} = 0 \\
&\mathbf{u}(\nabla \cdot \mathbf{r}) = 0, \quad \mathbf{r}(\nabla \cdot \mathbf{u}) = 0, \quad (\mathbf{r} \cdot \nabla)\mathbf{u} = 0
\end{aligned}$$

The convective operator $\mathbf{u}\cdot\nabla$ evaluates to

$$\mathbf{u}\cdot\nabla = \frac{\partial}{\partial t} \quad \text{because} \quad \mathbf{u}\cdot\nabla = \frac{\partial x}{\partial t}\frac{\partial}{\partial x} + \frac{\partial y}{\partial t}\frac{\partial}{\partial y} + \frac{\partial z}{\partial t}\frac{\partial}{\partial z} = \frac{\partial}{\partial t}$$

Which leaves us with

$$\nabla\times(\mathbf{u}\times\mathbf{a}) = -\frac{\partial \mathbf{a}}{\partial t} \quad \text{and} \quad \nabla\times(\mathbf{u}\times\mathbf{r}) = \frac{\partial \mathbf{r}}{\partial t}$$

By performing a 'left and right side' curl operation on the two equations $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})\langle\text{i}\rangle$ and $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})\langle\text{iii}\rangle$ (that is on $\mathbf{r} = \mathbf{u}\times\mathbf{a}$ and $\mathbf{a} = \mathbf{r}\times\mathbf{u}/u^2$, respectively, *e.g.* $\nabla\times\mathbf{r} = \nabla\times(\mathbf{u}\times\mathbf{a}) = \nabla\times\mathbf{r} = -\,\partial\mathbf{a}/\partial t$) we recover the Maxwell equations in vacuum for $\mathbf{a}$ and $\mathbf{r}$, to summarise:

$$\begin{aligned} &\nabla\times\mathbf{r} = -\frac{\partial \mathbf{a}}{\partial t} \qquad && \nabla\cdot\mathbf{r} = 0 \qquad && \nabla\cdot\mathbf{u} = 0 \\ &\nabla\times\mathbf{a} = \frac{1}{u^2}\frac{\partial \mathbf{r}}{\partial t} && \nabla\cdot\mathbf{a} = 0 \end{aligned}$$

We note the new requirement that $\nabla\cdot\mathbf{u} = 0$. It is well known that a further 'left and right side' curl operation on the above gives the d'Alembert wave equations. Therefore, any solution to the three simultaneous equations

$$\left\{ \mathbf{r} = \mathbf{u}\times\mathbf{a}, \quad \mathbf{u} = \frac{1}{\|\mathbf{a}\|^2}\mathbf{a}\times\mathbf{r}, \quad \mathbf{a} = \frac{1}{\|\mathbf{u}\|^2}\mathbf{r}\times\mathbf{u} \right\}$$

leads to the wave equations

$$\nabla^2\mathbf{a} - \frac{1}{u^2}\frac{\partial^2 \mathbf{a}}{\partial t^2} = 0 \quad \text{and} \quad \nabla^2\mathbf{r} - \frac{1}{u^2}\frac{\partial^2 \mathbf{r}}{\partial t^2} = 0$$

Therefore, $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ is a bimodal wave equation system. □

**Axiom 2 : (Wave action)** *Wave action is in the direction of wave propagation defined by* $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})\langle\text{ii}\rangle$ *hence the wave-action vector** $\mathbf{P} = \mathbf{a}\times\mathbf{r}$ *therefore* $\|\mathbf{P}\| = \|\mathbf{u}\|\,\|\mathbf{A}\|^2$.

**Comment 1 :** Arbitrary solutions to the d'Alembert wave equations are not necessarily solutions to $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ as they may not fulfill the Maxwellian demands. This questions the quantum superposition and indeterminacy of polarised photons as introduced by Dirac [3].

**Comment 2 :** Here I need to point out that the interpretations below of $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ are incomplete, *e.g.* they do not cover interactions among other things. This paper answers the constructive critique to [4] which suggested that particles described by $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ are deterministic and would not explain the phenomenon leading to the Bell inequality. This paper addresses that criticism.

**Comment 3 : (The physical interpretation of $\mathscr{M}_{\mathscr{P}}(\mathbf{u},\mathbf{a},\mathbf{r})$)** Let the physical space be an Euclidean complex coordinate $\mathbb{C}^3$ space $\mathscr{P} = [\![\mathrm{xyz}]\!]$, where each axis is a complex $\mathbb{z}$-plane. In this space three alternative interpretations for $\mathscr{M}_{\mathscr{P}}(\mathbf{u},\mathbf{a},\mathbf{r})$ are available:

1. When working with fields (flux per area), *e.g.*, electromagnetic fields, then $\mathscr{M}_{\mathscr{P}i}(\mathbf{u},\mathbf{B},\mathbf{E})$ represents one plane of a travelling plane wave, and $\sum\mathscr{M}_{\mathscr{P}i}(\mathbf{u},\mathbf{B},\mathbf{E})$

* Poynting defined it $\mathbf{S} = \mathbf{E}\times\mathbf{H}$

describes the wave of a radio broadcast. The orientation of the **B** and **E** fields remain unchanged as the plane propagates. In circularly polarised radio waves the orientation of the fields change from plane to plane. Also, here the magnetic field is not quantifiable but if expressed as $\mathbf{B} = \mathbf{A}/l^2$ then we isolate, or identify, the flux quantum **A** defining the field **B** in an area $l^2$.

2. Similarly, the bimodal wave theorem predicts potential (flux per distance) waves $\mathscr{M}_{\mathscr{P}}(\mathbf{u}, \mathbf{L}, \mathbf{V})$, here $\mathbf{L} = \mathbf{A}/l$.
3. Here, we seek solutions of $\mathscr{M}_{\mathscr{P}}(\mathbf{u}, \mathbf{A}, \mathbf{R})$, using fluxes to describe Maxwellian solitons; these can be one-dimensional (photons), two and three-dimensional (particles) . In [4] I have explored the physical properties of Maxwellian solitons in terms of physical quantities, and penned the name ***roton*** as an alternative for ***Maxwellian soliton***.

Above are the obvious interpretations found in an extended electromagnetic theory. The deeper and philosophical interpretation demanded by Poincaré's "*everything in the universe would be of electromagnetic origin*" requires a "God's" view from outside the universe. That view gives us the universe's state at any epoch of the universe.

**Axiom 3 : (The universe's state $\mathscr{M}_{\mathcal{S}}(\boldsymbol{t}, \mathbf{P}, \mathbf{Q})$)** *The universe's state $\mathscr{M}_{\mathcal{S}}(\boldsymbol{t}, \mathbf{P}, \mathbf{Q})$ is described by a complex coordinate $\mathbb{C}^3$ state-space $\mathcal{S} = [\![pqr]\!]$, where p, q, and r provide the state-coordinates for the state vector $\boldsymbol{t}$. The universe's state-wave is described by $\mathbf{P} = \sum \mathbf{A}_k$ that is the sum of all $\mathbf{A}_k$ that make up all the particles, all the potentials, and all the fields in the universe as listed in Comment-3 above.*

**Comment 4 : (The philosophical interpretation of $\mathscr{M}_{\mathcal{S}}(\boldsymbol{t}, \mathbf{P}, \mathbf{Q})$)** The philosophical discussion on the state of the universe now has a mathematical foundation.

1. The universe's epoch $\boldsymbol{e}$ is given by $\boldsymbol{e} = \int \boldsymbol{t}\, \mathrm{d}t$ that is a position in $\mathcal{S}$, making state-vector $\boldsymbol{t}$ the arrow-of-time. This gives us two interpretations for the past and future of the universe: (i) The epoch $\boldsymbol{e}$ progresses on a straight line which implies a dark end to the universe. Or, (ii) the arrow-of-time steers the epoch on a closed curve in $\mathcal{S}$ (analogous to 2-D and 3-dimensional solutions for $\mathscr{M}$ below) bringing the universe back to its original state but approached from the opposite direction (not a gravitational big shrink), thus describing a cyclic universe. The past histories are imprinted on the future microwave background; each rebirth begins with carryover information from the past.
2. The above describes a super-deterministic universe which, from all observations, it is not. One explanation at hand for a causal but quantum-indeterministic universe is that the infinite multitude of perturbations together with the infinite vastness of the universe results in a stochastic chaos on the atomic level, but remains deterministic on a larger scale. (I would prefer to believe that the stochastic chaos allows the free will, logical thought and curiosity to develop this work, rather than the universe dictating it to me; there were too many false starts and dead-end thoughts over a two decade period for the latter to be true.) Of course, there may be other reasons that introduce the stochastic chaos. Needless to say, the question of what brought the universe into existence and what caused the first perturbations are unanswerable and any suggestion towards an answer is not based in science.

**Comment 5 : (The physical interpretation of $\mathscr{M}_{\mathscr{P}}(\mathbf{u},\mathbf{a},\mathbf{r})$ plus $\mathscr{M}_{\mathscr{S}}(\mathfrak{t},\mathbf{P},\mathbf{Q})$)** For brevity, let $\mathscr{M}_{\mathscr{P}} = \sum \mathscr{M}_{\mathscr{P}i}(\mathbf{u},\mathbf{B},\mathbf{E}) + \sum \mathscr{M}_{\mathscr{P}j}(\mathbf{u},\mathbf{L},\mathbf{V}) + \sum \mathscr{M}_{\mathscr{P}k}(\mathbf{u},\mathbf{A},\mathbf{R})$ describe the universe. Any conceivable perturbation in any wave described by any $\mathscr{M}'_{\mathscr{P}n}$ will not be a contradiction of $\mathscr{M}_{\mathscr{P}}$. However once we consider the superposition of $\mathscr{M}_{\mathscr{P}}$ and $\mathscr{M}_{\mathscr{S}}$, a universal constraint is set on the perturbation $\mathscr{M}'_{\mathscr{P}n}$ as required by Axiom-3. However, if the perturbation $\mathscr{M}'_{\mathscr{P}n}$ is such that Axiom-3 is violated then a universal nonlocal restoration is required which initiates a “spooky action” that balances the $\mathscr{M}'_{\mathscr{P}n}$ perturbation with a restoring action on another $\mathscr{M}'_{\mathscr{P}m}$.

If $\mathscr{M}_{\mathscr{P}n}$ and $\mathscr{M}_{\mathscr{P}m}$ happen to be entangled particles then the above describes the phenomenon that leads to the Bell inequality. But this phenomenon is not limited to entangled particles and could describe, among other phenomena, the generation of potential in thermocouples.

**Solutions for $\mathscr{M}(\mathbf{u},\mathbf{A},\mathbf{R})$:** Here $\mathbf{A}$ is an activation flux* quantum, and we obtain 1D, 2D and 3-dimensional solutions for $\mathscr{M}$, where the dimensions refer to the velocity vector $\mathbf{u}$.

1D-roton: Linear propagation path along the z-axis (photon like)

$$\begin{aligned}
\mathbf{u}_\gamma &= \hat{z}\\
\mathbf{A}_\gamma &= \hat{x}\cos \grave{n}\omega_o t + \hat{y}\sin \grave{n}\omega_o t\\
\mathbf{R}_\gamma &= -\hat{x}\sin \grave{n}\omega_o t + \hat{y}\cos \grave{n}\omega_o t
\end{aligned}$$

2D-roton: Circular propagation path in the xy-plane centred at the origin

$$\begin{aligned}
\mathbf{u}_\odot &= \hat{x}\sin \grave{n}\omega_o t - \hat{y}\cos \grave{n}\omega_o t\\
\mathbf{A}_\odot &= \hat{x}\cos \grave{n}\omega_o t + \hat{y}\sin \grave{n}\omega_o t\\
\mathbf{R}_\odot &= \hat{z}
\end{aligned}$$

3D-roton: Closed curved, or wound up, path in xyz-space centred at the origin.

$$\begin{aligned}
\mathbf{u}_\varphi &= \hat{x}\sin\omega_1 t\sin \grave{n}\omega_o t - \hat{y}\sin\omega_1 t\cos \grave{n}\omega_o t - \hat{z}\cos\omega_1 t\\
\mathbf{A}_\varphi &= \hat{x}\cos \grave{n}\omega_o t + \hat{y}\sin \grave{n}\omega_o t\\
\mathbf{R}_\varphi &= \hat{x}\cos\omega_1 t\sin \grave{n}\omega_o t - \hat{y}\cos\omega_1 t\cos \grave{n}\omega_o t + \hat{z}\sin\omega_1 t
\end{aligned}$$

We note that $\left\{\mathbf{R} = \mathbf{u}\times\mathbf{A},\ \mathbf{u} = \|\mathbf{A}\|^{-2}(\mathbf{A}\times\mathbf{R}),\ \mathbf{A} = \|\mathbf{u}\|^{-2}(\mathbf{R}\times\mathbf{u})\right\}$ holds for all three cases above.

**Modelling a photon as a Maxwellian soliton:** We now develop the 1D-roton as a model for a photon and adopt a matrix convention.

$$\gamma \xrightarrow[\text{by}]{\text{dsc}} \begin{pmatrix}\mathbf{u}_\gamma\\ \mathbf{A}_\gamma\\ \mathbf{R}_\gamma\end{pmatrix} = \begin{pmatrix}0 & 0 & 1\\ \cos\omega t & \sin\omega t & 0\\ -\sin\omega t & \cos\omega t & 0\end{pmatrix}\begin{pmatrix}\hat{x}\\ \hat{y}\\ \hat{z}\end{pmatrix}$$

which we simplify by expressing the photon characteristic-matrix only, using the three axes defining the propagation axis and the rotation plane, here in the z direction

* We adopt the symbol $\mathbf{A}$ for that which might describe a magnetic flux usually denoted by $\phi$, but here $\mathbf{A}$ is a magnetic-like flux. In [4] this quantity is used as a complex quantity requiring its separation from conventional terminology.

with rotation on the x–y plane.

$$\gamma \xrightarrow[\text{by}]{\text{dsc}} \begin{pmatrix} 0 & 0 & 1 \\ \cos\omega t & \sin\omega t & 0 \\ -\sin\omega t & \cos\omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\mathsf{x}} \\ \hat{\mathsf{y}} \\ \hat{\mathsf{z}} \end{pmatrix}$$

But photons have defined QM properties, and we set the above into a right handed Euclidean space $\mathbb{C}^3$ as $[\![\mathsf{xyz}]\!]$. It is a six dimensional space where each axis, that is the x, y and z axes, is a complex $\mathbb{z}$-plane. In this space we need to define the following:

- Direction of propagation is defined by $\grave{p} = \pm 1$.
- Direction of rotation is referenced to $[\![\mathsf{xyz}]\!]$ as $\grave{r} = \pm 1$ (rotation vector)
- The helicity of the photon is given by $\grave{s} = \grave{p}\grave{r}$, or spin $S = \grave{s}\hbar$
- A degree of polarisation $\vartheta$. If $\vartheta = \pi/2$ then $\gamma$ is linearly polarised, if $0 \le \vartheta \le \pi/2$ then the photon has elliptical polarisation, and with $\vartheta = 0$ it has circular polarisation.
- The flux $\mathbf{A}_\gamma$ is either a source or sink flux, defined by $\grave{q} = \mathrm{q}^+$ or $\mathrm{q}^-$ and where $(\mathrm{q}^+)^2 = (\mathrm{q}^-)^2 = 1$ and $(\mathrm{q}^+)(\mathrm{q}^-) = -1$. In the 2D and 3D-rotons that would generate the charge, analogously it defines a charge for a photon. (A $\mathrm{q}^+$ cannot annihilate a $\mathrm{q}^-$ as that would destroy energy)

But, quantum mechanics identifies various photon states, *i.e.* spin, orbital momentum and polarisation. To provide a generalised description of a Maxwellian soliton which includes these states and satisfies the bimodal wave theorem, we get*†

$$\gamma \xrightarrow[\text{by}]{\text{dsc}} \begin{pmatrix} 0 & 0 & \grave{p} \\ \grave{q}\cos\grave{r}\omega t & \grave{q}\sin\grave{r}\omega t & 0 \\ -\grave{q}\grave{p}\sin\grave{r}\omega t & \grave{q}\grave{p}\cos\grave{r}\omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\mathsf{x}} \\ \hat{\mathsf{y}}e^{i\vartheta} \\ \hat{\mathsf{z}} \end{pmatrix}$$

That is a rotation plane defined by $\hat{\mathsf{x}}$ and $\hat{\mathsf{y}}e^{i\vartheta}$ which has the z-axis as a normal. Here we need to modify the quantum state for spin from $s = \pm 1$ to spin $s = \pm e^{i\vartheta}$

**Axiom 4 : (Interactions as nilpotent Maxwellian superpositions)** *A Maxwellian interaction is an event where the superposition of* $|\sum \psi_i\rangle$ *invokes a transition to a new superposition* $|\sum \phi_j\rangle$ *and is nilpotent if and only if:*

⟨1⟩ *Both* $|\sum \phi_i\rangle$ *and* $|\sum \psi_i\rangle$ *provide solutions to* $\mathscr{M}$.

⟨2⟩ *Energy conservation:* $\mathcal{H}|\sum \phi_i\rangle = \sum \|\mathbf{P}_i\| = \sum \|\mathbf{u}\|\,\|\mathbf{A}_i\|^2 = \mathcal{H}|\sum \psi_i\rangle$

⟨3⟩ *Universal state conservation: Requires additionally that* $\sum \mathbf{A}_i$ *is also a solution of* $\mathscr{M}_{\mathscr{P}}$ *and that the* $\sum \|\mathbf{P}_i\| = \|\sum \mathbf{A}_i \times (\boldsymbol{t} \times \sum \mathbf{A}_i)\|$, *i.e. a universal wave structure and energy preservation.*

⟨4⟩ *Momentum conservation:* $\hat{\mathcal{H}}|\sum \phi_i\rangle = \sum \mathbf{P}_i = \sum(\mathbf{A}_i \times \mathbf{R}_i) = \hat{\mathcal{H}}|\sum \psi_i\rangle$

⟨5⟩ *Charge conservation:* $\sum \grave{q}_i = \sum \grave{q}_j$.

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* $\mathbf{A} \times \mathbf{R} = \begin{vmatrix} \hat{\mathsf{x}} & \hat{\mathsf{y}}e^{i\vartheta} & \hat{\mathsf{z}} \\ \cos\grave{r}\omega t & \sin\grave{r}\omega t & 0 \\ -\grave{p}\sin\grave{r}\omega t & \grave{p}\cos\grave{r}\omega t & 0 \end{vmatrix} = \hat{\mathsf{z}}\grave{p}$

† Orbital angular momentum could be modelled as a rotating polarisation,

*e.g.* $\gamma \xrightarrow[\text{by}]{\text{dsc}} \begin{pmatrix} 0 & 0 & \grave{p} \\ \cos\grave{r}\omega t & \sin\grave{r}\omega t & 0 \\ -\grave{p}\sin\grave{r}\omega t & \grave{p}\cos\grave{r}\omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\mathsf{x}}e^{i\nu t} \\ \hat{\mathsf{y}}ie^{i\nu t} \\ \hat{\mathsf{z}} \end{pmatrix}$

where $\nu$ is the orbital angular momentum frequency. This only explains orbital angular momentum quantum states $-1, 0, 1$ but we know it is any integer number. Question: Are there observations of higher orbital angular momentum states on single photons or are these states observed only in beams? *I.e.* compounded states.

⟨6⟩ *Angular momentum conservation:* $\sum \grave{s}_i = \sum \grave{s}_j$.

### An asymmetrical EPR correlation-less experiment:

Figure-1, at the beginning of this document, sketches a simple EPR experiment designed to prove the validity of the Poincaréan ontology. The two photon generation of the atomic cascade is described as follows:

$$\left|\psi_{\text{High Potential}} + \sum \psi_j \;\; \text{Atom}\right\rangle \longrightarrow \left|\psi_{\text{Ground PotentiaL}} + \sum \psi_j \;\; \text{Atom} + \gamma_{\text{A}} + \gamma_{\text{B}}\right\rangle$$

If both $|\psi_{\text{High Potential}} + \sum \psi_j \;\; \text{Atom}\rangle$ and $|\psi_{\text{Ground PotentiaL}} + \sum \psi_j \;\; \text{Atom}\rangle$ have zero momentum (linear and rotational) before and after the transition, then a solution for the above interaction for $\gamma_{\text{A}}$ and $\gamma_{\text{B}}$ requires the superposition $\gamma_{\text{A}} + \gamma_{\text{B}}$ to be nilpotent. Nilpotency is given when $\gamma_{\text{A}} + \gamma_{\text{B}}$ is expressed as

$$\begin{pmatrix} 0 & 0 & \grave{p}_{\text{A}} \\ \grave{q}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & 0 \\ -\grave{q}_{\text{A}} \grave{p}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \grave{p}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} \\ \hat{\text{y}} \\ \hat{\text{z}} \end{pmatrix} + \begin{pmatrix} 0 & 0 & \grave{p}_{\text{B}} \\ \grave{q}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & -\grave{q}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & 0 \\ \grave{q}_{\text{B}} \grave{p}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & \grave{q}_{\text{B}} \grave{p}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} \\ \hat{\text{y}} \\ \hat{\text{z}} \end{pmatrix}$$

and where $\grave{p}_{\text{A}} + \grave{p}_b = 0$ and $\grave{r}_{\text{A}} + \grave{r}_{\text{B}} = 0$ gives $\grave{s}_{\text{A}} = \grave{s}_{\text{B}}$, and $\grave{q}_{\text{A}} + \grave{q}_{\text{B}} = \text{q}^- + \text{q}^+$. All five conditions ⟨1⟩ to ⟨6⟩ above are fulfilled.

If $\gamma_{\text{A}}$ is polarised in the x-orientation by a polarisation angle $\vartheta$ then that is described as follows

$$\begin{pmatrix} 0 & 0 & \grave{p}_{\text{A}} \\ \grave{q}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & 0 \\ -\grave{q}_{\text{A}} \grave{p}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \grave{p}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} \\ \hat{\text{y}} e^{i\vartheta} \\ \hat{\text{z}} \end{pmatrix} + \begin{pmatrix} 0 & 0 & \grave{p}_{\text{B}} \\ \grave{q}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & -\grave{q}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & 0 \\ \grave{q}_{\text{B}} \grave{p}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & \grave{q}_{\text{B}} \grave{p}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} \\ \hat{\text{y}} \\ \hat{\text{z}} \end{pmatrix}$$

If $\vartheta = \pi/2$ then $\gamma_{\text{A}}$ is linearly polarised in the x-axis, but if $0 \leq \vartheta \leq \pi/2$ then the photon has elliptical polarisation. Here $\hat{\text{y}} e^{i\vartheta}$ is a unit vector defining an axis that is orthogonal to both $\hat{\text{x}}$ and $\hat{\text{z}}$, where the $\hat{\text{y}}$-axis is rotated into the complex plane. Because of the asymmetry in $\gamma_{\text{A}}$ and $\gamma_{\text{B}}$ we immediately recognise that the entanglement condition ⟨1⟩ is violated, because $\mathbf{A}_{\text{A+B}} = \mathbf{A}_{\text{A}} + \mathbf{A}_{\text{B}}$ is not a solution of the simultaneous algebraic equations $\mathscr{M}$. In ideal conditions, a universal conservation phenomenon (Maxwellian wave conservation) acts on photon $\gamma_{\text{B}}$ and polarises it by the same amount on the orthogonal axis, demonstrated by

$$\begin{pmatrix} 0 & 0 & \grave{p}_{\text{A}} \\ \grave{q}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & 0 \\ -\grave{q}_{\text{A}} \grave{p}_{\text{A}} \sin \grave{r}_{\text{A}} \omega t & \grave{q}_{\text{A}} \grave{p}_{\text{A}} \cos \grave{r}_{\text{A}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} \\ \hat{\text{y}} e^{i\vartheta} \\ \hat{\text{z}} \end{pmatrix} + \begin{pmatrix} 0 & 0 & \grave{p}_{\text{B}} \\ \grave{q}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & -\grave{q}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & 0 \\ \grave{q}_{\text{B}} \grave{p}_{\text{B}} \cos \grave{r}_{\text{B}} \omega t & \grave{q}_{\text{B}} \grave{p}_{\text{B}} \sin \grave{r}_{\text{B}} \omega t & 0 \end{pmatrix} \begin{pmatrix} \hat{\text{x}} e^{i\vartheta} \\ \hat{\text{y}} \\ \hat{\text{z}} \end{pmatrix}$$

The superposition $\mathbf{A}_{\mathrm{A}_X+\mathrm{B}_Y}$ is given by

$$\chi\mathbf{A}_{\mathrm{A}_X+\mathrm{B}_Y} = \begin{pmatrix} \grave{q}_\mathrm{A}\cos\grave{r}_\mathrm{A}\omega t & \grave{q}_\mathrm{A}\sin\grave{r}_\mathrm{A}\omega t & 0 \end{pmatrix}\begin{pmatrix} \hat{\mathrm{x}} \\ \hat{\mathrm{y}}e^{i\vartheta} \\ \hat{\mathrm{z}} \end{pmatrix} + \begin{pmatrix} \grave{q}_\mathrm{B}\sin\grave{r}_\mathrm{B}\omega t & -\grave{q}_\mathrm{B}\cos\grave{r}_\mathrm{B}\omega t & 0 \end{pmatrix}\begin{pmatrix} \hat{\mathrm{x}}e^{i\vartheta} \\ \hat{\mathrm{y}} \\ \hat{\mathrm{z}} \end{pmatrix}$$

$$= \begin{pmatrix} \grave{q}_\mathrm{A}\cos\grave{r}_\mathrm{A}\omega t + \grave{q}_\mathrm{B}\sin\grave{r}_\mathrm{B}\omega t & \grave{q}_\mathrm{A}\sin\grave{r}_\mathrm{A}\omega t - \grave{q}_\mathrm{B}\cos\grave{r}_\mathrm{B}\omega t & 0 \end{pmatrix}\begin{pmatrix} \hat{\mathrm{x}}(1+e^{i\vartheta}) \\ \hat{\mathrm{y}}(1+e^{i\vartheta}) \\ 2\hat{\mathrm{z}} \end{pmatrix}$$

where $\chi$ is a scalar because the right hand part is not a unit vector. Normalising to obtain an expression for a unit vector we obtain:

$$\mathbf{A}_{\mathrm{A}_X+\mathrm{B}_Y} = \frac{1+e^{i\vartheta}}{\|1+e^{i\vartheta}\|}\frac{1}{\sqrt{2}}\begin{pmatrix} \grave{q}_\mathrm{A}\cos\grave{r}_\mathrm{A}\omega t + \grave{q}_\mathrm{B}\sin\grave{r}_\mathrm{B}\omega t & \grave{q}_\mathrm{A}\sin\grave{r}_\mathrm{A}\omega t - \grave{q}_\mathrm{B}\cos\grave{r}_\mathrm{B}\omega t & 0 \end{pmatrix}\begin{pmatrix} \hat{\mathrm{x}} \\ \hat{\mathrm{y}} \\ \hat{\mathrm{z}} \end{pmatrix}$$

and it is a valid solution of $\mathscr{M}$ satisfying the nilpotent condition $\langle 3\rangle$ *i.e.* the Maxwellian wave conservation.

To put the theory above to a test, I propose an experiment outlined in Figure 1, that requires no observations by Alice. It only requires relative intensity measurements of the entangled photon beam at Bob's station. The above theory predicts that under ideal conditions, Bob observes a skewed 25:75 polarisation distribution which violates the quantum mechanical prediction of an equal 50:50 distribution.

If I am not mistaken, Kwiat *et al.* [5] already have proven the above. They inserted half and quarter wave plates into one of the beams of a type-II spontaneous down-conversion entangled photon source to reproduce all four Bell states. They remarked "*Somewhat surprisingly, a net phase shift of $\pi$ may be obtained by a 90° rotation of a quarter wave plate in one of the paths.*" obviously a result that they had not expected and have not explained. This leads to an alternative but equivalent experiment as sketched in Figure 3. We use a type-II entangled source, but instead of harvesting the photons from the intersections of the ordinary and extraordinary light cones we

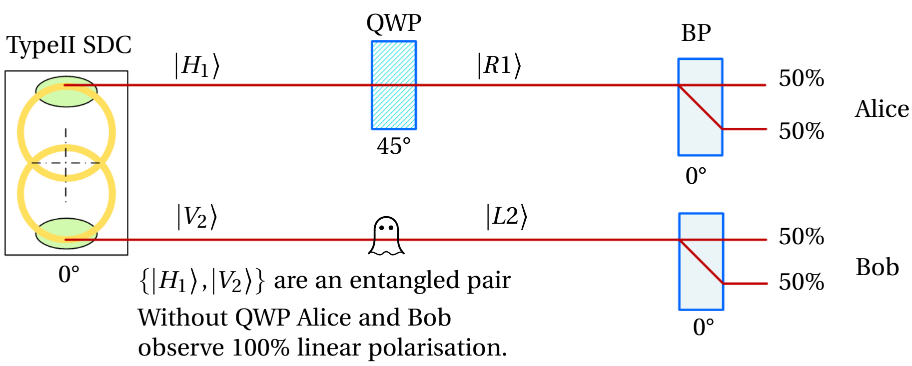


Figure 3: Alternative proposal for an experiment: Here horizontal and vertical polarised photons are harvested from a type-II spontaneous down-conversion entangled photon source (SDC), but from opposing sections of the light cones, instead from the intersections. The $|H_1\rangle$ photons are converted to $|R1\rangle$ by the quarter-wave plate (QWP). Universal state conservation acts on Bob's beam such that $\langle L_2|V_2\rangle$ and the prediction is that both Bob and Alice observe a 50:50 polarisation distribution even though the SDC produced $|H_1\rangle$ and $|V_2\rangle$ photon beams for Alice and Bob, respectively.

harvest opposing sections of the two light cones. These too must be entangled but now Alice's beam has only horizontally and Bob's only vertically polarised photons; momentum preservation demands that the photon pair so harvested were down converted from the same higher energy pump photon and all quantum states need to be preserved. The optical axes are so aligned that both Alice and Bob confirm 100% the respective polarisation orientation. Placing a quarter wave plate into Alice's path at 45° to the optical axes will polarise her beam circularly and by the above theories Bob will also receive circularly polarised photons; that results in an even 50:50 distribution of polarisation probabilities at both Alice's and Bob's stations.

It is thus important that this experiment is done. If the outcome is as predicted then that would mark an inflection point in the ontology of physics.

**Author's closing comment:** Whether or not $\mathscr{M}(\mathbf{u},\mathbf{a},\mathbf{r})$ is accepted as the foundation for general Maxwellian dynamics is not for me to determine; if it does then undoubtedly many extensions of it will be developed. Whether or not it provokes a rethinking of the electromagnetic phenomenon, or whether new discoveries are made resulting from all of the above, only time will tell. Nevertheless—for me—this paper, one of a series of papers, marks the beginning of new work in this subject. There is much that remains to be done; for example, extending the methods developed here to describe particle wave duality and the basic interactions of many particle systems. I have developed an interesting approach, but to bring it to conclusion requires some collaborative effort and intellectual sparring partners to review, critique and contribute towards an extended and collaborative work.

## References

[1] M. H. Poincaré. "Sur la dynamique de l'électron (Translation: On the Dynamics of the Electron)". In: *Rendiconti del Circolo matematico di Palermo* 21.1 (1906), pp. 129–175.

[2] Dudley H. Towne. *Wave phenomena.* New York: Dover Publications, 1988.

[3] P. A. M. Dirac. *The Principles of Quantum Mechanics.* Oxford University Press, 1930.

[4] Anton Lorenz Vrba. "General Maxwellian Dynamics defined by a novel equation set. Particles are Maxwellian solitons." In: *Proceedings: Harbingers of Neophysics* (2022), Online. URL: `https://neophysics.org/p/1673` (visited on 2023-01-30).

[5] Paul G. Kwiat et al. "New High-Intensity Source of Polarization-Entangled Photon Pairs". In: *Physical Review Letters* 75.24 (1995), pp. 4337–4341.

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