Entangled Double-Helix Superluminal Photon Model Defined by Fine Structure Constant Has Inertial Mass $M=E/c^2$

and

Quantum-Vortex Electron and Positron Formed From Superluminal Double-Helix Photon in Electron-Positron Pair Production

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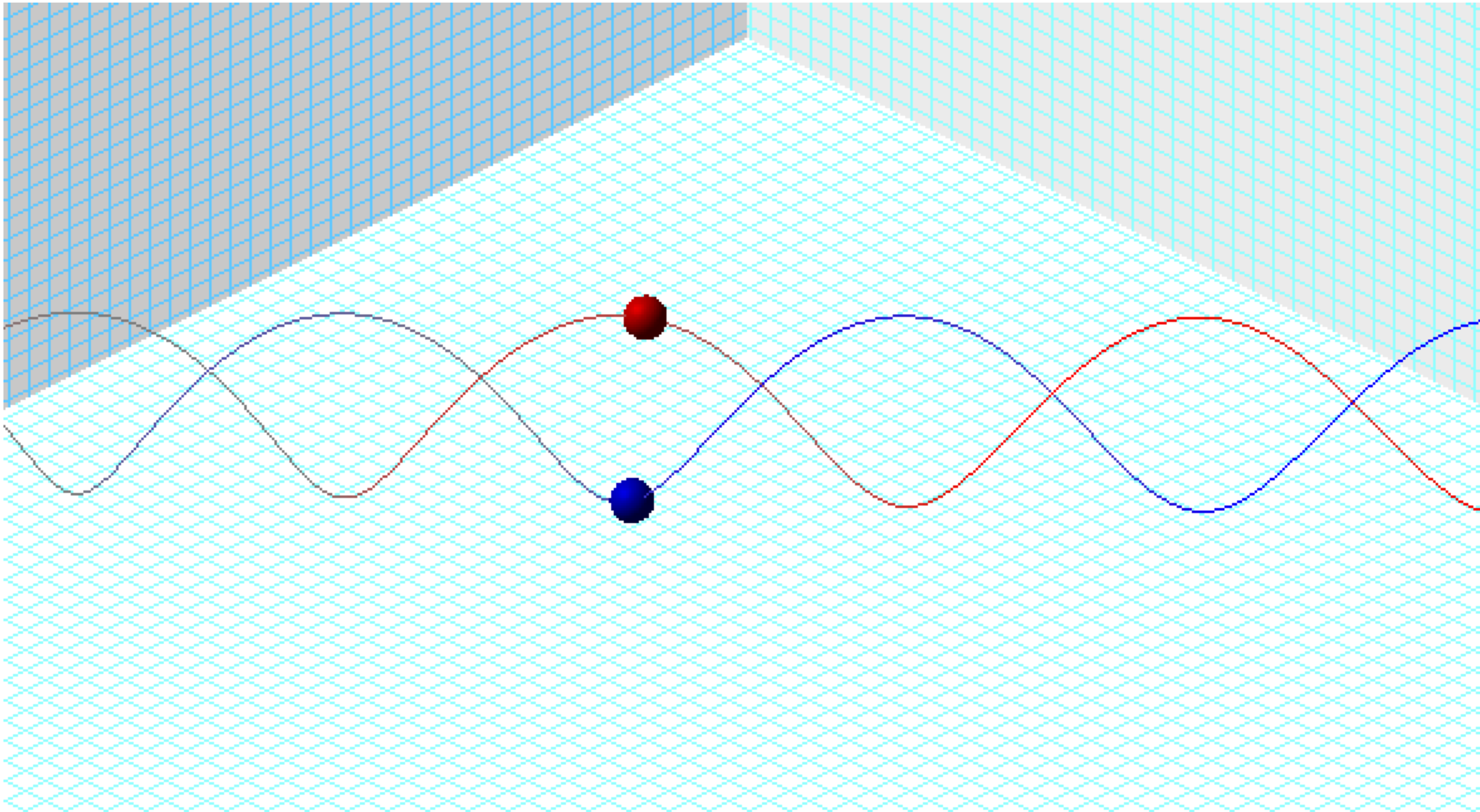
The Double-Helix Photon Model

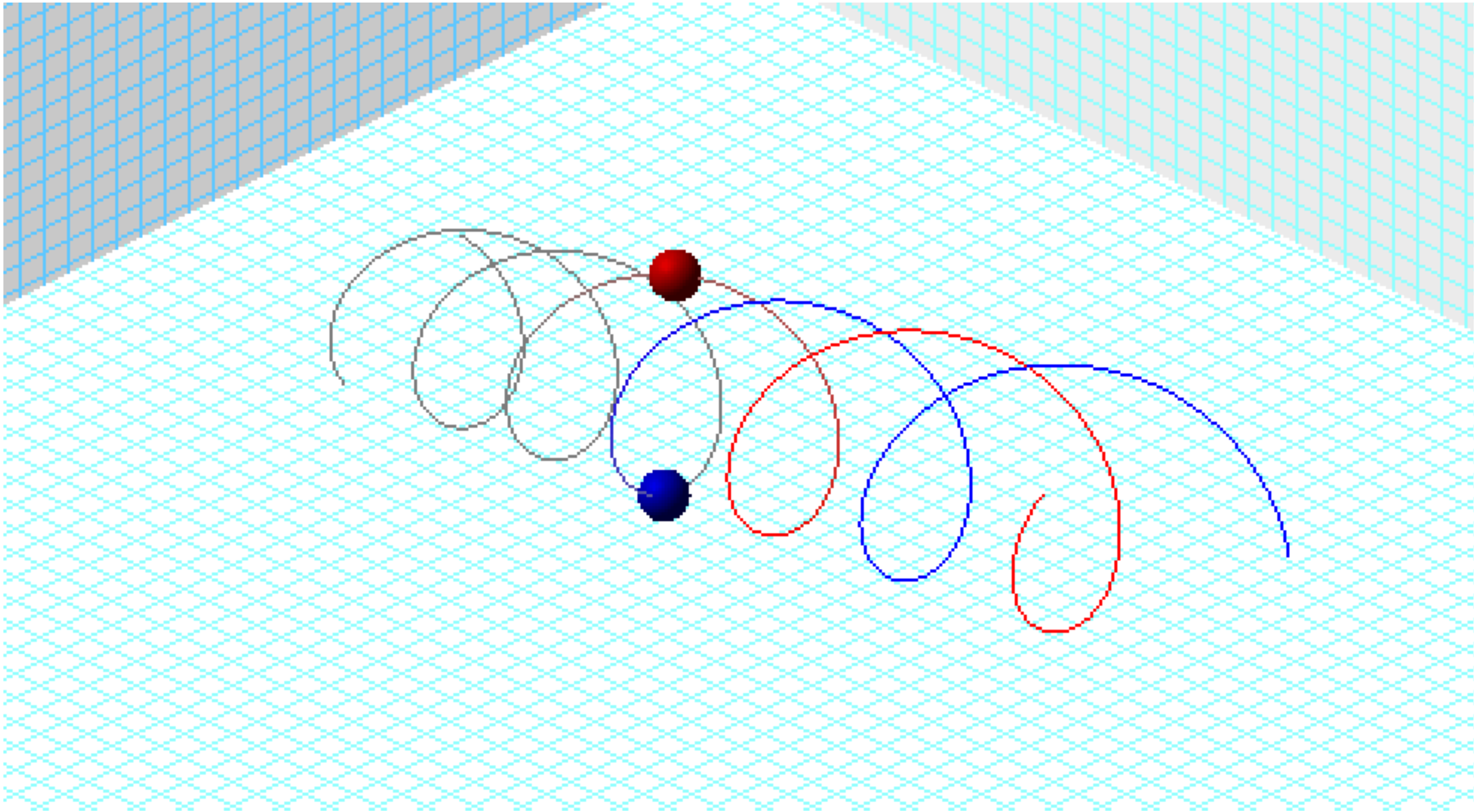
The double-helix photon model is composed of two oppositely charged superluminal energy quantum particles moving in a double-helical trajectory.

The energy quanta are held in the double-helical trajectory by the Coulomb attractive force between the two superluminal energy quanta of electric charge Q and -Q separated by the helical diameter D.

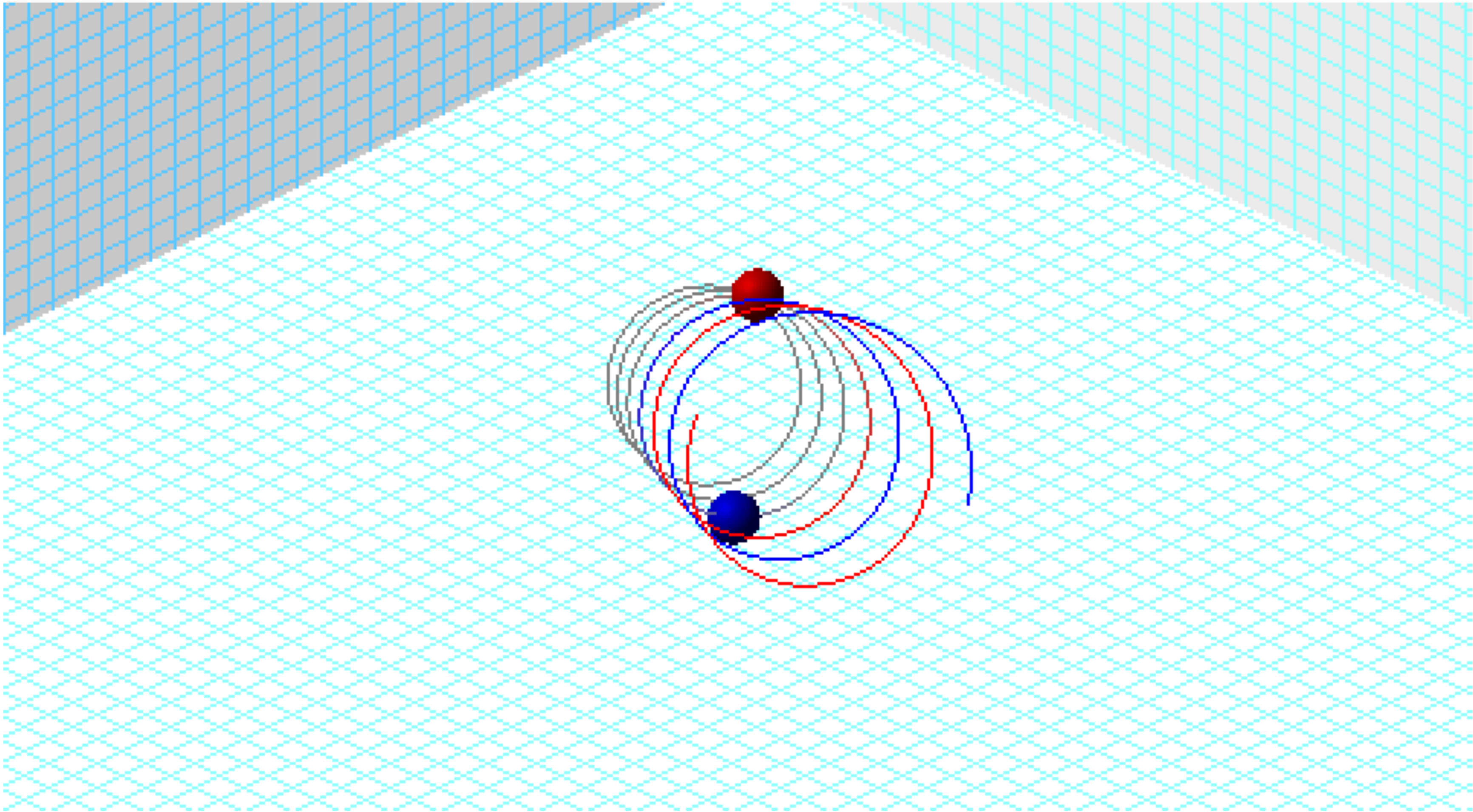
Double helix photon model, side view



Double helix photon model, angular view



Double helix photon model, end view



Helix 1 for Spin-1 Composite Photon Model for Photon of Wavelength λ

$$x_1(t) = \frac{\lambda}{2\pi}\cos(\omega t)$$

$$y_1(t) = \frac{\lambda}{2\pi}\sin(\omega t)$$

$$z_1(t) = ct$$

$$p_{x1}(t) = -\frac{h}{2\lambda}\sin(\omega t)$$

$$p_{y1}(t) = \frac{h}{2\lambda}\cos(\omega t)$$

$$p_{z1}(t) = \frac{h}{2\lambda}$$

Helix 2 for Spin-1 Composite Photon Model for Photon of Wavelength λ

$$x_2(t) = -\frac{\lambda}{2\pi}\cos(\omega t)$$

$$y_2(t) = -\frac{\lambda}{2\pi}\sin(\omega t)$$

$$z_2(t) = ct$$

$$p_{x2}(t) = \frac{h}{2\lambda}\sin(\omega t)$$

$$p_{y2}(t) = -\frac{h}{2\lambda}\cos(\omega t)$$

$$p_{z2}(t) = \frac{h}{2\lambda}$$

Derivation of the magnitude of each electric charge in the double-helix photon model

$$F_{coul} = F_{cent}$$

$$F_{coul} = dp_{trans} / dt = \omega p_{trans}$$

$$\frac{Q^2}{4\pi\varepsilon_o D^2} = \omega p_{trans}$$

$$\frac{Q^2}{4\pi\varepsilon_o (\lambda / \pi)^2} = (2\pi \frac{c}{\lambda})(\tfrac{1}{2} \frac{h}{\lambda})$$

$$\frac{Q^2 \pi^2}{4\pi\varepsilon_o \lambda^2} = \frac{\pi c h}{\lambda^2}$$

$$\frac{Q^2 \pi}{4\pi\varepsilon_o} = ch$$

$$\frac{Q^2 \pi}{4\pi\varepsilon_o} = ch(\frac{2\pi}{2\pi}) = 2\pi c\hbar$$

$$\frac{Q^2}{4\pi\varepsilon_o \hbar c} = 2$$

$$\frac{e^2}{4\pi\varepsilon_o \hbar c} = \frac{2e^2}{Q^2}$$

$$\alpha = \frac{2e^2}{Q^2}$$

$$Q^2 = \frac{2}{\alpha} e^2$$

$$Q = e\sqrt{\frac{2}{\alpha}} = e\sqrt{\frac{2}{1/137.04}} = e\sqrt{274.08}$$

$$Q = 16.6e$$

The electric charges on the rotating double-helix dipole

For the given equations for the double-helical trajectories, the opposite electric charges Q and $-Q$ on the two superluminal energy quanta are calculated to have magnitude $Q = e\sqrt{2/\alpha} = 16.6e$, where $\alpha = ke^2/\hbar c = 1/137.04$ is the fine structure constant of quantum electrodynamics (QED).

This charge Q is independent of the energy, frequency and wavelength of a photon.

The spin of the double-helix photon model

The total spin **s** of the composite photon composed of the two half-photons is calculated from the two half-photon equations by the vector cross product:

$$\mathbf{s} = \mathbf{R} \times \mathbf{P}$$

Calculation of the x and y components of the double helix photon model gives

$s_{x\ total} = 0$ and $s_{y\ total} = 0$

Calculation of $s_{z\ total}$, the total z-component of the double-helix photon model's spin, gives :

The total z-component $s_{z\ total}$ of the double-helix photon

$$
\begin{aligned}
s_{z\ total}(t) &= \{x_1(t)p_{y1}(t) - y_1(t)p_{x1}(t)\} + \{(x_2 p_{y2}(t) - y_2(t)p_{x2}(t)\} \\
&= \frac{\lambda}{2\pi}\cos(\omega t)\frac{h}{2\lambda}\cos(\omega t) - \frac{\lambda}{2\pi}\sin(\omega t)(-\frac{h}{2\lambda}\sin(\omega t)) \\
&\quad + (-\frac{\lambda}{2\pi}\cos(\omega t))(-\frac{h}{2\lambda}\cos(\omega t)) - (-\frac{\lambda}{2\pi}\sin(\omega t))\frac{h}{2\lambda}\sin(\omega t) \\
&= \frac{h}{4\pi}(2\sin^2(\omega t) + 2\cos^2(\omega t)) \\
&= \frac{h}{2\pi}(\sin^2(\omega t) + \cos^2(\omega t)) \\
&= \frac{h}{2\pi}(1) \\
&= \frac{h}{2\pi} \\
&= \hbar
\end{aligned}
$$

The speed of the two superluminal energy quanta

This speed v is calculated from the velocity components of each single helical-moving particle:

$$v^2 = v_X{}^2 + v_Y{}^2 + v_Z{}^2 = (dx/dt)^2 + (dy/dt)^2 + (dz/dt)^2$$

$$= (\lambda\omega/2\pi)^2(\sin^2\omega t + \cos^2\omega t) + c^2$$

$$= c^2(1) + c^2 = 2c^2 \text{ since } \lambda\omega/2\pi = c$$

So $v = c\sqrt{2} = 1.414\,c$

But the forward velocity of the composite photon is $v_z = c = 3.00 \times 10^8$ meters/sec, which is the experimental value of a photon's speed.

The total momentum of the double-helix photon

The forward momentum of each superluminal quantum particle is $p_{z1}(t)=p_{z1}(t)= h/2\lambda$

So the total composite forward momentum of the composite model is

$P_{total} = p_{1z}(t)+p_{2z}(t) = h/2\lambda + h/2\lambda = h/\lambda$

This is the experimental value of a photon's linear momentum.

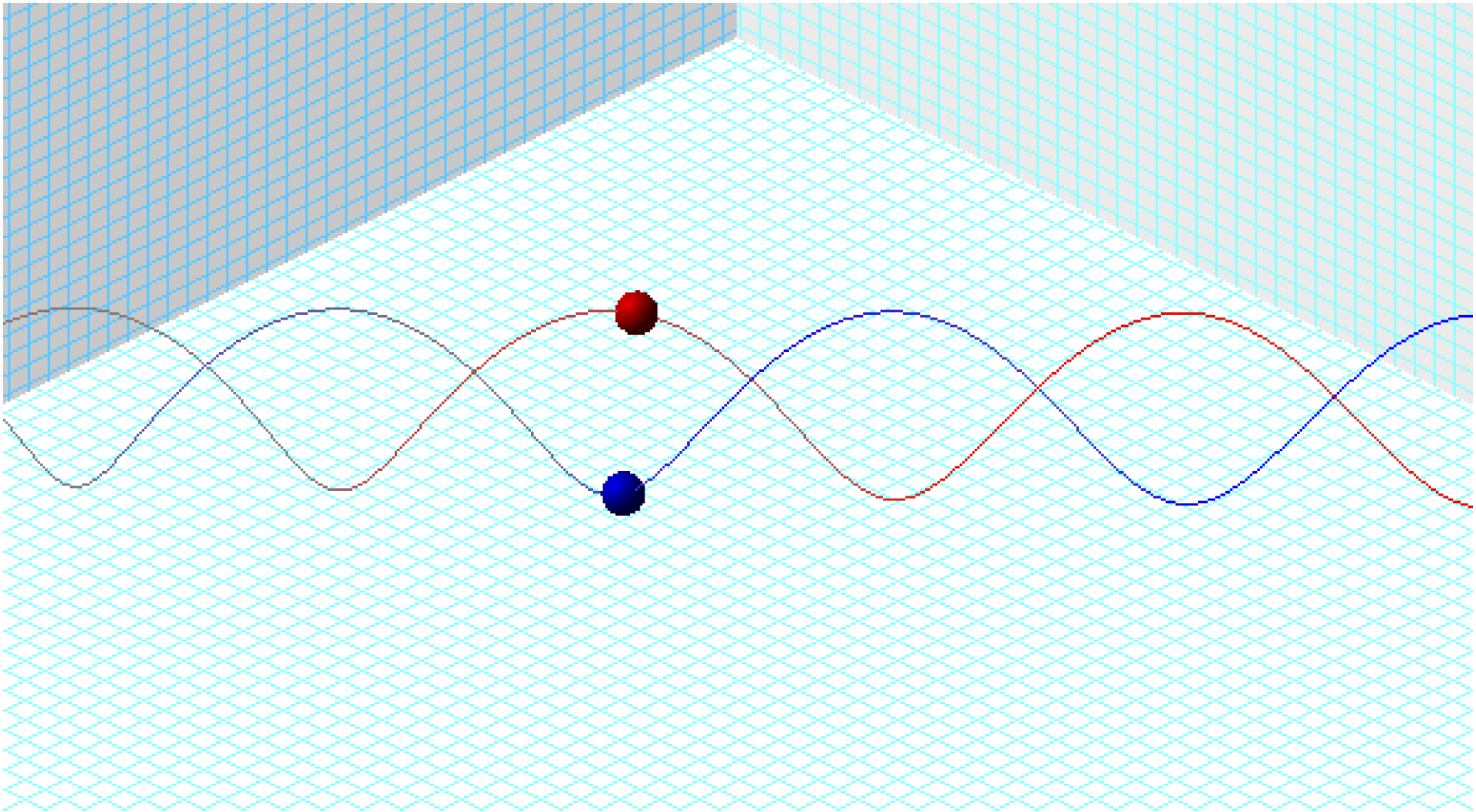
The distance between the two superluminal quanta

This distance D is given from the Pythagorean theorem by

$$D = \sqrt{(x_1(t)-x_2(t))^2 + (y_1(t)-y_2(t))^2}$$
$$= \sqrt{(\lambda/2\pi)^2 ((2\cos\omega t)^2 + (2\sin\omega t)^2)}$$
$$= \lambda/\pi \sqrt{(\cos^2\omega t + \sin^2\omega t)}$$
$$= \lambda/\pi$$

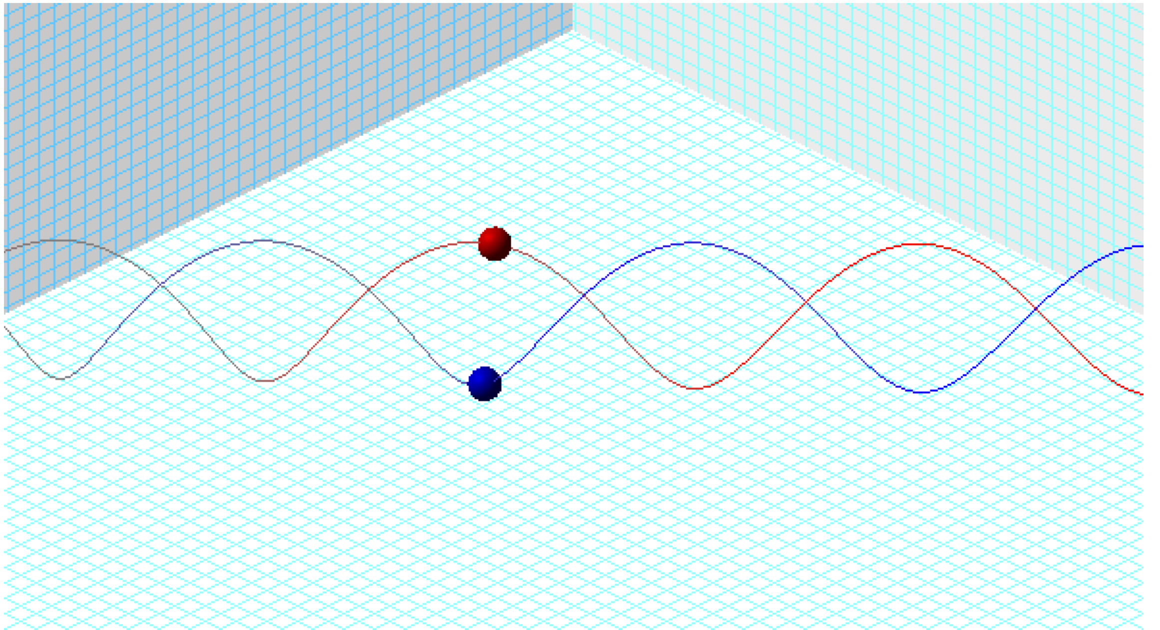
This is the diameter of the double helix photon.

Double helix photon model, side view



The superluminal quanta of the double-helix photon are quantum-mechanically entangled

The two charged superluminal quanta composing the double-helix photon model act together like a single particle−the photon.



Electron-positron pair production from the double-helix photon model

The composite photon model suggests a mechanism for electron-positron pair production.

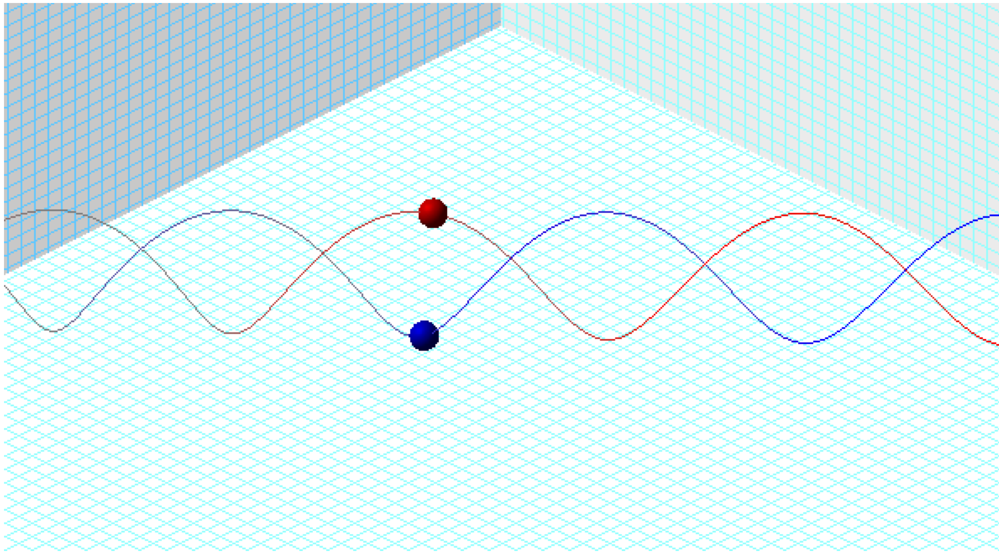
In the presence of an atomic nucleus, the two charged superluminal quanta of a sufficiently energetic photon reduce their electric charge and are thrown off as an electron of charge $-e$ and a and a positron of charge $+e$.

Experimental test of double-helix photon model

The predicted charges Q and $-Q$ provide a strong experimental test of the composite photon model.

Close analysis of electron-positron pair production could show how the charge magnitude $Q = 16.6\ e$ of each superluminal quantum in the double helix photon model becomes the charge magnitude $q = 1\ e$ of the electron and the positron. This would be strong experimental evidence for the double-helix photon model.

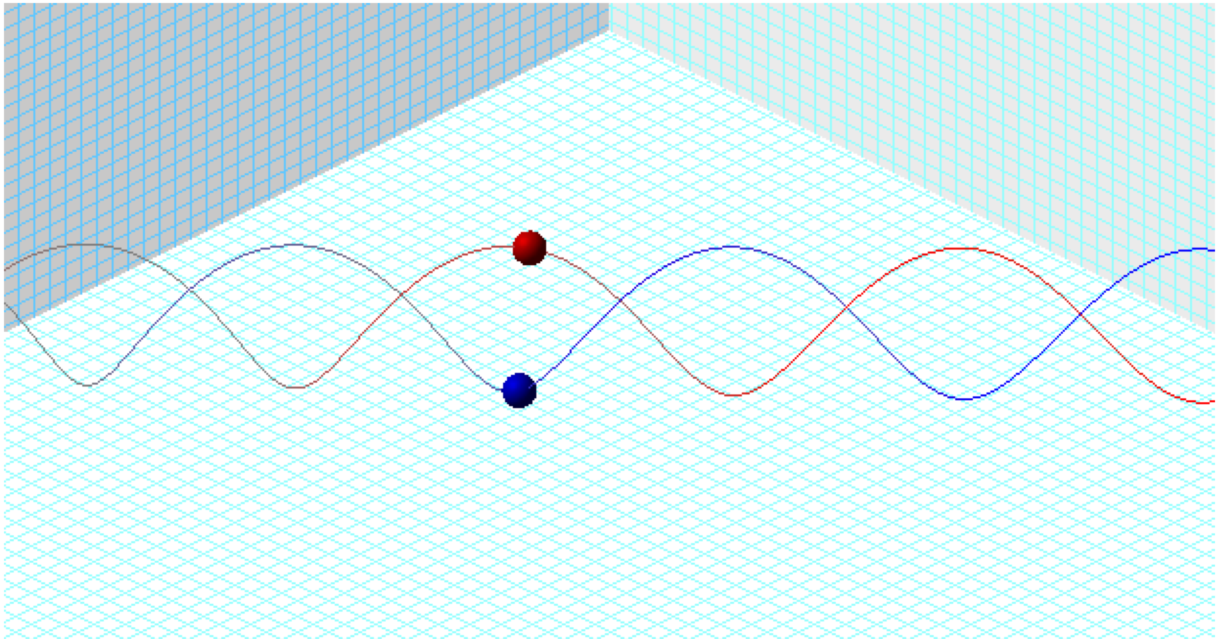
Calculation of the inertial mass $M=E_{photon}/c^2$ of the double-helix photon model



$$M = 2m_{half}$$
$$= 2(d\vec{p}_t / dt) / a_c$$
$$= 2(\omega p_t) / (R\omega^2)$$
$$= 2p_t / R\omega$$
$$= 2(h / 2\lambda) / (\lambda / 2\pi \times 2\pi c / \lambda)$$
$$= h / c\lambda$$
$$= h / (c \times c / \nu)$$
$$= h\nu / c^2 = E_{photon} / c^2$$

Negative electrical potential energy of the double-helix photon model

The superluminal particles of the photon model are bound together by a negative potential energy $U = -E = -h\nu$ by their Coulomb attractive force, as calculated in the next slide.



The ratio of the double helix's photon's electrical potential energy *U* to its energy *E=hv=hc/λ*

$$U/E = \frac{-Q^2/4\pi\varepsilon_o D}{hc/\lambda}$$

$$= \frac{(-2e^2/\alpha)/4\pi\varepsilon_o(\lambda/\pi)}{hc/\lambda}$$

$$= (1/\alpha)(e^2/4\pi\varepsilon_o hc)(-2\pi)$$

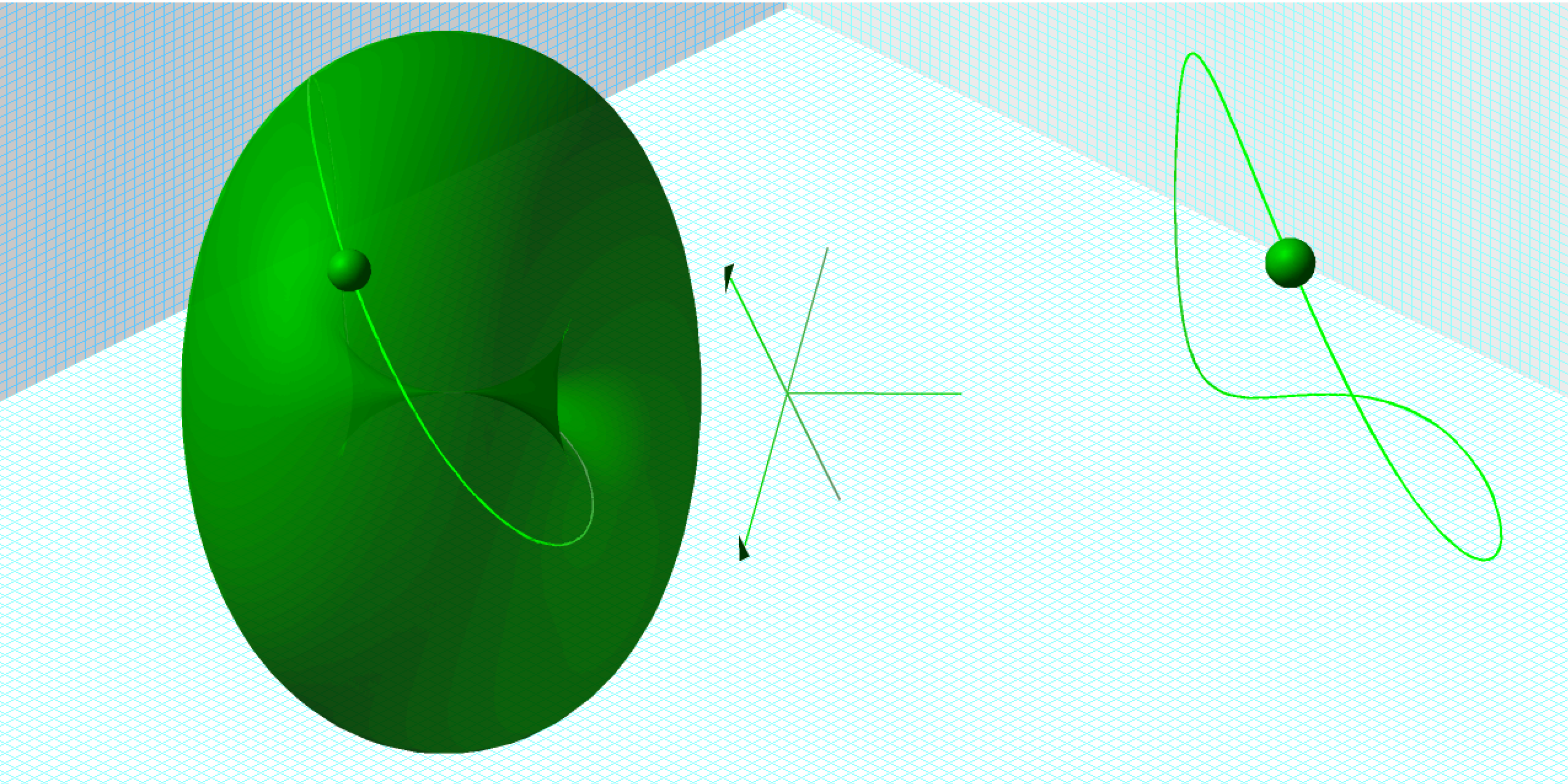
$$= (1/\alpha)(e^2/4\pi\varepsilon_o \hbar c)(-1)$$

$$= (1/\alpha)(\alpha)(-1)$$

$$= -1$$

So $U = -E = -hv$

Superluminal half-photon quantum-vortex electron model formed from spin-½ charged half-photon model. The superluminal quantum moves on the surface of a horn torus.



Equations of the superluminal half-photon quantum-vortex electron model composed of a spin-1/2 charged half-photon

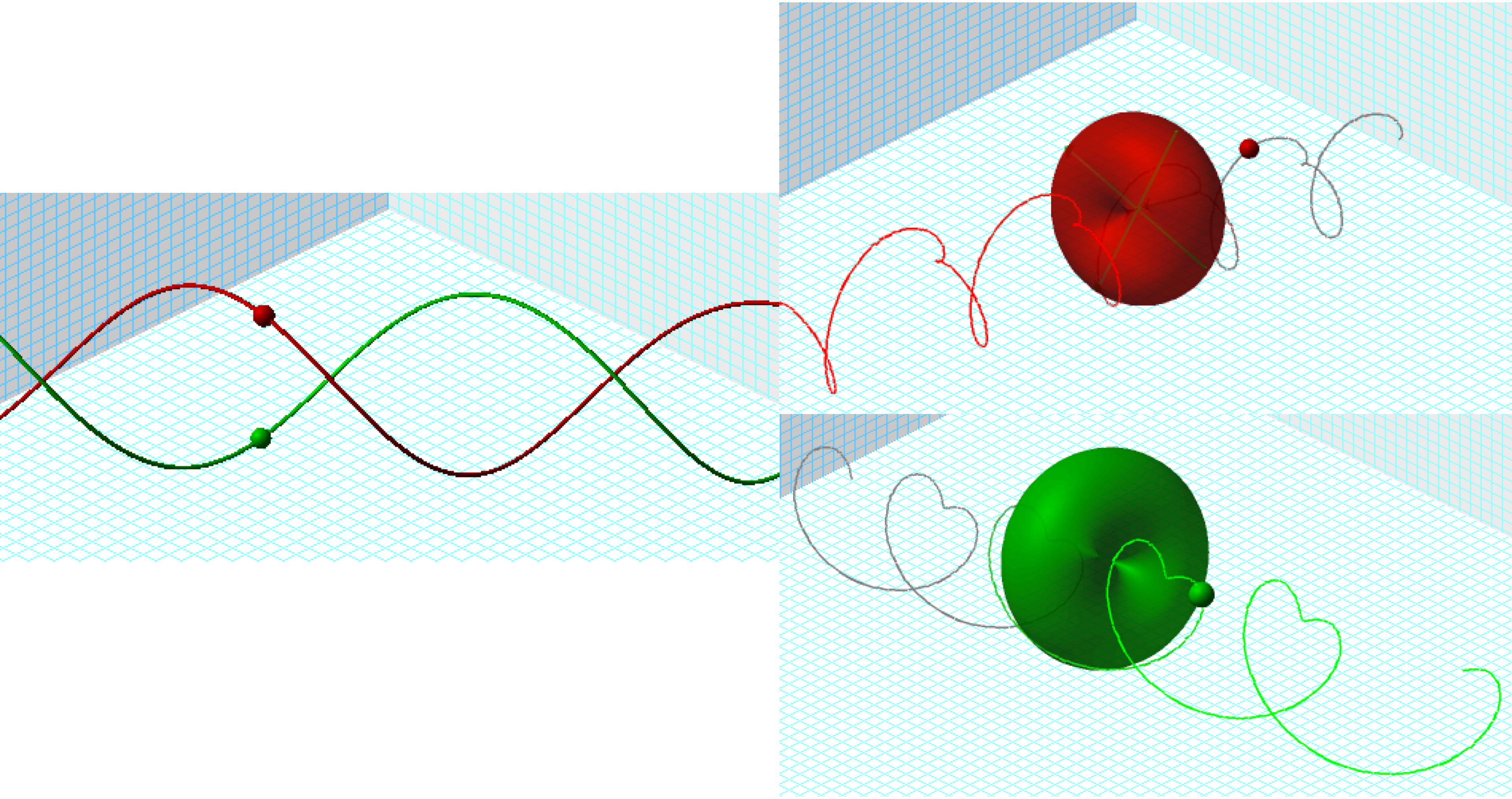
$$x = \frac{\lambda_C}{4\pi}(1 + \cos\omega_{zitt} t)(\cos\omega_{zitt} t)$$

$$y = \frac{\lambda_C}{4\pi}(1 + \cos\omega_{zitt} t)(\sin\omega_{zitt} t)$$

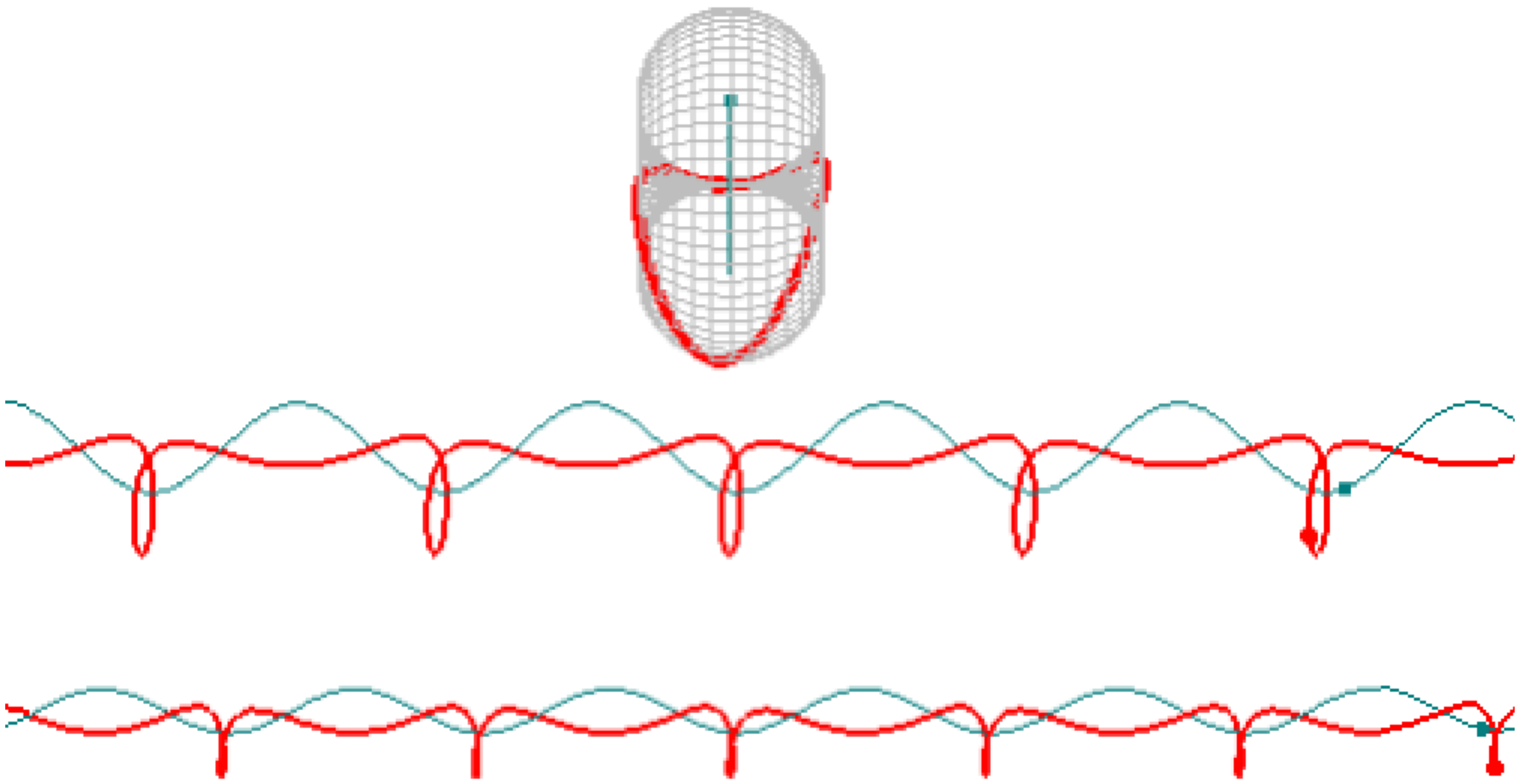
$$z = \frac{\lambda_C}{4\pi}(\sin\omega_{zitt} t)$$

where $\lambda_C = h / mc = 2.43 \times 10^{-12}\,\mathrm{m}$ is the Compton wavelength. $\lambda_C / 4\pi$ is the radius of a double-helix photon of energy equal to the rest energies of an electron plus a positron, and is also the helical radius of the electron model. $\omega_{zitt} = 2\pi v_{zitt} = 2mc^2 / \hbar$ is the electron's zitterbewegung angular frequency.

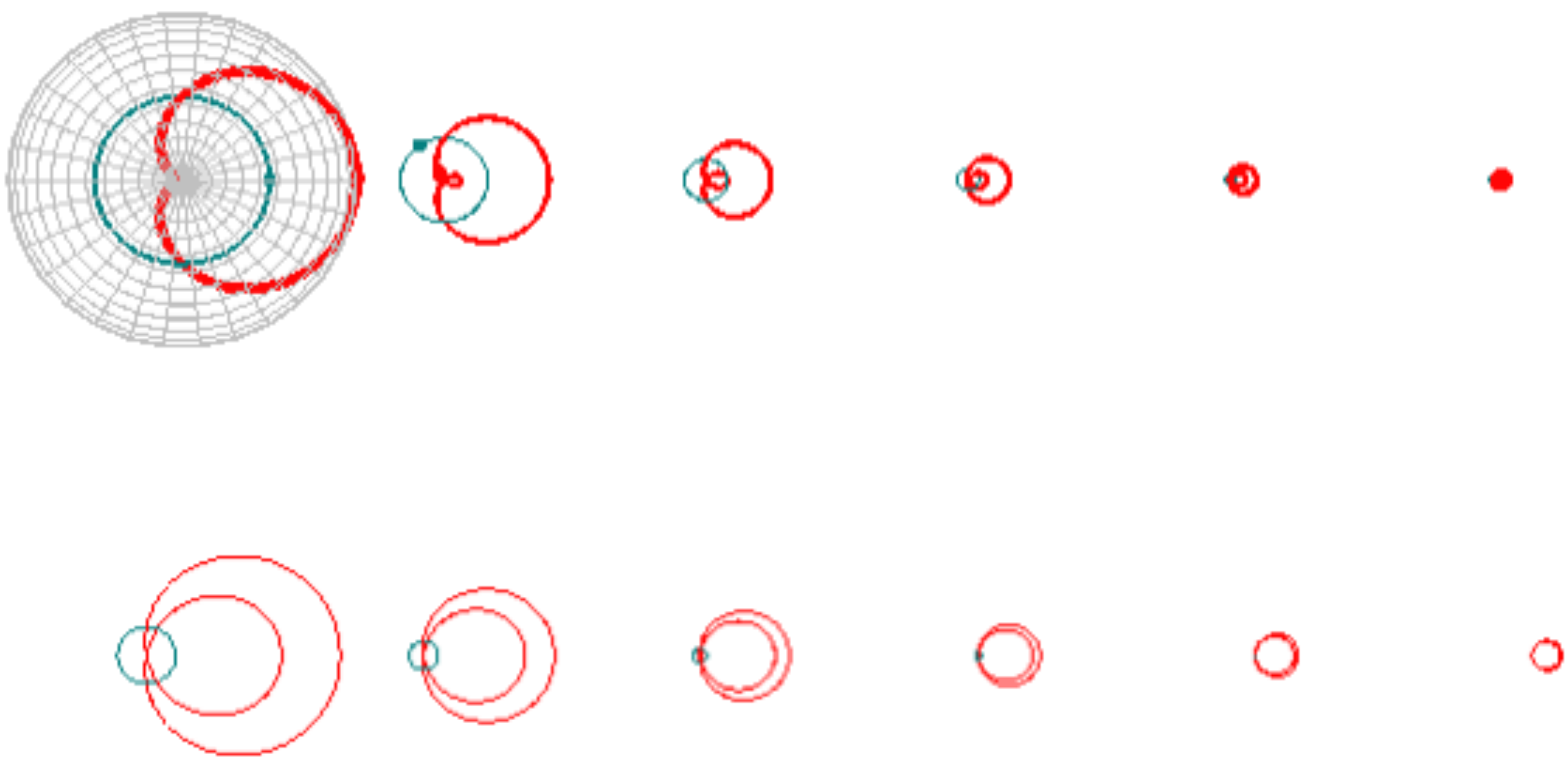
Electron-positron pair production from double-helix photon model



Relativistic Quantum Vortex Electron Model at different velocities (side view)



Relativistic Quantum Vortex Electron Model at different velocities (front view)



Does the double-helix photon model help to explain quantum mechanics?

- Is the composite photon model composed of a superluminal charge dipole of charges $Q=16.6e$ and $-Q=16.6e$ consistent with Maxwell's equations?

- Do physical laws developed since Maxwell need to be reevaluated in light of the double-helix photon model?

The double-helix photon model and Heisenberg's Uncertainty Principle

Heisenberg's uncertainty principle:

$$\Delta x \times \Delta p_x \geq \hbar / 2$$

The rms (root mean square) values of the position *x* and momentum component p_x in each of the spin-1/2 charged half-photons in the double-helix photon model give the following relation:

$$\Delta x \times \Delta p_x = \hbar / 4$$

Can the Heisenberg Uncertainty Principle be derived from the double-helix photon model?