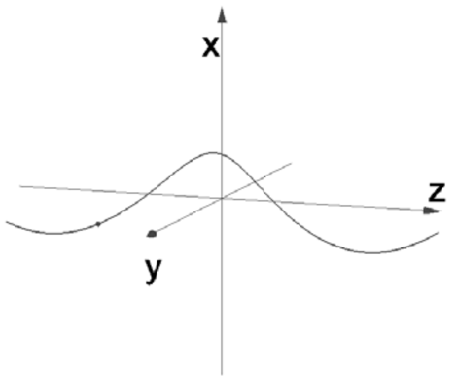
FTL Quantum Models of the Photon and the Electron



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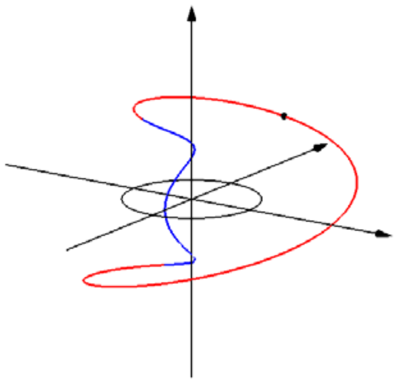

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Session F05: Innovative Theories and Concepts for Communication

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The transluminal quantum: a new unifying concept for a photon and an electron

A transluminal quantum

* is a helically moving point-like object having a frequency and a wavelength, and carrying energy and momentum.
* can pass through the speed of light.
* can generate a photon or an electron depending on whether the quantum's helical trajectory is open or closed.

Photon and Electron Models

- 1. Superluminal quantum model of the photon — An uncharged superluminal quantum moves in an open helical trajectory of radius $R = \lambda / 2\pi$.

- 2. Superluminal/subluminal quantum model of the electron — A charged quantum moves in a closed double-looped helical trajectory with λ equal to one Compton wavelength h/mc.

Photon and Electron Models

(continued)

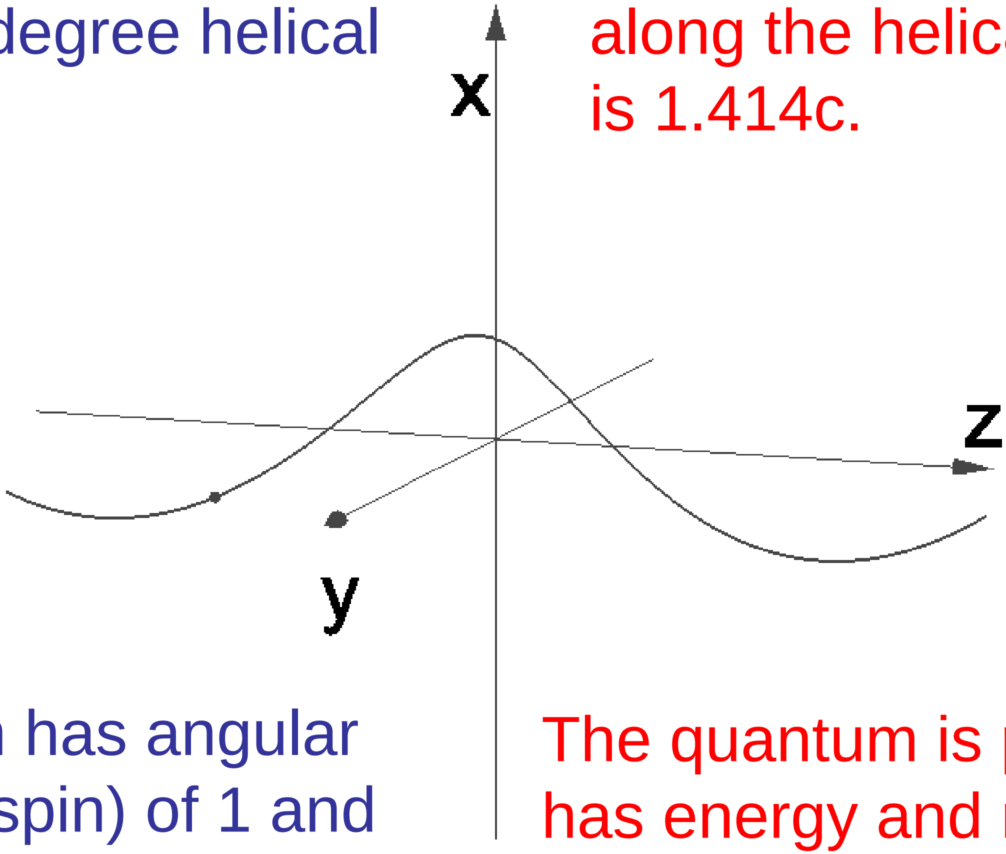
- 3. The electron model and the Dirac equation. The electron model has quantitative properties of the relativistic Dirac equation’s electron including its spin, magnetic moment and “jittery motion” speed, amplitude and frequency.

- 4. The electron’s inertia – may be related to the electron model’s internally circulating ‘momentum at rest’ mc .

Quantum Model of the Photon

For a photon, the quantum travels a 45-degree helical path.

The quantum's speed along the helical trajectory is 1.414c.



The quantum has angular momentum (spin) of 1 and a charge of zero.

The quantum is point-like and has energy and momentum but not mass.

Trajectory Equations for Quantum Model of a Photon

photon spin $s_z = \hbar$ photon momentum $p_z = h / \lambda$

Position and momentum components

for a right-handed photon:

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

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

$$z(t) = ct$$

$$p_x(t) = -\frac{h}{\lambda}\sin(\omega t)$$

$$p_y(t) = \frac{h}{\lambda}\cos(\omega t)$$

$$p_z(t) = \frac{h}{\lambda}$$

Parameters of the Photon model

Photon Parameter	Photon Model Parameter
Detected particle	Uncharged point-like quantum
Energy $\hbar\omega$	Angular frequency along helix ω
Momentum h/λ	Pitch of helix λ
Spin $\hbar$	Radius of helical axis $\lambda/2\pi$
Polarization left or right	Helicity of helix left or right
Speed c	Longitudinal velocity component c

Heisenberg Uncertainty Relations And The Photon Model

$$\Delta \equiv \text{root mean square (rms) value}$$

- The quantum's transverse x and y coordinates:

$$\Delta x \Delta p_x = \left(\frac{1}{\sqrt{2}}\frac{\lambda}{2\pi}\right)\left(\frac{1}{\sqrt{2}}\frac{h}{\lambda}\right) = \frac{h}{4\pi}$$

$$\Delta y \Delta p_y = \left(\frac{1}{\sqrt{2}}\frac{\lambda}{2\pi}\right)\left(\frac{1}{\sqrt{2}}\frac{h}{\lambda}\right) = \frac{h}{4\pi}$$

- Heisenberg uncertainty relations:

$$\Delta x \Delta p_x \geq \frac{h}{4\pi} \quad \text{and} \quad \Delta y \Delta p_y \geq \frac{h}{4\pi}$$

->The photon model's transverse coordinates are <u>at the limit</u> of the Heisenberg uncertainty relation.

Dirac's electron

Paul Dirac (1928) derived his relativistic equation for the electron based on the relativistic particle energy formula $E^2 = p^2c^2 + m^2c^4$.

$$i\hbar\gamma^{\mu}\partial_{\mu}\psi - mc\psi = 0$$

1)Dirac assumed that the electron is point-like.

The Dirac Equation

2) Gives the correct electron spin $\frac{1}{2}\hbar$

3) Gives the correct electron magnetic moment $e\hbar/2m$ (pre-QED)

Predicts the electron's theoretical Jittery Motion (*zitterbewegung*):

4) Frequency $2mc^2/h$

5) Amplitude $\frac{1}{2}\hbar/mc$

6) Speed c

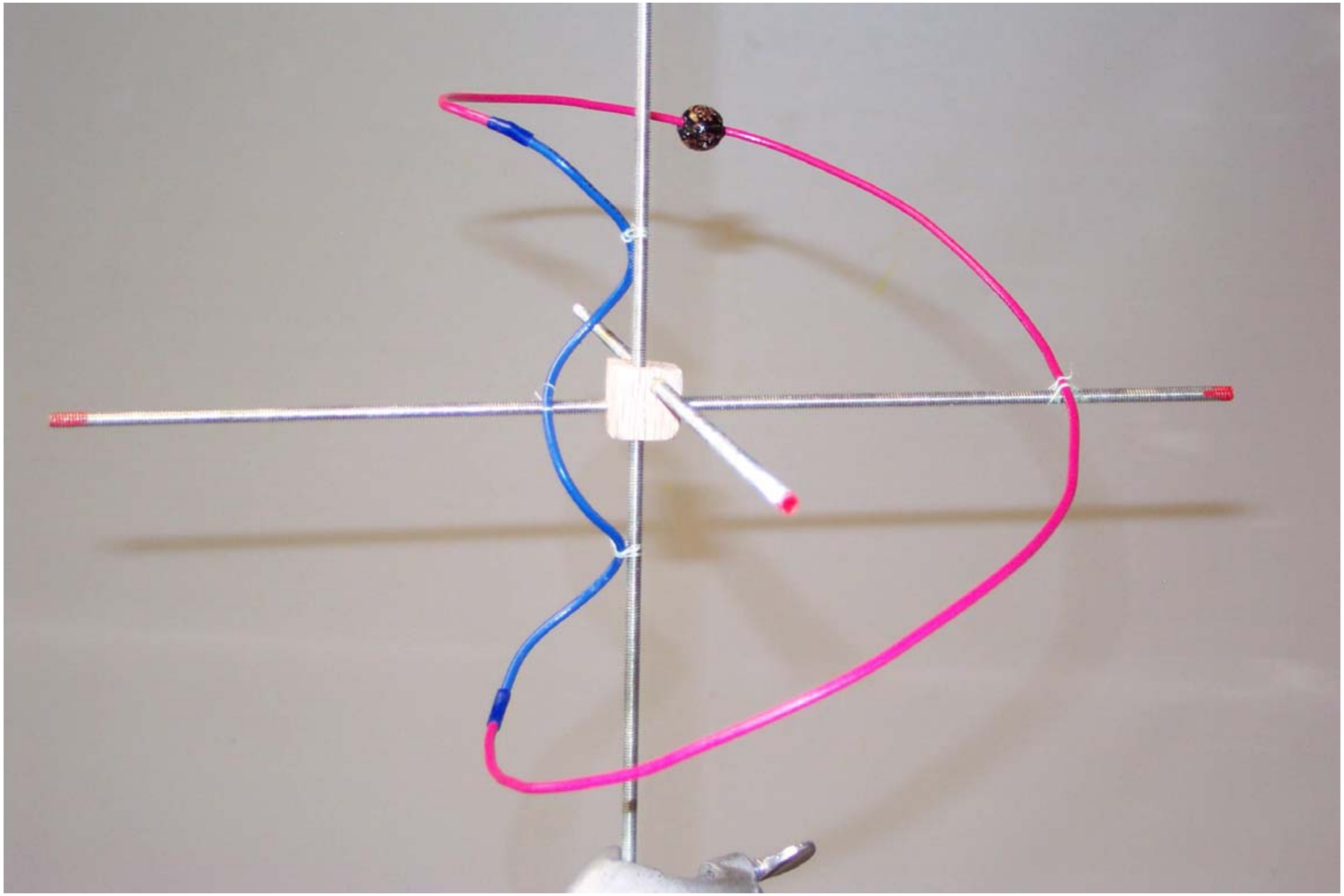
7) Predicts the electron's antiparticle (positron)

8) Predicts an electron with a quantum rotational periodicity of 4π .

But… Dirac had no model of the electron.

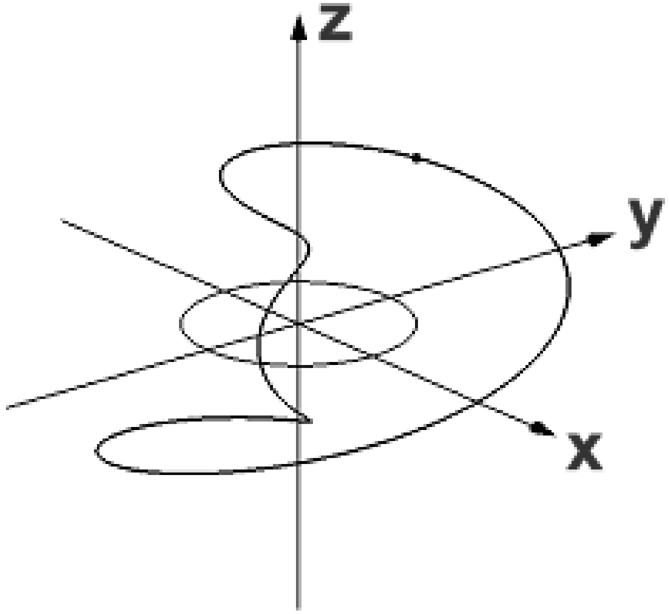
The proposed FTL quantum model of the electron has all 8 of these properties.

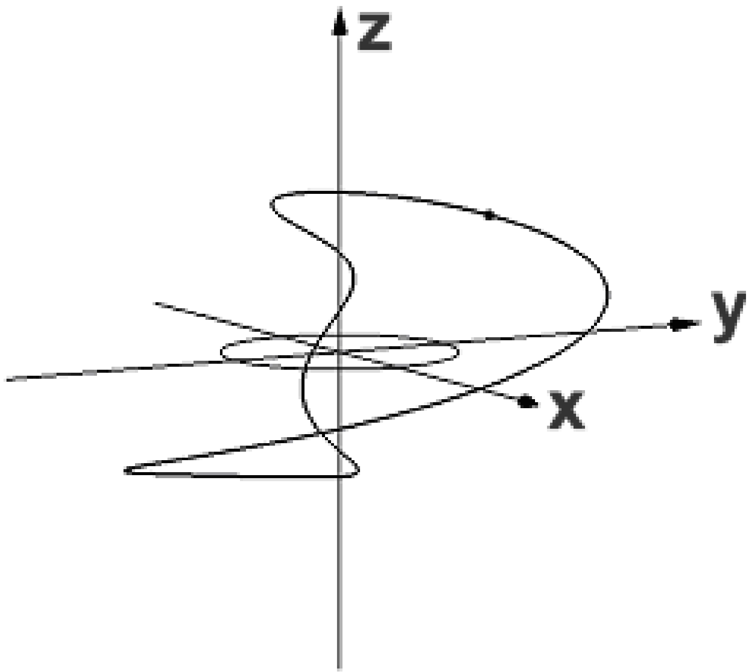
Transluminal Quantum Model of the Electron



Red trajectory: quantum is superluminal. Blue trajectory: quantum is subluminal.

Transluminal Quantum Model of the Electron





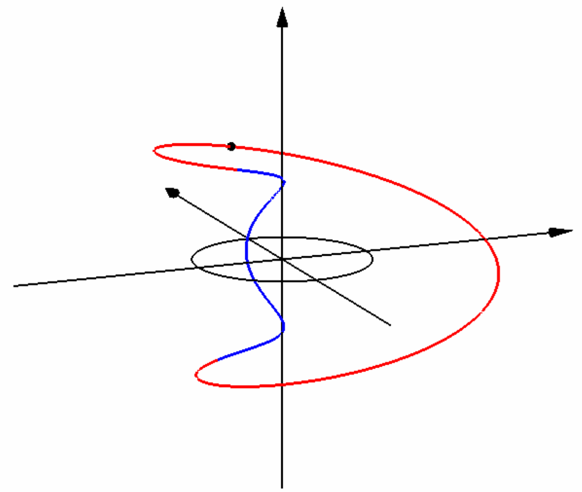
Along the quantum's trajectory:

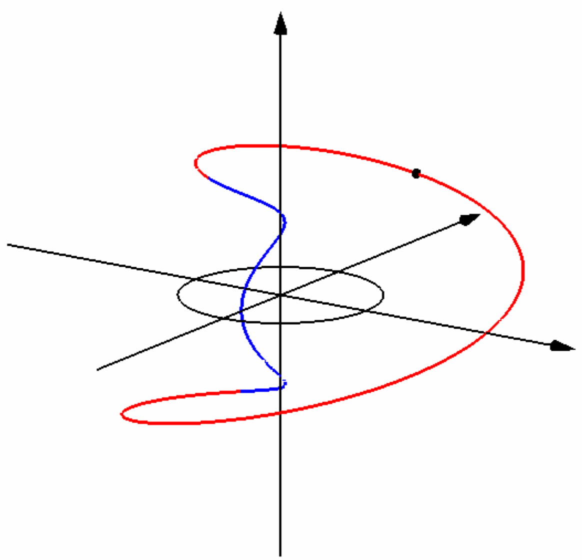
- The maximum speed is 2.515c .
- The minimum speed is 0.707c .

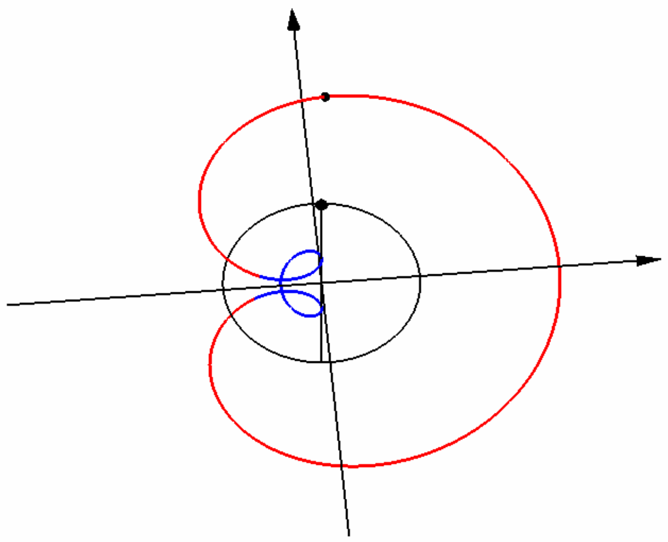
The small circle is the axis of the double-looped helical trajectory.

Transluminal Quantum Model of the Electron

Superluminal (red) and subluminal (blue) portions of electron quantum's trajectory







Transluminal Quantum Model of the Electron

Equations of the transluminal quantum's trajectory
- a closed, double-looped helix

$$x(t) = R_0 (1 + \sqrt{2} \cos(\omega_0 t)) \cos(2\omega_0 t)$$

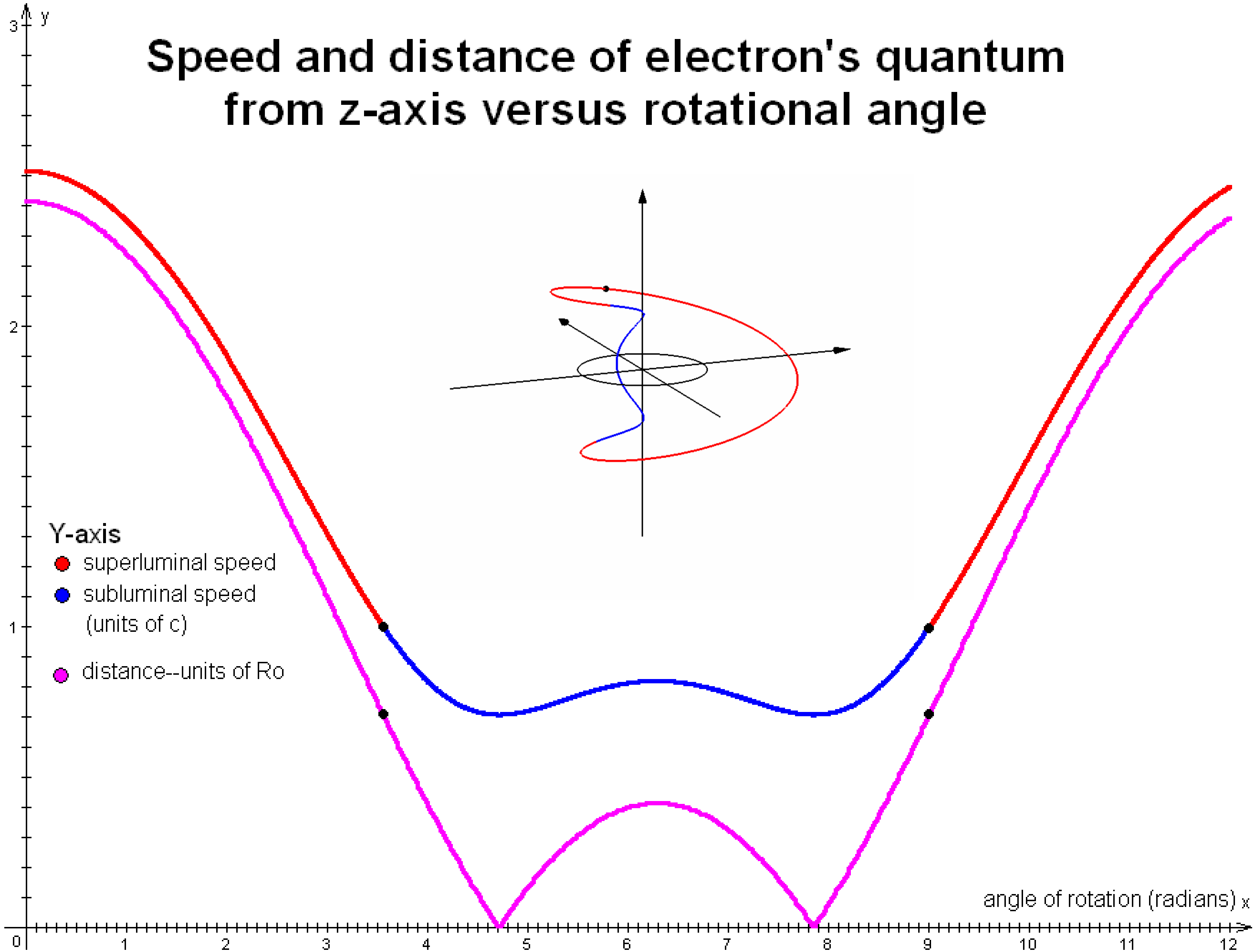
$$y(t) = R_0 (1 + \sqrt{2} \cos(\omega_0 t)) \sin(2\omega_0 t)$$

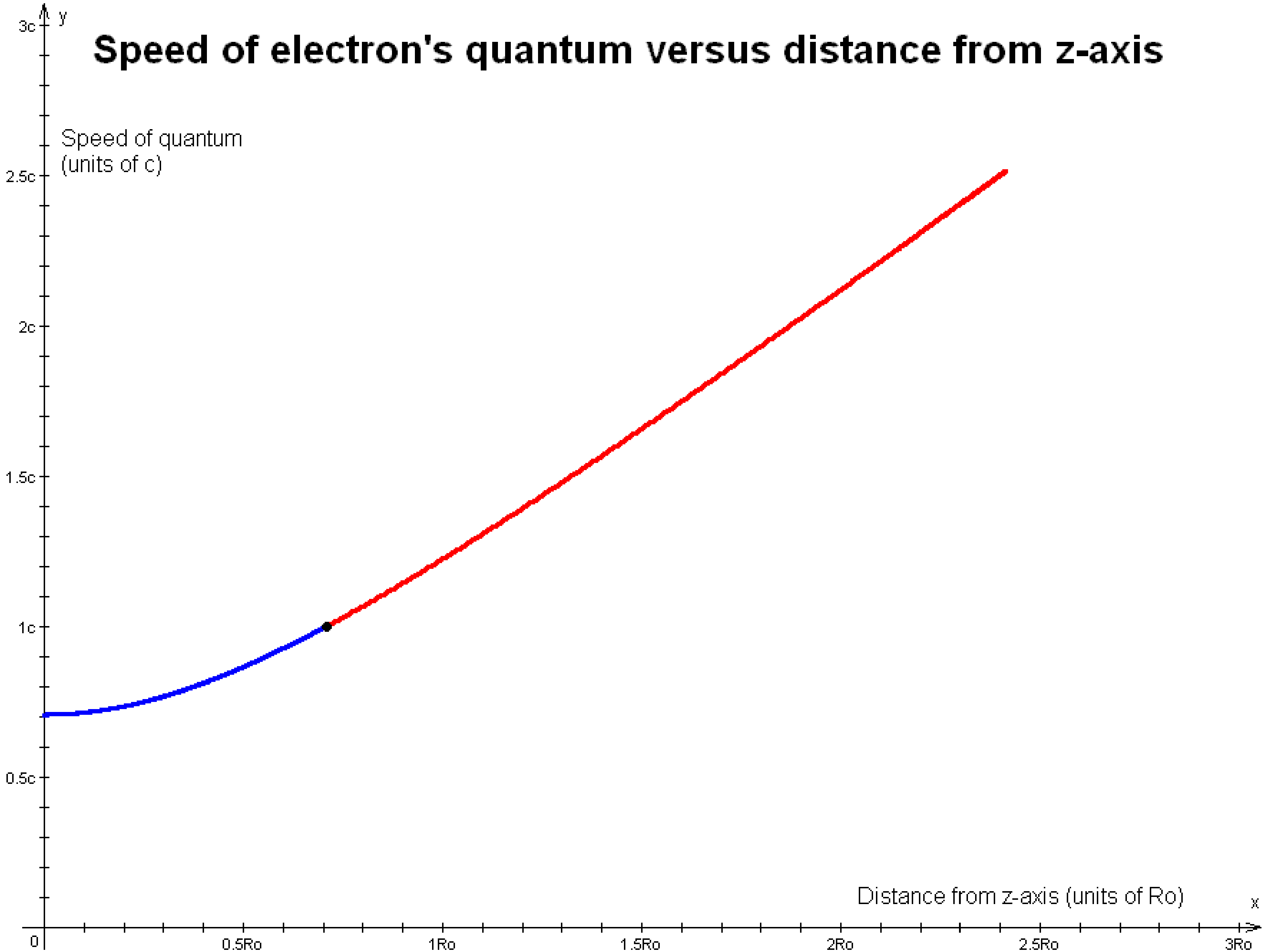
$$z(t) = R_0 \sqrt{2} \sin(\omega_0 t)$$

$$R_0 = \frac{1}{2} \frac{\hbar}{mc} = 1.9 \times 10^{-13} \mathrm{m} \qquad \omega_0 = \frac{mc^2}{\hbar} = 7.9 \times 10^{20} / \sec$$

Parameters of the Electron Model

Electron Parameter		Electron Model Parameter	
1. Mass/energy	mc^2	Compton wavelength	h/mc
2. Charge	$-e$	Point-like charge	$-e$
3. Spin	$\frac{1}{2}\hbar$	Radius of helical axis	$\frac{1}{2}\hbar / mc$
4. Magnetic moment	$\frac{-e\hbar}{2m}$	Radius of helix	$\frac{\sqrt{2}}{2}\hbar / mc$
5. Electron or positron		Helicity of helix	L,R

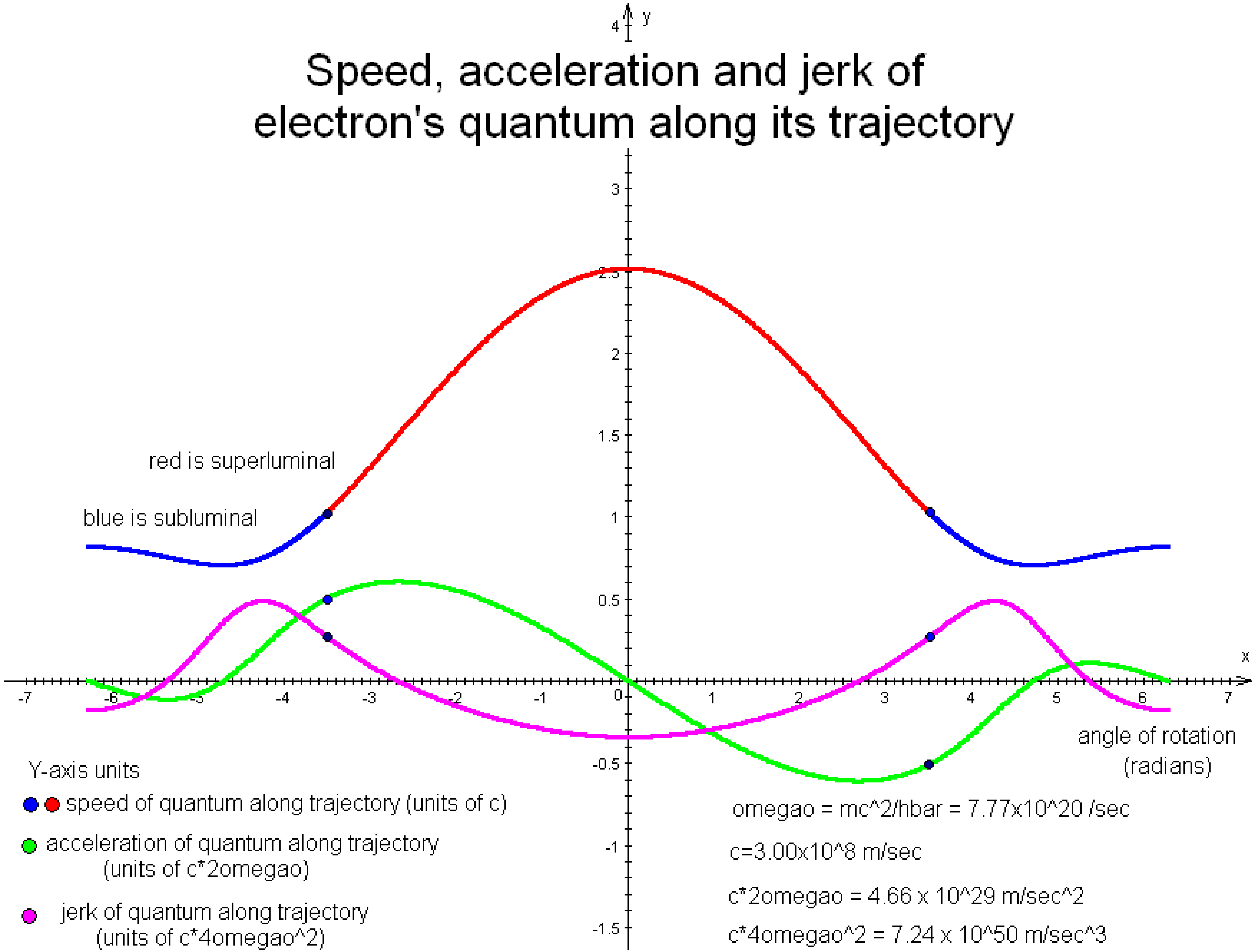

Speed and distance of electron's quantum from z-axis versus rotational angle
Y-axis
superluminal speed
subluminal speed
(units of c)
distance--units of Ro
angle of rotation (radians) x
y
0
1
2
3
4
5
6
7
8
9
10
11
12


Speed of electron's quantum versus distance from z-axis
Speed of quantum
(units of c)
Distance from z-axis (units of Ro)
y
x
3c
2.5c
2c
1.5c
1c
0.5c
0
0.5Ro
1Ro
1.5Ro
2Ro
2.5Ro
3Ro

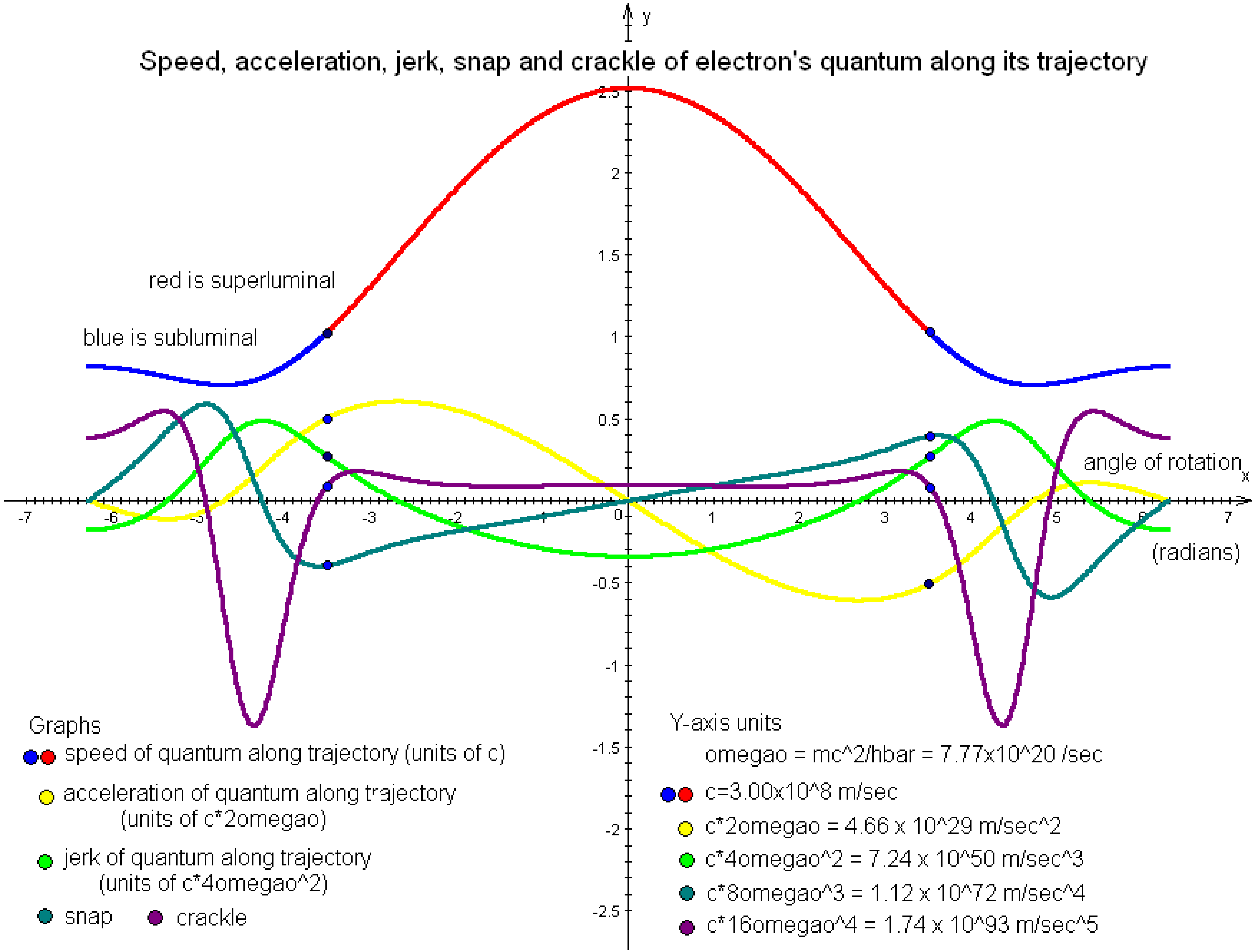
Electron Quantum's Trajectory: Distance and Time Ratios

- Superluminal distance: 76% (76.2683%)
- Subluminal distance: 24% (23.7317%).

- Superluminal time : 57% (56.6405%)
- Subluminal time: 43% (43.3595%).



Speed, acceleration and jerk of
electron's quantum along its trajectory
y
x
red is superluminal
blue is subluminal
angle of rotation
(radians)
Y-axis units
speed of quantum along trajectory (units of c)
acceleration of quantum along trajectory
(units of c*2omegao)
jerk of quantum along trajectory
(units of c*4omegao^2)
omegao = mc^2/hbar = 7.77x10^20 /sec
c=3.00x10^8 m/sec
c*2omegao = 4.66 x 10^29 m/sec^2
c*4omegao^2 = 7.24 x 10^50 m/sec^3


Speed, acceleration, jerk, snap and crackle of electron's quantum along its trajectory
y
red is superluminal
blue is subluminal
angle of rotation
x
(radians)
Graphs
speed of quantum along trajectory (units of c)
acceleration of quantum along trajectory
(units of c*2omegao)
jerk of quantum along trajectory
(units of c*4omegao^2)
snap
crackle
Y-axis units
omegao = mc^2/hbar = 7.77x10^20 /sec
c=3.00x10^8 m/sec
c*2omegao = 4.66 x 10^29 m/sec^2
c*4omegao^2 = 7.24 x 10^50 m/sec^3
c*8omegao^3 = 1.12 x 10^72 m/sec^4
c*16omegao^4 = 1.74 x 10^93 m/sec^5

Dirac Equation's "Jittery Motion" Properties of the Electron Model

1. Zitterbewegung speed of electron (eigenvalue of Dirac equation for free electron):

$$v_{zitt} = c$$

Longitudinal component of speed of electron's quantum along circular axis.

$$v_{longitudinal} = c$$

2. *Zitterbewegung* angular frequency:

$$\omega_{zitt} = 2mc^2/\hbar = 2\omega_0 = 1.6 \times 10^{21}/\mathrm{sec}$$

Electron model angular frequency in x-y plane

$$\omega_{xy} = 2\omega_0$$

3. *Zitterbewegung* amplitude:

$$R_{zitt} = \tfrac{1}{2}\hbar/mc = R_0 = 1.9 \times 10^{-13}\,\mathrm{m}$$

Root mean square size of electron quantum's trajectory:

$$x_{rms} = y_{rms} = z_{rms} = R_0$$

Other Dirac Equation Properties of the Electron Model

4. Spin $s_z = \frac{1}{2}\hbar$

5. Magnetic moment $M_z = -e\hbar / 2m$

Points 4 and 5 lead to Dirac Gyromagnetic ratio $g = 2$

6. Anti-particle predicted -- Mirror Image of electron

o Two possible helicities of electron model--electron and positron

Heisenberg Uncertainty Relations and the Electron Model

$$\Delta \equiv \text{root mean square (rms) value}$$

- Electron model's x and y coordinates:

$$\Delta x \Delta p_x = \left(\frac{1}{2}\hbar / mc\right)\left(\frac{1}{\sqrt{2}} \cdot mc\right) = .707 \frac{h}{4\pi}$$

$$\Delta y \Delta p_y = \left(\frac{1}{2}\hbar / mc\right)\left(\frac{1}{\sqrt{2}} \cdot mc\right) = .707 \frac{h}{4\pi}$$

- Heisenberg uncertainty relations:

$$\Delta x \Delta p_x \geq \frac{h}{4\pi} \quad \text{and} \quad \Delta y \Delta p_y \geq \frac{h}{4\pi}$$

->The electron model is <u>under the 'radar'</u> of the Heisenberg uncertainty relation.

Inertia and the Electron Model

- The electron model's internal circulating momentum in the $x-y$ plane is $p = mc$.
- The relativistic equation for mass-energy is

$$E^2 = p^2c^2 + m^2c^4$$

- This can be rewritten as

$$\frac{E^2}{c^2} = p^2 + (mc)^2$$

- Which means that mc may be the electron's inertia or 'momentum at rest' within the electron.

Testing the Electron Model

- Scattering Data: The model predicts 1) spin-up and spin-down and 2) a helical left or right handedness for the electron and the positron corresponding to left or right circularly polarized photons.
  – Therefore, left and right-handed gamma photons may sometimes scatter differently from electrons and correspondingly differently from positrons.

- Special Ratios: The electron model's predicted superluminal/subluminal ratios may be compared with problematical empirical particle data.
  – For distance along trajectory, FTL/STL = 76%/24%
  – For time along the trajectory, FTL/STL = 57%/43%

Conclusions

- The FTL quantum models of the electron and the photon contain quantitative experimental and theoretical properties of the electron and the photon *based on transluminal quantum trajectories*.

- While the transluminal quantum is point-like, the continuous internal structure of photon and electron models generated by the quantum can be graphed and visualized in 3D.

- The electron model may be tested by projecting left and right-handed gamma photons on electrons and comparing scattering rates *even though the models lie at or below the Heisenberg uncertainty limits for position and momentum*.

Vision Value

The transluminal quantum models of the photon and electron are anchored in the physics and mathematics of Dirac and Schroedinger. This model may be of heuristic value in suggesting new qualitative and quantitative approaches to:

- Explaining Elementary (SM) particles
- Exploring Sub-elementary structures
- Energy
- Entanglement
- FTL Communication
- FTL Transport
- FTL Travel