# The Electron, Twisted Photons and Knotted Light

$e^-$

$e^+$

$h\nu$

$h\nu$

Qiu-Hong Hu

Department of Physics, Gothenburg University and LightLab Sweden AB (Publ), SE-412 96 Göteborg, Sweden

"You know, it would be sufficient to really understand the electron."
—— Albert Einstein

## What is an Electron?

The topological structure of the electron is a closed two-turn helix (a so called Hubius Helix) that is generated by circulatory motion of a mass-less particle at the speed of light.

$$\begin{cases} x = \left( r_e + \frac{1}{2} r_0 \sin \omega_d t \right) \cos \omega_z t, \\ y = \left( r_e + \frac{1}{2} r_0 \sin \omega_d t \right) \sin \omega_z t, \\ z = \frac{1}{2} r_0 \cos \omega_d t, \end{cases}$$

$$r_e = \frac{\hbar}{2mc}, \quad \omega_d = \frac{mc^2}{\hbar}, \quad \omega_z = \frac{2mc^2}{\hbar},$$
$$r_0 = 0 \quad (0 \le \omega_d t \le 2\pi, 0 \le \omega_z t \le \pi),$$
$$r_0 = \frac{e^2}{mc^2} \quad (2\pi \le \omega_d t \le 4\pi, \pi \le \omega_z t \le 2\pi),$$

A system of parametric equations for the motion of a massless particle
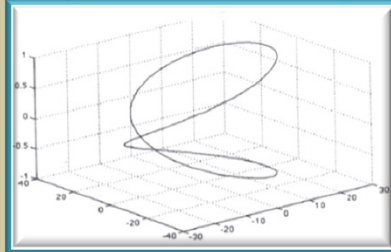
Graphical representation of the Hubius Helix created from the parametric equations

The physical constants, geometric variables and parameter time are in such a way related.

Physical Aspects vs. Geometric Aspects:

$$r_e = \frac{\lambda_C}{4\pi} = \frac{\hbar}{2mc}, \alpha = \frac{r_0}{2r_e} = \frac{e^2}{\hbar c} \approx \frac{1}{137}, T_w = \frac{r_0}{2\pi r_e} = \frac{\alpha}{\pi} = \frac{e^2}{\pi \hbar c}, \mu_e = \frac{e\hbar}{2mc}\left[1 + \frac{1}{2}\left(\frac{\alpha}{\pi}\right)\right]$$

Quantization Condition,    The Fine Structure Constant,     The Charge Identified with the Twist,     The Magnetic Moment

Where $r_e$ is the radius of the electron, $\lambda_C$ is the Compton wavelength, $r_0$ is the classical radius of the electron, $\omega_d$ is the de Broglie frequency, $\omega_z$ is the Zitterbewegung frequency, $T_w$ is the twist of the Hubius Helix.

## Twisted Photon and Knotted Light

PHOTON
with
Quantized, curved, twisted and closed world line

↕

ELECTRON

Varying    curvature
and    twist

ARTIFICIAL ELECTRONS

Closing the world line

Simplifying the world line

Twisted photons were produced

Knotted light were produced

References: Qiu-Hong Hu, Physics Essays, 17, 442, 2004,
G. Molina-Terriza et al Nature Phys. 3, 305, W. Irvine et al, Nature Phys. 4, 716.