

# To the physical nature of spin and unified theory of matter

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I suggest explanation of the physical nature of spin in unification of particles by model of photonic vortices.

I summarize arguments for unification model where I consider all particles as built of photons. I consider photon moving vortically along circumference of length equal to wavelength of photon  $\lambda$ , i.e. of radius  $R = \lambda/2\pi = \lambda$ . This *photonic vortex* is a resting particle with rest mass  $m = h\nu/c^2$ .

Calculation of the angular momentum of the photonic vortex

$$M_{PV} = I_{PV}\omega \quad (1)$$

shows that it is spin. ( $I_{PV}$  is moment of inertia of the photonic vortex). Since photon is not a point particle, but a *wave* quantum, then photon is *delocalized* at all circumference of vortex. Therefore for finding the moment of inertia of the vortex  $I_{PV}$  we can use homogeneous disc model, the moment of inertia of which is  $I = mR^2/2$ , where  $R$  is radius of vortex circumference,  $R = \lambda/2\pi = \lambda$  and  $m = p/c = h/(\lambda c)$ . So, moment of inertia of the photon vortex  $I_{PV}$  is:

$$I_{PV} = \frac{mR^2}{2} = \frac{h}{2\lambda c} \left( \frac{\lambda}{2\pi} \right)^2 = \frac{h}{2\lambda c} \frac{\lambda^2}{4\pi^2} = \frac{h\lambda}{8\pi^2 c} \quad (2)$$

angular velocity of photon  $\omega$  at vortical motion (in vortex) is:

$$\omega = \frac{c}{R} = \frac{2\pi c}{\lambda} \quad (3)$$

then substitute (2) and (3) in (1), and photon vortex angular momentum is:

$$M_{PV} = I_{PV}\omega = \frac{h\lambda}{8\pi^2 c} \frac{2\pi c}{\lambda} = \frac{h}{4\pi} = \frac{\hbar}{2}$$

Consequently, *angular momentum of the photon vortex does not depend on wavelength of the photon and is a constant value equal to  $\hbar/2$ :*

$$M_{PV} = \frac{\hbar}{2} = inv$$

So, photon vortex is a fermion with spin  $j = \hbar/2$ , and rest mass  $m = h\nu/c^2$ ! Since *all leptons and all quarks have spin  $\hbar/2$* , then I consider here leptons and quarks as *photonic vortices*. I use Kaluza's 4th dimension of space for description of electric charge. This model of photonic vortices successfully explains structure and properties of ALL experimentally known particles!

The model of photonic vortices explains "double magnetism" of the result of Einstein-de Haas experiment. In explanation of that experiment before it was assumed as if electron is a rotating *ball*, with angular momentum  $\mathbf{M} = m\mathbf{v}r$  and magnetic moment (without QED's corrections)  $\mu = IS = e\nu\pi r^2$ , then ratio  $\mu/\mathbf{M}$  would be:

$$\mu/\mathbf{M} = -\frac{e}{2m}$$

( $v = r\omega = 2\pi r\nu$ ) while Einstein-de Haas and Barnett experiments gave value

$$\mu/\mathbf{M} = -\frac{e}{m}$$

This contradiction with experiment proves that *electron is not a ball*, but it does not prove as if "spin is not angular momentum".

Let's calculate the ratio  $\mu/\mathbf{M}$  not from *unproved assumption* "electron is a ball", but from the position "*electron is a photonic vortex*", and compare it with experimental value. Angular momentum of electron is *not*  $m\mathbf{v}r$ , but is  $\hbar/2 = \text{const}$ . Since in my model, the photon moves vortically inside of electron at speed  $v=c$ , this means that electron rotates at speed  $v=c$ . Photon of frequency  $\nu$  moving vortically inside of electron at speed  $v=c$  makes electric current  $I = e\nu$ . (for electric charge I consider theory in 4D space using Kaluza's extra coordinate). Electron has magnetic moment  $\mu = IS$ , where  $S = \pi R^2$ ,  $R$  is radius of vortex circumference,  $R = \lambda/2\pi = \lambda$ . Using  $h/\lambda c = m_e$ , for magnetic moment of electron we have:

$$\mu = IS = e\nu S = \frac{e\nu\lambda^2}{4\pi} = \frac{eh}{4\pi m} = \frac{e\hbar}{2m}$$

then  $\mu/\mathbf{M}$  ratio in my model of photonic vortices is:

$$\frac{\mu}{M} = -\frac{\hbar e}{2m \hbar} = -\frac{e}{m}$$

that *coincides* with results of experiments of Einstein-de Haas and Barnett!

So, indeed, spin of electron is its angular momentum!

The difference in structure of leptons and quarks is discussed in the article. I construct model of photonic vortices and show that it's a very realistic candidate for unified theory of matter where there is one truly elementary particle - photon. I show that the photonic vortex concept explains spin, uncertainty relations, wave properties of particles etc. In the article I also show correlation of the model with another experiments. The present model of photonic vortices explains the physical sense of the formula  $E = mc^2$ . If all matter is built of energy quanta - photons - then it's clear why massive bodies in rest have energy - fully consist of energy. Heisenberg's indeterminacy relations follow from this model, it lets to explain and understand them.