Why a photon is not a particle

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Abstract – The variables and parameters of the presented model for the generation of an arbitrary photon fit like the pieces of a jigsaw puzzle and therefor justify the conclusion that the model eliminates the wave-particle duality of the photon by explicitly excluding the possibility that it can be a (massless) particle too.

Introduction

Considering a photon as an (extremely) short pulse with an electro-magnetic wave as carrier, eliminates the so-called wave-particle duality. This article shows how the origin of such a pulse can be explained by applying Ampère's and Faraday's law in Bohr's atomic model. Using the Rydberg formula and the assumed energy E=hf, the expected pulse durations and their related EM-powers are presented.

Bohr's atomic model

In Bohr's atomic model, in case of a stable atom, an equal number of electrons revolve around the nucleus, as there are protons in this nucleus. These electrons can rotate in orbits with different distances with respect to the nucleus. These distances are discreet. In other words: an electron will never orbit in between the determined circles.
The generally accepted concept is that a photon is emitted if an electron jumps out of an inner orbit into a more outer orbit. The question is: how is such a photon precisely generated?

Forces holding the electron in its orbit

An electron is held in its orbit by three forces:

- the centrifugal force trying to eclipse the electron out of its orbit.
- the centripetal gravitational force between nucleus and electron
- the centripetal Coulomb force between nucleus and electron

with:

r	radius of the orbit of the electron		m
v_e	velocity of the electron along its orbit		m/s
Z	atom number		
m_e	mass of the electron	$9.1*10^{-31}$	kg
m_p	mass of proton	$1.7*10^{-27}$	kg
m_n	mass of the nucleus	$2\ Z\ m_p$	kg
G	gravitational constant	$6.7*10^{-11}$	Nm^2kg^{-2}
k_e	Coulomb's constant $(1/4\pi\varepsilon_0)$	$8.99*10^9$	Nm^2C^{-2}
q_e	electric charge of the electron	$1.6*10^{-19}$	C

The mathematical descriptions of the mentioned forces are:

Centrifugal force: $F_{cf} = m_e v_e^2/r$
Gravitational force: $F_G = Gm_n m_e/r^2$
Coulomb force: $F_C = k_e Z q_e^2/r^2$

Remarks:

-r has the discreet values $n^2 a_0$, with a_0 so called Bohr radius, and n=1, 2, 3……

-The mass of a proton is about equal to the mass of a neutron.

-The number of neutrons is taken equal to the number of protons.

- $F_G \sim 10^{-67} Z/r^2$ and $F_C \sim 10^{-28} Z/r^2$, with as expected result that F_G is incomparably small compared to F_C.

So, the real number of neutrons does not play any role in this article, neither does F_G anymore.

As a result, the electron is held in its orbit by:

$$F_{cf} = F_C$$

So: $m_e v_e^2/r = k_e Z q_e^2/r^2$

from which it follows that:

$$v_e = \{k_e Z q_e^2/(m_e r)\}^{½}$$

The basic idea behind the generation of a photon

The fundamental part of the investigated model is the assumption that the orbit of an electron around the nucleus of an atom is equivalent to a circular shaped electric current, creating a magnetic field.

Suppose the "round trip" of an electron is s_e seconds and its electric charge is represented by the symbol q_e. Then the first approximation of the meant electric current is $q_e/s_e = i_e$ ampere. The mentioned "round trip" is equal to $2\pi r/v_e$, with r the radius of the orbit of the electron and v_e the velocity along that orbit.
Such an electric current causes a straight-lined magnetic field H_e, perpendicular to plane of the orbit and enclosed by the orbit of the electron.

$$H_e = i_e/2r = q_e v_e/4\pi r^2 = q_e^2 (k_e Z/m_e)^{½}/4\pi r^{2,5}$$

As soon as the electron eclipses its orbit, r changes, so the strength of this magnetic field changes. And a change of a magnetic field causes a change of an electric field.

A source of an electro-magnetic wave shows up!

The purpose of this analysis is to investigate whether this idea makes sense or not in relation to the available information about photons.

The kinetic and potential energy of an orbiting electron

The kinetic energy E_k of an electron in orbit r, versus its potential energy E_p is:

$E_k = ½m_ev_e^2$ versus $E_p = k_eZq_e^2/r$

Applying the above found expression $v_e^2 = k_eZq_e^2/(m_er)$ in E_k results in:

$E_k = ½m_ek_eZq_e^2/m_er = ½k_eZq_e^2/r = \mathbf{½}E_p$

This compared to the situation of a mass m_e orbiting around a mass m_n shows a gravitational potential energy $E_g = Gm_nm_e/r$ versus the kinetic energy $½m_ev_e^2$.
Based on $F_{cf} = F_G$ or $Gm_nm_e/r^2 = m_ev_e^2/r$ it follows that $v_e^2 = Gm_n/r$.
This applied to the kinetic energy results in $E_k = ½Gm_em_n/r$, so the kinetic energy in such a situation also equals half the potential energy!
The expressions above show that in both situations the kinetic as well as the potential energy of an orbiting object is proportional to 1/r.

As a result: the larger the orbit, the smaller both kinds of energy.
This statement dramatically contradicts the prevailing conception.

See for example http://en.wikipedia.org/wiki/Atomic_orbital

Orbital energy
In atoms with a single electron (hydrogen-like atoms), the energy of an orbital (and, consequently, of any electrons in the orbital) is determined exclusively by n. The n=1 orbital has the lowest possible energy in the atom. Each successively higher value of n has a higher level of energy, but the difference decreases as n increases. For high n, the level of energy becomes so high that the electron can easily escape from the atom.

To my surprise this blunder is copied blindly on several places on the Internet.
I never saw it described or expressed correctly!

At this point it is interesting to realize that Bohr's model also forces us to conclude that an electron will never eclipse, from whatever orbit, neither towards, nor away from the nucleus, if an external force would not compel it to do so. Exactly the same yields for an orbiting planet and spacecraft. A kind of (electron) binding energy has to be overcome.

This will be investigated in more detail hereafter.

Background of the Rydberg expression

Citation from Wikipedia:
"The Planck constant h has been introduced to express the relation between frequency f and energy E for a light quantum (photon) as: E=hf."

Another description shows:
"The Planck constant was first described as the proportionality constant between the energy (E) of a photon and the frequency (f) of its associated electromagnetic wave."

The formula E=hf is a non-physical equation, because it suggests that the energy of a photon is proportional to the frequency of its carrier. It is well known that this can, physically speaking, not be true. Only the amplitude of the electro-magnetic wave can be related to its power, thus to **its** energy, of the photon. Seemingly there is relation between the frequency and the amplitude of the carrier of a photon.

It is generally accepted that the orbits of an electron are discrete. However, up to now nothing in Bohr's model forces us to such a hypothesis. For whatever radius r, the balance between the Coulomb and the centrifugal force is, by definition, perfect. But that would also mean that an arbitrary small orbit radius would be possible, or even worse: that an electron would melt together with a proton to a neutron, resulting in the elimination of the atom. Based on this proof by contradiction it is indeed logical to assume only discrete orbits.

The discrete radii are mathematically represented by $r_n = n^2 a_0/Z$, with n is an integer. The radius a_0 is the so called Bohr's radius, the smallest in the neutral hydrogen atom.

The mathematical expression for a_0 is found as follows.

The idea behind the quantitative presentation of the discrete radii is based on the assumption, for whatever reason, that the angular momentum $m_e v_e r_n$ of the electron is quantized, expressed as:

$$m_e v_e r_n = nh/2\pi$$

Applying this to the relations:

$$F_{cf} = m_e v_e^2/r = F_C = k_e Z q_e^2/r^2$$

it follows that :

$$r = n^2h^2/(4\pi^2 k_e Z q_e^2 m_e)$$

r is defined as a_0 for n=1 and Z=1, so:

$$a_0 = h^2/(4\pi^2 k_e q_e^2 m_e)$$

The difference in kinetic energy of the electron orbiting in n_1 respectively n_2, is represented by:

$\Delta E_{kn} = ½m_e (v_{e1}^2 - v_{e2}^2)$, with: $v_e^2 = k_eZq_e^2/m_er$ resulting in:

$$\Delta E_{kn} = (k_eZq_e^2/2)*(1/r_{n1} – 1/r_{n2}) = (k_eZq_e^2/2a_0/Z)*(1/n_1^2 – 1/n_2^2)$$

Applying the expression for a_0:

$$\Delta E_{kn} = \{k_eZ^2q_e^2/(2h^2/(4\pi^2k_eq_e^2m_e))\} *(1/n_1^2 – 1/n_2^2)$$

$$\Delta E_{kn} = h^{-2}k_e^2Z^2q_e^42\pi^2m_e * (1/n_1^2 – 1/n_2^2)$$

With: $k_e = 1/4\pi\varepsilon_0$

$$\Delta E_{kn} = Z^2m_eq_e^4\ 2\pi^2/h^2(4\pi\varepsilon_0*4\pi\varepsilon_0) * (1/n_1^2 – 1/n_2^2)$$

$$\Delta E_{kn} = hc * Z^2m_eq_e^4/(8\varepsilon_0^2h^3c) * (1/n_1^2 – 1/n_2^2)$$

The Rydberg expression is:

$$1/\lambda= R_\infty (1/n_1^2-1/n_2^2)$$

with the following parameters:

λ	wavelength of the carrier			m
R_∞	Rydberg's constant	$(Z^2m_e\, q_e^4)/(8\varepsilon_0^2h^3c)$	$1.097*10^7$	m^{-1}
h	Planck's constant		$6.626*10^{-34}$	$kg\ m^2\ s^{-1}$
ε_0	dielectric permittivity		$8.854*10^{-12}$	$A^2\ s^4\ kg^{-1}m^{-3}$
μ_0	magnetic permeability		$4\pi*10^{-7}$	NA^{-2}
c	velocity of light in vacuum		$2.999*10^8$	m/s

With: $hc/\lambda = hf$:

$$hf = hc * R_\infty (1/n_1^2-1/n_2^2)$$

If the potential, instead of the kinetic, energy of the orbiting electron had been taken as reference for the change of energy, the result would be:

$$\Delta E_{pn} = k_eZq_e(1/r_{n1} - 1/r_{n2})$$

$$\Delta E_{pn} = k_eZ^2q_e/a_0 * (1/n_1^2 - 1/n_2^2)$$

$$\Delta E_{pn} = 2 * hc * Z^2m_eq_e^4/(8\varepsilon_0^2h^3c) * (1/n_1^2 – 1/n_2^2)$$

$$\Delta E_{pn} = 2 * hc * R_\infty (1/n_1^2-1/n_2^2) ,$$

being in agreement with the relation found above: $E_k =½E_p$.

An orbiting electron compared with an orbiting spacecraft

The question is: why would the difference in potential energy ΔE_{pn}, as calculated in the previous chapter, not be equal to the energy of the photon, instead of ΔE_{kn}.
Or: if an electron eclipses from an inner to an outer orbit the total energy in the atom decreases with $\Delta E_{kn} + \Delta E_{pn} = 3*\Delta E_{kn}$. So why would the energy of the emitted photon not be equal to 3 times the difference in kinetic energy?
And what happens with the energy of the external force that compelled the electron to eclipse?

In order to obtain a better understanding of the several energies related to an orbiting electron, I investigated these energies in case of a spacecraft orbiting a planet.

Suppose the present orbit of the spacecraft is at radius r_1 with velocity v_1 and it has to be brought to r_2 with velocity v_2, with $r_2 > r_1$, so $v_2 < v_1$. It is assumed that, in order to bring the spacecraft from orbit 1 to orbit 2, it has to be accelerated first to get out of orbit 1 and after a while it has to be decelerated to v_2, so that it will end at r_2 with velocity v_2.
To accelerate it from v_1 to $v_1+\Delta v_1$ requires the energy $\Delta E_1 = ½m_s\{(v_1+\Delta v_1)^2-v_1^2\}$.
To decelerate it from $v_1+\Delta v_1$ to v_2 requires the energy $\Delta E_2 = ½m_s\{ v_1+\Delta v_1)^2-v_2^2\}$.
In both situations the word "requires" is used to emphasize that it is the energy that has to be delivered by the rocket motors.

> *We have to realize that negative energies don't exist.*
> *"Energy itself" is always positive and it can only be negative in relation to another energy, in order to show that it is smaller than that other one.*

The sum of the two kinetic energies is the total energy delivered by the rocket motors only to slow down the velocity from v_1 to v_2: $E_{sk} = ½m_s\{v_1^2-v_2^2+4v_1\Delta v_1+2\Delta v_1^2\}$. The part: $½m_s\{4v_1\Delta v_1+2\Delta v_1^2\}$ is the result of the fact that the spacecraft has been accelerated first, notwithstanding the fact that the final velocity has to be lower than the initial one. This to prevent it from crashing on the planet.
This part of the spacecraft energy will therefor be written as: $E_{sk} = ½m_s(v_1^2-v_2^2) + E_{boost}$

The other part of the energy that has to be supplied by the spacecraft in order to change orbit is the energy necessary to tow away the spacecraft from the planet. This part follows from the calculation of the difference in potential energy between the two situations.
N.B. This is a false formulation but I will continue the calculation in order to get a good understanding of what is the real situation.

This mentioned difference in potential energy mathematically is:

$$E_{sp} = Gm_pm_s (1/r_1 – 1/r_2).$$

As shown earlier: $v_i^2 = Gm_s/r_i$

Applying this equation in the expression of E_{sp} it is found that the total energy necessary to bring the spacecraft from orbit r_1 to r_2 thus is :

$$E_{sk} + E_{sp} = ½m_s(v_1^2-v_2^2) + m_p(v_1^2– v_2^2) + E_{boost}$$

Because $m_s <<< m_p$ the energy to be supplied by the spacecraft in order to move from orbit r_1 to r_2 is very well approximated by: $m_p(v_1^2-v_2^2) + E_{boost}$.

One can easily conclude that a spacecraft orbiting earth will not be able at all to produce an energy like: $m_p(v_1^2-v_2^2)$, being about $2*10^{32}$ Joule for v_1= 7km/s and v_2= 3km/s.
To quote Wikipedia:"This is roughly equal to one week of the Sun's total energy output."!

The false description at the start of this argumentation is the following. The spacecraft does not need to be towed away from earth! To be compared with the situation that you swing a stone, tied to one end of a rope, the other end holding in your hand. If the rope breaks, the stone flies away from you, due to the centrifugal force $m_{stone}v_{stone}^2/r$.

So, the changing gravitational potential energy doesn't play any role.

Neither will it do in case of an orbiting electron!

At the end of the day a stabilized spacecraft is created with a lower kinetic energy, but the system as a whole absorbed energy to get there. So still, what happened with that absorbed energy? The answer to this question is: it has been emitted by the rocket motors as exhaust. So, just like as in the situation of an electron, changing orbit, this system also emits energy! A remarkable resemblance!
Regarding this conspicuous resemblance it is very likely that, just like the emitted energy of the rocket motors equals the difference in kinetic energy of the spacecraft, the energy of the emitted photon also equals this difference in kinetic energy of the electron. But still we don't know how efficiently the electron changes orbit.

An external force must have pushed, so accelerated, the electron out of the inner orbit. Is this energy added to the energy of the photon? Basically we don't know, because the energy of a photon has never been measured.

Most likely this part of its energy is small compared to the difference in kinetic energy.

Further elaboration of the model

Several measurements have been carried out in order to verify the outcome of the Rydberg expression. See the table under “step 3” for the specification of the defined series. None of these measurements show the measured energy of the related photons. So there is yet no experimental evidence yet of the validity of the relation E=hf for the energy of a photon.
To further elaborate on the idea behind the generation of a photon, it is assumed that the energy of a photon equals the difference in kinetic energy of the electron generating this photon by changing orbit.

As will be shown later, the real value of the energy of a photon does not play such an important role. Certainly not regarding the basic principle that is under investigation.

To summarize: the basic idea behind the generation of a photon is that an orbiting electron is equivalent to a circular shaped electric current.
Such an electric current causes a magnetic field H_e, with $H_e = q_e^2(k_eZ/m_e)^{½}/4\pi r^{2,5}$, perpendicular to the plane through the orbit of the electron.
So, as soon as the electron eclipses its orbit, r changes, and the strength of this magnetic field changes. A change of a magnetic field causes a change of an electric field, resulting in an EM-field, propagating with velocity ***c*** with respect to the nucleus of the atom.

Step 1: the eclipse of an electron from n=1 to n=2 in the neutral hydrogen atom

The value of Z of this atom is 1
The two radii therefor are: $r_1 = a_0 = 5.29*10^{-11}$ m and $r_2 = 2.12*10^{-10}$ m.

The magnetic field strengths related to the two equivalent electric currents are calculated as follows:

	$r_1 = 0.53*10^{-10}$	$r_2 = 2.12*10^{-10}$	m
$v_e = q_e\{k_e/(m_e r)\}^{½}$	$v_{e1} = 2.19*10^6$	$v_{e2} = 1.09*10^6$	m/s
$s_e = 2\pi r/v_e$	$s_{e1} = 1.52*10^{-16}$	$s_{e2} = 1.22*10^{-15}$	s
$i_e = q_e/s_e$	$i_{e1} = 1.05*10^{-3}$	$i_{e2} = 1.32*10^{-4}$	A
$H_e = i_e/2r$	$H_{e1} = 9.97*10^6$	$H_{e2} = 3.11*10^5$	A/m

The amplitude of the sinusoidal shaped magnetic field of the carrier of the photon will be represented by A_H, like A_E will be the amplitude of its sinusoidal electric field.

The relation between A_H and A_E is:

$$A_E = Z_v A_H \qquad \text{V/m}$$

where Z_v is the so called characteristic impedance for vacuum.

$$Z_v = (\mu_0/\varepsilon_0)^{½} = 377 \qquad \Omega$$

Based on these two amplitudes the power density of the EM-field is:

$$P_d = A_E/\sqrt{2} * A_H/\sqrt{2} = Z_v A_H^2/2 \qquad \text{VA/m}^2$$

It is assumed that the surface, related to this power density, is constrained by the orbit of the electron from which it eclipses, so the power P of the photon in this example is:

$$P = Z_v A_H^2/2 * \pi r_1^2 \qquad W$$

This assumption will be argued under: "Intermediate conclusions regarding step 1"

In order to be able to calculate the energy of the photon, with the model under consideration, this power has to be multiplied with the duration of the photon.
This duration will be represented by the name pulse width, abbreviated as plsw.

In this sense the calculated energy of the photon is mathematically represented by:

$$E_c = plsw * Z_v A_H^2/2 * \pi r_1^2 \qquad Joule$$

Both the parameters plsw and A_H are yet unknown.

Estimation of the pulse width of the photon

It is assumed that the minimum value of the pulse width is one period of the carrier of the photon, because if it would be less it is difficult to imagine that it would be possible to find the energy of the photon to be E = hf.
The maximum value is certainly constrained by the round trip time of the orbit to which the electron has been eclipsed, because after that time period the magnetic field is completely stabilized. Applying the Rydberg expression f in this example is calculated as:

$$f=c/\lambda = 2.999*10^8 * 1.097*10^7 (1-1/4) = 2.47*10^{15}$$, resulting in $T = 4.05*10^{-16}$

So $4.05*10^{-16} < plsw < 12.2*10^{-16}$ s

The estimation for the pulse width <u>in this example</u> is that it equals 2 times a period of the carrier: $8.1*10^{-16}$ s. It is considered unlikely that the carrier stops abruptly at an arbitrary moment within such a period.

The power density of the photon in this example can now be calculated as:

$$P_d = hf/(plsw*\pi r_1^2) = 6.626*10^{-34} * 2.47*10^{15} / (8*10^{-16} * \pi * (0.53*10^{-10})^2)$$

$$P_d = 2.29*10^{17} \qquad W/m^2$$

So: $Z_v A_H^2/2 = 2.29*10^{17}$ W/m²

Resulting in:

$$A_H = 3.49*10^7 \qquad A/m$$

N.B.
This magnetic field strength is of the same order of magnitude as the field strength H_{e1} !

In order to obtain more reliance (or maybe not) in the validity of the model, the variable dH_e/dt, at the moment of the eclipse, is analysed.
It is assumed that dH_e/dt has its maximum value at the moment the electron eclipses.
At a certain moment the magnetic field strength H(t), belonging to the EM field that will be generated, can be represented by: $H(t) = A_H \sin(\omega t)$ and the next assumption is that this sinusoidal function starts also at the moment the electron eclipses. So, the maximum value of dH_e/dt is assumed to be at t=0. This maximum value thus is represented mathematically by $A_H\ \omega$, with ω the radial frequency of the carrier of the photon.

The first approximation of dH_e/dt is $\Delta H_e/\Delta t$, with $\Delta H_e = H_{e1} - H_{e2}$ and Δt a yet to find appropriate value.

$A_H\ \omega = A_H * 2\pi f = 3.49*10^7 * 2\pi * 2.47*10^{15} = 5.41*10^{23}$ A/ms

Applying $\Delta H_e = H_{e1} - H_{e2} = 9.65*10^6$, leads to $\Delta t = 9.65*10^6 / 5.41*10^{23} = 1.78*10^{-17}$ s

This value for Δt is an order of magnitude smaller than the round trip time of the orbit from which the electron eclipses.
That doesn't feel unrealistic and it means that the magnetic field H_{e1}, created by the equivalent electric current due to the circular movement of the electron, instantly decreases to a negligible value, compared to this initial field, because $H_{e2} << H_{e1}$.

Intermediate conclusions regarding step 1

The model applied to the neutral hydrogen atom where an electron eclipses from the most inner orbit (n=1) to the next outer orbit (n=2), learns that:

- -The energy of the emitted photon, expressed as E=hf, exactly equals the difference between the kinetic energy of the electron in the inner orbit minus this energy in the outer orbit.
- -This conclusion dramatically contradicts the "standard" conception, formulated like: "The n=1 orbital has the lowest possible energy in the atom. Each successively higher value of n has a higher level of energy,……..".
- -The length of the photon has to be at least one period of the frequency of its carrier and will certainly be not longer than 3 of these periods.
- -Dividing the energy of the photon by the length of the photon the power [VA] of the photon is found. To find a value for the strength of the magnetic, resp. electric field, of the carrier of the photon, [A/m] resp. [V/m], this power has to be divided by the surface to which it belongs. Up to this moment all variables were found to be strongly related to the orbit from where the electron eclipses, so the most likely surface is assumed to be the surface of the orbit from where the electron eclipses: πr_1^2 in this example.
- -Application of these variables shows that the magnetic field strengths of the EM carrier of the photon varies from 4.94 to $2.47*10^7$ A/m, all three of the same order of magnitude as the linear magnetic field strength, generated by the orbiting electron in orbit n=1: $7*10^7$ A/m.
- -These conclusions justify analyses of other photon emissions, based on the model under consideration.

Step 2: The eclipse of an electron from n=1 to n=n_2 in the neutral hydrogen atom

In step 1 it is assumed that the length of the photon is two times the period of its carrier, also based on the assumption that it will certainly not be longer than s_{e2}. In this step the round trip time s_{en}, with n≥3, will be much larger than s_{e2}. Notwithstanding that feature plsw will, as a first estimate, be taken two times the period independent of n_2.

The frequency of the carrier is calculated by means of the Rydberg expression, resulting in as well the length of the photon as 2/f, as in its energy E=hf.

The power of the photon now equals hf/plsw (= ½hf^2).

This result divided by the surface πr_1^2 equals the power density of the photon.

The magnetic field strength A_H is calculated from: $A_H = (2P_d /Z_v)^{½}$ and Δt from:
$\Delta t = \Delta H/(A_H\ \omega)$. This last calculation learned that ΔH has to be interpreted as:
$\Delta H = H_1 - H_{n2}$ and not as H_1 notwithstanding the fact that $H_{n2} << H_1$.
The relatively small error in the calculation of E_c for $n_2 \geq 3$, in case ΔH is chosen to be H_1, is completely eliminated for $\Delta H = H_1 - H_{n2}$!

Effectively I found this remarkable result in step 3, due to the fact that the error in E_c grew explosively to > 100% in the Brackett series.

The importance of the correct calculation of Δt will be shown later.

n_2	1/λ	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
2	8,23E+06	1,64E-18	4,052E-16	8,10E-16	2,02E-03	2,29E+17	3,49E+07	1,78E-17
3	9,76E+06	1,94E-18	3,419E-16	6,84E-16	2,83E-03	3,22E+17	4,14E+07	1,31E-17
4	1,03E+07	2,04E-18	3,242E-16	6,48E-16	3,15E-03	3,58E+17	4,36E+07	1,18E-17
5	1,05E+07	2,09E-18	3,166E-16	6,33E-16	3,31E-03	3,76E+17	4,47E+07	1,12E-17
6	1,07E+07	2,12E-18	3,126E-16	6,25E-16	3,39E-03	3,85E+17	4,52E+07	1,10E-17
7	1,08E+07	2,14E-18	3,103E-16	6,21E-16	3,44E-03	3,91E+17	4,56E+07	1,08E-17
8	1,08E+07	2,15E-18	3,087E-16	6,17E-16	3,48E-03	3,95E+17	4,58E+07	1,07E-17
9	1,08E+07	2,15E-18	3,077E-16	6,15E-16	3,50E-03	3,98E+17	4,60E+07	1,06E-17
10	1,09E+07	2,16E-18	3,070E-16	6,14E-16	3,52E-03	4,00E+17	4,61E+07	1,06E-17
11	1,09E+07	2,16E-18	3,065E-16	6,13E-16	3,53E-03	4,01E+17	4,61E+07	1,05E-17

Intermediate conclusions regarding step 2

-The presented values don't show any abnormality, as could be expected, because only the orbit to which the electron eclipses has been changed, while the orbit from where it eclipses proved to be the most important parameter for the quantification of the variables (see step 1).
-ΔH in the expression $\Delta t = \Delta H/(A_H\ \omega)$, has explicitly to be interpreted as: $\Delta H = H_1 - H_{n2}$ and not as: $\Delta H = H_1$.
-The results of the calculations justify analyses of other photon emissions, based on the model under consideration.

Step 3: The eclipse of an electron from $n=n_1$ to $n=n_2$ in the neutral hydrogen atom

The related frequencies to these eclipses, as mathematically presented by the Rydberg formula, have been measured by and named after the shown scientists.

n_1	n_2	Name series	wave length first n_2	wave length $n_2 \to \infty$
1	$2 \to \infty$	Lyman	$121.486 \cdot 10^{-9}$	$91.1144 \cdot 10^{-9}$
2	$3 \to \infty$	Balmer	$656.024 \cdot 10^{-9}$	$364.458 \cdot 10^{-9}$
3	$4 \to \infty$	Paschen	$1874.35 \cdot 10^{-9}$	$820.030 \cdot 10^{-9}$
4	$5 \to \infty$	Brackett	$4049.53 \cdot 10^{-9}$	$1457.83 \cdot 10^{-9}$
5	$6 \to \infty$	Pfund	$7454.82 \cdot 10^{-9}$	$2278.61 \cdot 10^{-9}$
6	$7 \to \infty$	Humphreys	$12363.5 \cdot 10^{-9}$	$3280.12 \cdot 10^{-9}$

The table shows that the **Lyman series** has been analysed under step 2

For all series the relation $hf = ½m_e(v_{n1}{}^2 - v_{n2}{}^2)$ has been checked and found to be valid.
The most important conclusion is that the magnetic fields $A_{H(n1+1)}$, relative to the magnetic field generated by the orbit of the electron from where it eclipses, increase from a factor 3 to about a factor 7, along the series, if plsw = 2/f.

If plsw is taken $(n_1+1)/f$, this ratio varies over all series from 3.5 to 4.3

If it is taken $(n_1+2)/f$ this range becomes 2.9 to 3.9.

For all three values of plsw the absolute value of A_{Hn2}, within each series, shows, as function of n_2, an increase varying from 1.3 in the Lyman series up to 2.7 in the Humphreys series

Based on this information it is considered more likely that plsw $\approx (n_1+1)/f$.
The model under investigation doesn't give a decisive answer.
Only measurements of the length of the photon will give it.

For all series the same table as presented under step 2 has been calculated and shown in the attachment. N.B. The pulse width in these calculations is $(n_1+1)/f$!

Final step: The eclipse of an electron from $n=n_1$ to $n=n_2$ in an arbitrary ion

An arbitrary ion in this study is meant to be a nucleus with Z protons around which one electron is orbiting.
The only basic parameters that change in such a situation are the radii of the orbits, because these are represented by $r_n = n^2 a_0/Z$.
So, in fact nothing changes fundamentally, by altering the value of Z.
The Excel spread sheets (not included in this article), that have been used for the calculations for the series mentioned under step 3, indeed don't show any abnormalities by changing Z.
As an example: the length of the photon for $n_1=1$ and $n_2=2$ is ≈0,01 femtosecond for Z =9, while for Z=1 this length is ≈1 femtosecond.

The characteristics of the photon expressed mathematically

In order to understand in detail how a photon looks like, the calculation of the energy is build up by four characteristics of the pulse: frequency, length, power density and surface related to this power density:

$$E_c = Z_v A_H^2/2 * \pi r_1^2 * plsw(f)$$

With $A_H = (\Delta H/\Delta t)/2\pi f$ and $plsw = (n_1+1)/f$ this can also be written as:

$$E_c = \{Z_v \Delta H^2 \Delta t^{-2} (2\pi f)^{-2}\}/2 * \pi r_1^2 * (n_1+1)/f$$

The analyses described under step 2 and 3 proved that $\Delta H = H_{n1} - H_{n2}$, from now on presented as $\Delta H_{n1,n2}$. Δt will be presented as $\Delta t_{n1,n2}$, f as $f_{n1,n2}$ and r_1 as r_{n1}.

As a result E_c wil be presented as $E_{n1,n2}$ and can be written as:

$$E_{n1,n2} = \{Z_v \Delta H_{n1,n2}^2 \Delta t_{n1,n2}^{-2} (2\pi f_{n1,n2})^{-2}\}/2 * \pi r_{n1}^2 * (n_1+1)/f_{n1,n2}$$

If $\Delta t_{n1,n2}$ is now considered as an unknown variable and $E_{n1,n2}$ is replaced by the known variable $hf_{n1,n2}$, then:

$$\Delta t_{n1,n2}^{-2} = hf_{n1,n2} * \{ Z_v^{-1} * \Delta H_{n1,n2}^{-2} * (2\pi f_{n1,n2})^2 \} * 2 * \pi^{-1} r_{n1}^{-2} \} * f_{n1,n2}/(n_1+1)$$

This equation applied in the formula for power density: $Z_v \{(\Delta H/\Delta t)/2\pi f\}^2/2$ leads to:

$$P_d = (hf_{n1,n2}^2/\pi r_{n1}^2)/(n_1+1)$$

thus $E_{n1,n2}$ presented as: “power density * surface * pulse width“ to:

$$E_{n1,n2} = (hf_{n1,n2}^2/\pi r_{n1}^2)/(n_1+1) * \pi r_{n1}^2 * (n_1+1)/f_{n1,n2}$$

Presented as: “power * pulse width”:

$$E_{n1,n2} = (h f_{n1,n2}^2)/(n_1+1) * (n_1+1)/f_{n1,n2}$$

Presented as generally accepted:

$$E_{n1,n2} = h f_{n1,n2}$$

The magnetic resp. electric field strength of the carrier of the photon can, based on the presented model, thus be calculated from an expression that only consists of the Rydberg parameter $f_{n1,n2}$ and the atom parameters n_1 and r_{n1}, assumed that the length of the photon is $(n_1+1)/f_{n1,n2}$.

$A_H = hf_{n1,n2}^2/\pi r_{n1}^2/(n_1+1))$ A/m $\qquad$ $A_E = Z_v A_H$ V/m

This proves that the particle-wave duality of a photon has been eliminated by this model, because what might yet be the reason to qualify a photon as a particle (too)?

Conclusions

The study has proven that the generation of a photon can be explained by considering an orbiting electron in an atom as an electric current.
This current causes a straight-lined magnetic field, perpendicular to plane of the orbit and enclosed by the orbit of the electron.
As soon as the electron eclipses to a more inner orbit, this magnetic field decreases rapidly and cause through this an electric field.
A source of an EM filed has been created.

Calculations, carried out on this model, proved that this principle indeed works, but above all it also gives an impression of the length of the photon.
Real values have to be gained by measurements.

Based on the educated estimates of the length of the photon, the power of the photon can be calculated and as a result the strength of the magnetic and electric field of the carrier of the photon.

As a result it can be concluded that this model eliminates the wave-particle duality.

Einstein wrote about this duality the following;
"*It seems as though we must use sometimes the one theory and sometimes the other, while at times we may use either. We are faced with a new kind of difficulty. We have two contradictory pictures of reality; separately neither of them fully explains the phenomena of light, but together they do*".

My words:
Nature doesn't deal with dualities, paradoxes or contradictions.
Judgments like these are created by mankind, not understanding a certain phenomenon.
Physical science should not accept these kinds of judgements.

See the 'Encore' on the next page too.

Encore

The presented model of the generation of a photon is based on Ampère's and Faraday's law, bound together in the Maxwell laws, normally called Maxwell's equations.
By working out Maxwell's equations, the velocity of light in vacuum is calculated as ***c***.
N.B. Maxwell lived in the century that the ether-model was generally accepted within the scientific community. As a result the reference for ***c*** was by definition this ether.

The Principle of Relativity states: all physical laws are the same in all inertial systems.

The inner part of an atom and its direct surrounding is by definition vacuum.
Applying the Principle of Relativity in the presented model leads to the conclusion that a photon, generated by an atom, based on the mentioned physical laws, must have a propagation velocity ***c*** w.r.t. this atom, *whatever the velocity of this atom might be*.

Effectively this is the so-called emission theory, vigorously rejected by the community of physicists.

To quote Wikipedia:

> "Emission theories obey the principle of relativity by having no preferred frame for light transmission, but say that light is emitted at speed "c" relative to its source instead of applying the invariance postulate."

Einstein's Special Theory of Relativity is based on the hypothesis of a system "in rest" w.r.t. which the velocity of light in vacuum would be ***c.***
The community of physicists realized that this system "in rest" is equivalent to the, by Einstein himself, abandoned ether-model and therefore slinky changed his hypothesis in: ***c*** w.r.t. any inertial system, known under the expression: "invariance postulate".
In this way a "non-Einstein" Special Theory of Relativity has been created, of which the hypothesis is fundamentally contradictive with Einstein's hypothesis!
N.B.

> *A postulate is an assumption, so self-evident that further evidence, if it would be possible to deliver it at all, is not required.*
> *A hypothesis is an assumption that needs yet to be proven.*

One of the consequences of the invariance hypothesis is that the velocity of light in vacuum is also ***c*** w.r.t. its source, *whatever the speed of that source might be*!
But that same community of physicists seemingly excludes this inertial system from all the "any inertial systems", as put forward in the invariance hypothesis!

This inconsequence, the contradiction between Einstein's hypothesis and the invariance hypothesis and the contradiction of both these hypotheses with the Principle of Relativity, leads to the unavoidable conclusion that the Special Theory of Relativity has to be rejected.

Regarding the velocity of light: only the emission theory can be valid.
It is indeed a *theory*, not a hypothesis.

See also: http://vixra.org/abs/1504.0234 and http://vixra.org/abs/1502.0080

Attachment

Lyman series

n_2	$1/\lambda$	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
2	8,23E+06	1,64E-18	4,1E-16	8,10E-16	2,02E-03	2,29E+17	3,49E+07	1,78E-17
3	9,76E+06	1,94E-18	3,4E-16	6,84E-16	2,83E-03	3,22E+17	4,14E+07	1,31E-17
4	1,03E+07	2,04E-18	3,2E-16	6,48E-16	3,15E-03	3,58E+17	4,36E+07	1,18E-17
5	1,05E+07	2,09E-18	3,2E-16	6,33E-16	3,31E-03	3,76E+17	4,47E+07	1,12E-17
6	1,07E+07	2,12E-18	3,1E-16	6,25E-16	3,39E-03	3,85E+17	4,52E+07	1,10E-17
7	1,08E+07	2,14E-18	3,1E-16	6,21E-16	3,44E-03	3,91E+17	4,56E+07	1,08E-17
8	1,08E+07	2,15E-18	3,1E-16	6,17E-16	3,48E-03	3,95E+17	4,58E+07	1,07E-17
9	1,08E+07	2,15E-18	3,1E-16	6,15E-16	3,50E-03	3,98E+17	4,60E+07	1,06E-17
10	1,09E+07	2,16E-18	3,1E-16	6,14E-16	3,52E-03	4,00E+17	4,61E+07	1,06E-17
11	1,09E+07	2,16E-18	3,1E-16	6,13E-16	3,53E-03	4,01E+17	4,61E+07	1,05E-17

Balmer series

n_2	$1/\lambda$	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
3	1,52E+06	3,03E-19	2,2E-15	6,56E-15	4,61E-05	3,28E+14	1,32E+06	7,14E-17
4	2,06E+06	4,09E-19	1,6E-15	4,86E-15	8,41E-05	5,97E+14	1,78E+06	4,37E-17
5	2,30E+06	4,58E-19	1,4E-15	4,34E-15	1,05E-04	7,49E+14	1,99E+06	3,56E-17
6	2,44E+06	4,84E-19	1,4E-15	4,10E-15	1,18E-04	8,39E+14	2,11E+06	3,20E-17
7	2,52E+06	5,01E-19	1,3E-15	3,97E-15	1,26E-04	8,96E+14	2,18E+06	3,00E-17
8	2,57E+06	5,11E-19	1,3E-15	3,89E-15	1,31E-04	9,33E+14	2,23E+06	2,88E-17
9	2,61E+06	5,18E-19	1,3E-15	3,84E-15	1,35E-04	9,60E+14	2,26E+06	2,81E-17
10	2,63E+06	5,23E-19	1,3E-15	3,80E-15	1,38E-04	9,79E+14	2,28E+06	2,75E-17
11	2,65E+06	5,27E-19	1,3E-15	3,77E-15	1,40E-04	9,93E+14	2,30E+06	2,71E-17

Paschen series

n_2	$1/\lambda$	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
4	5,34E+05	1,06E-19	6,3E-15	2,50E-14	4,24E-06	5,95E+12	1,78E+05	1,75E-16
5	7,80E+05	1,55E-19	4,3E-15	1,71E-14	9,07E-06	1,27E+13	2,60E+05	9,89E-17
6	9,15E+05	1,82E-19	3,6E-15	1,46E-14	1,25E-05	1,75E+13	3,05E+05	7,57E-17
7	9,95E+05	1,98E-19	3,4E-15	1,34E-14	1,48E-05	2,07E+13	3,32E+05	6,50E-17
8	1,05E+06	2,08E-19	3,2E-15	1,27E-14	1,64E-05	2,30E+13	3,49E+05	5,91E-17
9	1,08E+06	2,15E-19	3,1E-15	1,23E-14	1,75E-05	2,46E+13	3,61E+05	5,54E-17
10	1,11E+06	2,20E-19	3,0E-15	1,20E-14	1,83E-05	2,57E+13	3,70E+05	5,29E-17
11	1,13E+06	2,24E-19	3,0E-15	1,18E-14	1,90E-05	2,66E+13	3,76E+05	5,12E-17

Brackett series

n_2	1/λ	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
5	2,47E+05	4,91E-20	1,4E-14	6,75E-14	7,26E-07	3,23E+11	4,14E+04	3,40E-16
6	3,81E+05	7,57E-20	8,8E-15	4,38E-14	1,73E-06	7,68E+11	6,39E+04	1,84E-16
7	4,62E+05	9,18E-20	7,2E-15	3,61E-14	2,54E-06	1,13E+12	7,74E+04	1,36E-16
8	5,14E+05	1,02E-19	6,5E-15	3,24E-14	3,15E-06	1,40E+12	8,62E+04	1,13E-16
9	5,50E+05	1,09E-19	6,1E-15	3,03E-14	3,61E-06	1,60E+12	9,22E+04	1,00E-16
10	5,76E+05	1,14E-19	5,8E-15	2,89E-14	3,95E-06	1,76E+12	9,66E+04	9,19E-17
11	5,95E+05	1,18E-19	5,6E-15	2,80E-14	4,22E-06	1,87E+12	9,97E+04	8,64E-17

Pfund series

n_2	1/λ	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
6	1,34E+05	2,66E-20	2,5E-14	1,49E-13	1,79E-07	3,25E+10	1,31E+04	5,75E-16
7	2,15E+05	4,27E-20	1,6E-14	9,31E-14	4,59E-07	8,35E+10	2,11E+04	3,04E-16
8	2,68E+05	5,31E-20	1,2E-14	7,48E-14	7,10E-07	1,29E+11	2,62E+04	2,19E-16
9	3,04E+05	6,03E-20	1,1E-14	6,59E-14	9,14E-07	1,66E+11	2,97E+04	1,78E-16
10	3,29E+05	6,54E-20	1,0E-14	6,08E-14	1,08E-06	1,96E+11	3,22E+04	1,54E-16
11	3,48E+05	6,92E-20	9,6E-15	5,75E-14	1,20E-06	2,19E+11	3,41E+04	1,40E-16

Humphreys series

n_2	1/λ	hf	1/f=T	plsw	hf/plsw	P_d	A_H	Δt
7	8,09E+04	1,61E-20	4,1E-14	2,89E-13	5,57E-08	4,88E+09	5,09E+03	8,88E-16
8	1,33E+05	2,65E-20	2,5E-14	1,75E-13	1,51E-07	1,33E+10	8,40E+03	4,63E-16
9	1,69E+05	3,36E-20	2,0E-14	1,38E-13	2,44E-07	2,14E+10	1,07E+04	3,27E-16
10	1,95E+05	3,88E-20	1,7E-14	1,20E-13	3,24E-07	2,84E+10	1,23E+04	2,62E-16
11	2,14E+05	4,25E-20	1,6E-14	1,09E-13	3,90E-07	3,42E+10	1,35E+04	2,24E-16