Expanding on De Broglie's treatment of the Hydrogen atom

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Acknowledgements

This paper was inspired by the theory of Randell Mills MD (see www.blacklightpower.com), from whom the concept of resonant energy transfer has been borrowed. Steven Florek was the first to suggest publicly that on the Hydrino Study Group list, that perhaps the De Broglie wave of electron wrapped around multiple times before reconnecting. My thanks also to Dr. Michael J. Schaffer for his suggestions, criticisms, and patience. I would also like to acknowledge the contribution of whoever is responsible for inspiring dreams.

Introduction

This document is deliberately restricted to the simplest possible representation of the model. It is only intended to convey the basic concept, and is neither intended to be an exhaustive exploration of the topic nor to be mathematically exact in all respects. Hence the reader will indubitably find minor corrections that need to be applied. However it is the belief of the author, that it is sufficiently accurate to fulfill its intended purpose. To this end, a non-relativistic derivation has been included. A relativistic derivation may be found on the web page (see References).

Theory

In 1913 Niels Bohr proposed that quantization of the angular momentum of the Hydrogen atom according to:-

$L = n\hbar$ where $n = 1,2,3$ etc.

would explain its spectrum. This was fine, but the quantization of angular momentum was a postulate, without any real explanation.

In 1924 Louis De Broglie went one better, and proposed that the same quantization condition resulted if one wrapped the “De Broglie” wavelength of the electron around the circumference of the orbit, according to:-

$n\lambda = 2\pi r \quad n = 1,2,3$ etc.

wherein λ is of course, the De Broglie wavelength, and r is the radius of the orbital.

This made a great deal of sense, since the electron would be self reinforcing if its De Broglie wave was in phase with itself having completed an orbital. At slightly smaller or larger radii, the wave would get out of phase with itself, and the electron would tend to self extinguish at the changed radius.
This meant that only certain radii were stable.

I would now like to expand upon De Broglie’s solution, and suggest that smaller stable radii than the “ground state” ($n = 1$) might be possible, if one allows Lissajous type orbitals in three dimensions, such that multiple linked two dimensional orbitals need to be completed before the electron actually reconnects with itself.
One can picture the simplest of these by drawing the number “8” on a piece of paper, then folding the paper through the “waist” of the “8”, such that the top half of the “8” overlaps the bottom half.

This process results in the same De Broglie equation (see Non-relativistic Derivation).

$n\lambda = 2\pi r$ where now however n has been extended:- $n = 1/137, 1/136, \ldots 1/2, 1,2,3,\ldots$ etc.

For values of $n < 1$, it is convenient to replace n with $1/p$ and rewrite this as:-

$\lambda(p) = p2\pi r$ where $p = 1,2,\ldots 137$

Since the velocity of the electron for any orbital is

$v(p) = p\alpha c$

where α is the fine structure constant, and “c” is the speed of light, the velocity would reach the speed of light if p could reach $1/\alpha$. Since “c” is a natural limit, the largest value of p is 137, i.e. the largest integer smaller than $1/\alpha$.

The radius of the atom for each value of n is $a(n) = n^2 \times a_0$ (where a_0 is the Bohr radius).
The resulting orbitals also extend the Bohr postulate such that

$L = n\hbar$ where now however, n = 1/137, 1/136, … ½ , 1, 2, 3 etc.

Here we see that in dropping below the "ground" state, the angular momentum of the electron changes by a fraction of $\hbar$. This has an interesting consequence for the emission of radiation.
In order to relieve itself of angular momentum while dropping to a sub-level, the electron would need to either emit a plane wave photon, or a circularly or elliptically polarized photon. The former doesn't allow the electron to dispose of enough angular momentum, even when emitted tangentially to the orbit, while for circularly polarized photons we see that the angular momentum (L) would be:-

$L = E/c \times r$ where $r = \lambda / 2\pi$ and $E = h \times \upsilon$ resulting in

$$L = h \times \upsilon/c \times \lambda / 2\pi$$

Since $\lambda \times \upsilon = c$ this results in

$$L = h / 2\pi = \hbar$$

In other words, all circularly polarized photons have the same angular momentum ($\hbar$), irrespective of their energy. It therefore seems reasonable to assume that this is a consequence of inherent properties of the space time continuum.

If the angular momentum of the photon has a minimal value set by the nature of space time at $\hbar$ then we see that in dropping from the normal "ground" state to the first sub level state, the change in angular momentum of the electron ($\hbar/2$) is insufficient for the creation of a circularly polarized photon (since total angular momentum of the system comprising the atom and the photon must be conserved), hence neatly explaining the inability of the Hydrogen atom to drop below the "ground" state *purely* through the emission of radiation. In fact a drop to *any* of the allowed sub-levels would provide inadequate angular momentum for the creation of such a photon.
Note however that the electron is not actually prevented from entering those states. It just can't do so through emission of EM radiation. On the other hand, if an alternative means is provided to the atom, through which it can lose both energy and angular momentum, then it may enter such a state. Collision with another atom or molecule can provide a means of transferring angular momentum, while energy transfer can concurrently take place if the receiving particle resonates with the transmitting particle.

An implication of this is that a second H atom may be capable of catalyzing the drop below the ground state of the first H atom, since both resonate at the same frequency.

The resultant "excess" energy may be manifest to some extent in the extraordinary effectiveness of the Langmuir atomic Hydrogen torch.

Non-relativistic derivation

Variable definitions

$a_o := 0.529177249 \cdot 10^{-10} \cdot m$ $\quad fm := 10^{-15} \cdot m$

$c := 299792458 \cdot \frac{m}{sec}$ $\quad ce := 1.602176462 \cdot 10^{-19} \cdot coul$ $\quad me := 9.10938188 \cdot 10^{-31} \cdot kg$ $\quad \alpha := 7.297352533 \cdot 10^{-3}$ $\quad eV := ce \cdot volt$

$h := 6.62606876 \cdot 10^{-34} \cdot joule \cdot sec$ $\quad amu := 1.6605402 \cdot 10^{-27} \cdot kg$ $\quad mp := 1.6726231 \cdot 10^{-27} \cdot kg$ $\quad Å := 10^{-10} \cdot m$

$mn := 1.6749286 \cdot 10^{-27} \cdot kg$ $\quad \varepsilon := 8.854187817 \cdot 10^{-12} \cdot \frac{farad}{m}$ $\quad \mu_o := 4 \cdot \pi \cdot 10^{-7} \cdot \frac{newton}{amp^2}$ $\quad Hz := sec^{-1}$

$me := \frac{me \cdot mp}{me + mp}$ Reduced electron mass

The principal quantum number "p", used here, is 1/n, where n is the usual principal quantum number

Calculations

$\lambda = p \cdot 2 \cdot \pi \cdot r$ Lissajous (I)

$\lambda = \frac{h}{me \cdot v}$ De Broglie (II)

$\frac{me \cdot v^2}{r} = \frac{ce^2}{4 \cdot \pi \cdot \varepsilon \cdot r^2}$ Force balance (III)

$p \cdot 2 \cdot \pi \cdot r = \frac{h}{me \cdot v}$ Lissajous + De Broglie (IV)

solving for v => $v = \frac{h}{(2 \cdot \pi \cdot r \cdot me \cdot p)}$ (V)

Substitution of V in III and solving for r =>

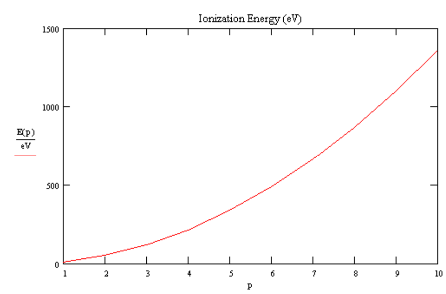
$r(p) := \frac{h^2 \cdot \varepsilon}{me \cdot \pi \cdot ce^2 \cdot p^2}$ This is Bohr radius / p^2 (VI)

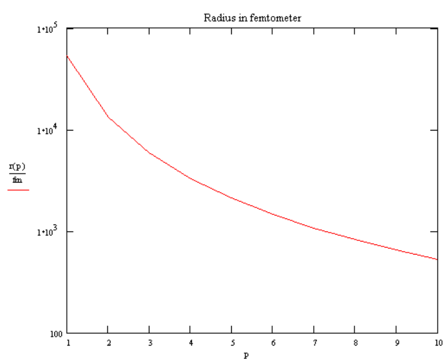
$E = \frac{ce^2}{4 \cdot \pi \cdot \varepsilon \cdot r} - \frac{1}{2} \cdot me \cdot v^2$ Ionization energy (VII)

Substitution of V and VI in VII =>

$E(p) := \frac{1}{8} \cdot \frac{ce^4}{(\varepsilon^2 \cdot h^2)} \cdot me \cdot p^2$ This is p^2 x ionization energy of "ground state" Hydrogen (VIII)

$p := 1, 2 .. 10$ Give p e.g. the values 1 to 10





$E_{Ionization_p} := E(p)$ $\quad Radius_p := r(p)$

Number in shaded column is p

$E_{Ionization} =$ (·eV)

	0
0	0
1	13.598
2	54.393
3	122.385
4	217.573
5	339.957
6	489.538
7	666.316
8	870.29
9	1101.461
10	1359.829

$Radius =$ (·Å)

	0
0	0
1	0.52947
2	0.13237
3	0.05883
4	0.03309
5	0.02118
6	0.01471
7	0.01081
8	0.00827
9	0.00654
10	0.00529

Similarities and differences with Mills' theory

Similarities

Both theories predict:-

- 137 new orbitals for the Hydrogen atom below those of the currently acknowledged ground state.
- The same energy levels for those new orbitals.
- The same velocity of the electron in the orbitals.

Differences

Property	Mills	This theory
Orbital radius	Bohr radius x n	Bohr radius x n^2
Electron angular momentum	ħ (constant for all orbitals)	ħ x n
Reason for orbitals	Trapped photon; "virtual charge"	3D Lissajous orbitals; extended De Broglie wavelength
Central force	Increases with "virtual charge"	Ordinary Coulomb force from single proton.
Behavior with regard to other nuclei	More likely to remain stable due to increased central force	May lose electron to other nucleus, if close enough.

Heisenberg Uncertainty Principle

The HUP is sometimes used to explain why the Hydrogen atom cannot go below the ground state. I believe I can provide a plausible explanation as to why the HUP may not properly be used for this purpose.
First, consider the fact that the HUP actually places limits on our ability to measure things, it doesn't actually say anything about the stability of atoms.
If you insist on trying to use it for that purpose, then you might consider that in that case, it would be more appropriate to think in terms of the electron's ability to measure itself.
Note that in this model, the electron follows essentially circular paths about the nucleus, and hence we use angular momentum and angular position. The angular position is completely indeterminate, and the angular momentum is a constant for each orbital. This is also true of the sub ground state orbitals.
By the same token, the time is completely indeterminate, and the energy level is a constant for each orbital.
In short, the HUP is no hindrance to the electron entering sub ground state orbitals.

Reference

An explicit mathematical exposition of this theory may be found at http://rvanspaa.freehostia.com/New-hydrogen.html .

Dr. Mills' theory may be found at his web site www.blacklightpower.com.