A deterministic explanation of the electron jump in the hydrogenoid atom

A comprehensive (deterministic) explanation of the emission and aborption of radiation by the electron when jumping from a stationary orbit (k) to another (i), and vice-versa (from i to k) has been proposed by M. Rocha e Silva, of the University of Sao Paulo, in Ribeirão Preto, Sao Paulo, Brazil.

The main argument was to suggest that the electron is bound by a time parameter (frequency = T^{-1}) to the center of the hydrogen atom, and its displacement along the time coordinate (y_4 = ict) is regulated by the rules of Weyl's geometry. Planck's constant (h/2 Π) becomes a factor of proportionality (operator) transforming "time mass (m_{44}) into "space mass (m_{11}, m_{22}, m_{33})". These are the components of a negative metric tensor defined by an elementary interval

$$ds^2 = -g_{ii}\ (dx_i dx_i) \quad \text{where} \quad g_{ii} = 2T$$

and 2T is the total kinetic energy of the electron in an orbit the metric of which is defined by the bi-covariant tensor g_{ii}, representing the components of "space mass" (m_{11}, m_{22}, m_{33}) and m_{44} or g_{44} as the component of "time mass", this last one being expressed as the frequency proper divided by the square of light velocity. Therefore, the relation between energy (E) and space mass ($E = mc^2$) is symmetrical to that relating "time mass" to frequency $m_{44} = f_i/c^2$ or $f_i = m_{44}\ c^2$.

In such a way, emission and absorption of radiation are expressed as changes of metric

$$\Delta m_{44} = \frac{\Delta f_{ik}}{c^2} = \frac{2\Pi}{h} \Delta m_{ii}$$

In other words, the law of radiation, according to Ritz' combination principle can be expressed as a displacement in a Weyl's space-time continuum with a negative curvature

$$-ds^2 = g_{ik} dx_i dx_k$$

with "adjustment of gauge", from orbit <u>k</u> to orbit <u>i</u>.

What is left indeterminate are the spatial coordinates, to which Schrödinger equation as well as the concepts of "old" and "new" quantum mechanics can be applied. Therefore, the electron continues to be a <u>cloud</u> in the spatial coordinates of any stationary orbit, but well focussed along the time coordinate along which it must undergo changes ("parallel displacements") while jumping from orbit <u>k</u> to <u>i</u>, or vice-versa. Considered as an operator changing "time" to "space" mass, Planck's constant is introduced as an "interval thickeness of the universe", and the jump becomes deterministic along the time coordinate.

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In each orbit (stationary) the electron is prohibited of emitting radiation because it is bound to the metric of the space-time continuum fixed by the geodesic of a non-euclidian,

☆ M.Rocha e Silva, 1978.A possible geometric interpretation of the electron jump in the hydrogenoid atom. <u>Spc. in Sc.and Tecn.</u> 1, nº 2, pg.175-194.

four dimensional space with a negative curvature ($-ds^2$), reminiscent of a Lobatchewski or Bolyai geometry, concave space (a pseudo-sphere), and the jumps from orbit (k) to (i) are determined by adjustments of "gauge", according to the principles of Weyl's geometry.

According to such principles, a "parallel displacement" along the time coordinate will change the metric tensor (g_{ii}) into (g_{kk}) with a decrease of "time mass".

$$\Delta m_{44} = (f_i - f_k) / c^2$$

Likewise, the energy (E_{ik}) emitted will be expressed by

$$\Delta m_{ii} = \frac{h f_{ik}}{2 \Pi c^2} = E_{ik} / c^2$$

This being the geometrical formulation of Ritz' law of radiation. The new formulation of Ritz' law of radiation in terms of Weyl's geometrical postulates will take the form.

$$d(\log f) = \text{Const. and } d^2(\log f) = 0$$

generating "classes" of emitted radiation of simple, double and triple jumps, instead of the "classical series" of Lyman, Balmer, Pashen and Pfund in the U.V., visible and I.R. of the spectrum of hydrogen.

Rydberg's constant ($R = 3{,}29 \times 10^{15}$) is the limiting value of the frequency (f_m) under normal conditions. The electron can be featured as having a frequency halo represented by

Rydberg's constant commanding emission and absorption of radiation, and a core about 300.000 times heavier, that will be altered only by radiating energy in the frequency range $\leq 9 \times 10^{20}$ (= c^2) considered the upper limit of frequency to the whole mass of the electron. Irradiation of quanta in the visible or U.V. range only changes mass and frequency in the order of 10^{-6} to 10^{-7} of the whole "spatial" and "time"mass that would be consummed. Radiation at a level corresponding to Rydberg's constant ($3,29 \times 10^{15}$) will mean reduction of the electron to its inner core with a mass loss of 1/300.000 of the whole mass of the perticle. For any intermediary quantum, when the electron jumps from i to k or from k to i, the emitted or absonbed radiation, will be geometrically represented by adjustments of gauge, and the new classes will be generated by the successive powers of the ratio

$$\frac{\Delta f}{f} = \frac{f_i - f_k}{f_i}$$ in such a way thet starting with

$f_m = R = 3.29 \times 10^{15}$ cycles/sec the next single jump, will start from $f_2 = \frac{R}{4} = 0,821 \times 10^{15}$, and so sucessively, the ratios $\left(\frac{\Delta f}{f}\right)^n$ taken as the successive powers of the fundamental one:

$$\frac{\Delta f}{f},\ \left(\frac{\Delta f}{f}\right)^2\ \left(\frac{\Delta f}{f}\right)^3 \ldots \left(\frac{\Delta f}{f}\right)^n$$

as indicated in table 1.

When the values obtained with such powers of the fundamental ratio (0,75) for single jumpers are compared with those obtained directly from the established experimental value for f_1, in a single jumps class, the results do not perfectly agree as shown in table I, section I. A correction has been introduced, consisting of subtracting from the experimental data a small constant value of frequency (Σ = 0,009.11 cycles/second to produce an almost perfect agreement (colum II) of "calculated" to "found" values. Considering, however, that all values are taken from theoretical ones (Rydberg's constant and its aliquots, obtained by dividing it by n^2) giving "classes" of single jumps as emitted radiation covering the whole extension of the spectrum (from U.V. to soft IR), the agrement was considered excellent, though not perfect, to assume that the emission spectrum of the hydrogenoid atom, can be generated by pure geometrical laws, as such of Weyl's geometry.

Better corrections may be found in the future, if some limitations of the ingenuity of Bohr's atom could be found: for instance, a better determination of Rydberg's constant, or some internal conditions of the core of the hydrogen atom may impose a small addition to the frequencias proper to each stationary orbit (i, k), or even an inversion of the argument considering the values obtained in accordance with the fundamental law $d(\log f)$ = Const. or $d^2(\log f) = 0$ as the real law of permanence as far as the emission or absorption of radiation is concerned.

But, the obvious consequence of the new law, would be to consider the micro-universe inside of the atom, as following a geometrical pattern, in which the fundamental interval ($-ds^2$) is negative sugesting a non-euclidian, Lobatchewskian or Bolyaian space-time continuum as that prevailing in the concave surface of a sphere. Such a geometrical interval would be represented by a hypersphere the geometry of which is well known. It is interesting to note that such a surface is not alien to our intuition, as stressed about 100 years ago by the physiologist-physicist Hermann von Helmholtz. For a recent discussion see J.L. Richards, Br. J. of Philosophy of Sc 28, 235-253, 1977. That the time parameter should be considered in the geometry of the jump, would be not only a possiblity but a necessary consequence of the fusion of space and time in a four dimensional continuum known as Minkowsky - Einstein's space-time of general Relactivity. The fact that the spatial coordinates are left indeterminate, in the regulation of the movements of the electron along the time coordinates is an obvious consequence of the principle of indetermination $\Delta E. \Delta t \doteq h/2\Pi$, easily deductible from the theory as shown in a later part of the paper. Planck's constant, though conserving its dimentions of an "atom of action", is presented as an "interval thickness of the Universe", being an operator that transforms "space mass" into "time mass":

$$m_{ii} = \frac{h}{2\Pi} m_{44}$$

In that sense, the electron can still be considered as a "cloud", as much as a disk mantained in high rotation in a stick fixed at the nose of a malabarist is shown as a cloud, vibrating in all directions, though keeping constant its distance (time paremeter) to the nose of the malabarist. Possibly if you measure the average distance of the disc to the stick, it follows Schrödinger's equation and if we "photograph" the disk it will appear not very different from the spatial projection of the electron in a static spatial frame of reference.

Such a simple and intuitive presentation of the whole subject of emission and absorption of radiation by the electrons of a hydrogeneoid atom, would not be much more prosaic than the intuitive presentation by Einstein of a gravitational field, inside an elevator falling freely to the surface of the earth.

We can extend further the comparison of the disk in equilibrium, in the nose of the malabarist, if we impose the condition that going from a large stick to a small onde or vice-versa, the changes must obey the condition (Law) that any adapatation of gauge (changes in kinetic energy) must conform to the postulates of a parallel displacenent in a Weyl's space, along the time coordinate and that increase or decrease of energy involves a "transformational" opeartor represented by $\hbar = \frac{h}{2\Pi}$ (Planck's constant divided by 2Π). The "spatial position" of the electron can still be regulated by the time indpendent Schrödinger equation, which generates the usual image of the smearing scattered cloud, according to Heisenberg's "indetermination principle".

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TABLE I

Values of the differential $\Delta\alpha = \Delta f/f$ for single, double, triple and quadruple bonds, taking f_1 = R or Rydberg's constant, as the highest value of the frequency commanding the jumps.

Frequencies (x 10^{15}) (f_i cycles/second)	Single Jumps Ratios (found) $\frac{(f_i - f_{i+1})}{f_i}$		Single Jumps Ratios (calc.) $(\frac{\Delta f}{f})^n$	Double Jumps Ratios (found) $\frac{(f_i - f_{i+2})}{f_i}$	Double Jumps Ratios (calc.) $(\frac{\Delta f}{f})^n$	Triple Jumps Ratios (found) $\frac{(f_i - f_{i+2})}{f_i}$	Triple Jumps Ratios (calc.) $(\frac{\Delta f}{f})^n$	Quadruple Jumps Ratios (found) $\frac{(f_i - f_{i+4})}{f_i}$	Quadruple Jumps Ratios (calc.) $(\frac{\Delta f}{f})^n$
	I	II (§)	III	I	II	I	II	I	II
f_1 = 3.287, 870 (R)									
f_2 = 0.821, 975	0.7499	0.7472	0.7500						
f_3 = 0.365, 318	0.5556	0.5445	0.5625	0.8889	0.8660				
f_4 = 0.205, 491	0.4375	0.4125	0.4218	0.7500	0.7499	0.9375	0.9130		
f_5 = 0.131, 515	0.3601	0.3164	0.3164	0.6404	0.6494	0.8402	0.8335	0.9600	0.9350
f_6 = 0.091, 330	0.3059	0.2354	0.2373	0.5555	0.5624	0.7500	0.7585	0.8890	0.8742
f_7 = 0.067, 099	0.2653	0.1655	0.1780	0.4892	0.4871	0.6735	0.6325	0.8163	0.8174
f_8 = 0.051, 372 (*)	0.2343	0.0986	0.1335	0.4371	0.4218	0.6089	0.6323	0.7500	0.7642

(§) This column has been corrected by subtracting from all differences the constant value Σ = 0.009, 11 in the calculation of the ratios of column I.

(*) Value extrapolated, as R/64.

Note: The discrepancy between found and expected ratios in the lowest levels of single jumpers is difficult to understand according to the theory, and might depend on some correction term (§) still unexplained.

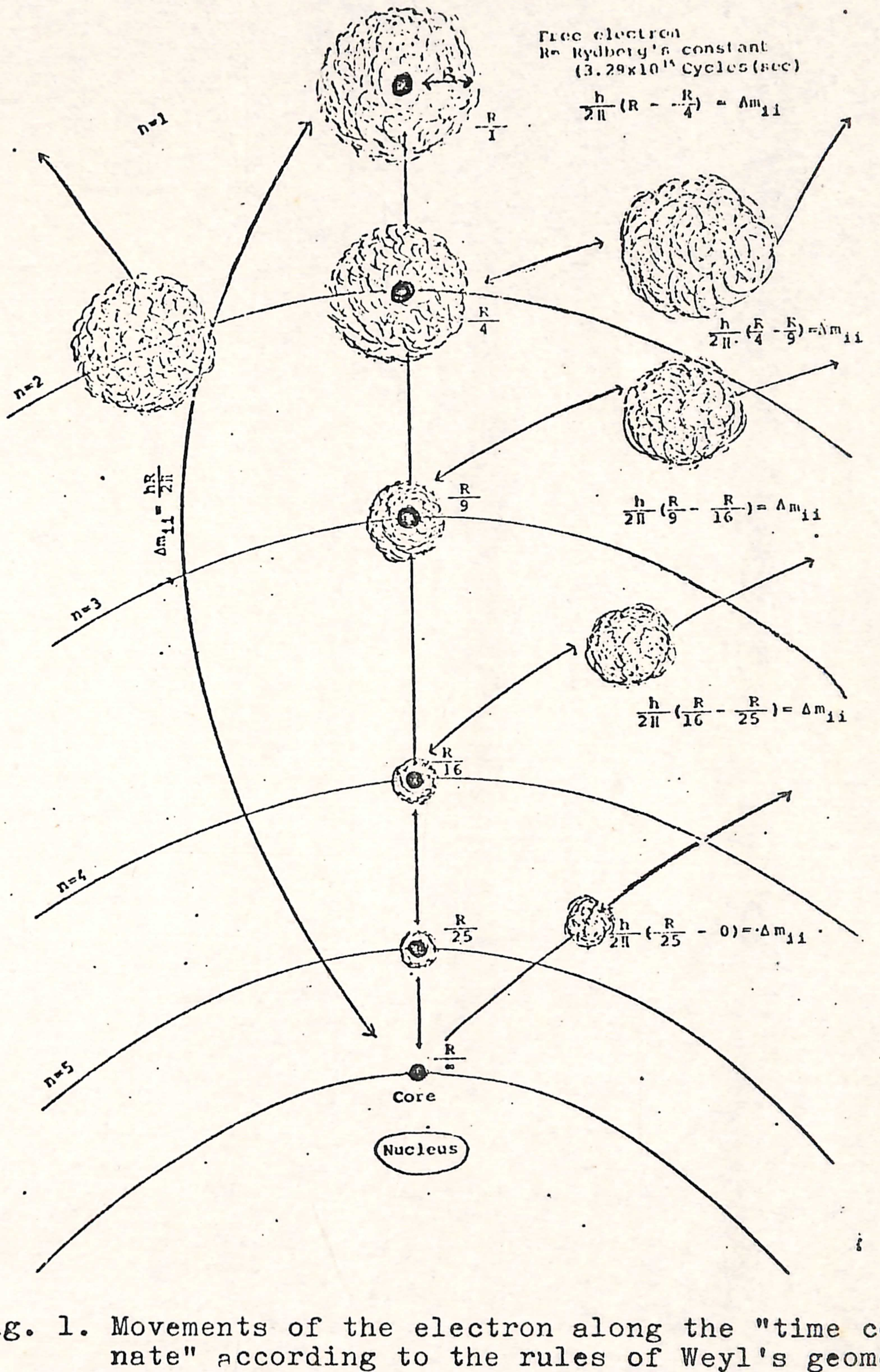

Fig. 1. Movements of the electron along the "time coordinate" according to the rules of Weyl's geometry, i.e. with adjustment of "gauge" by emitting or absorbing quanta of energy. The position of the electron on time (frequency) is highly deterministic though its position in space (not represented here) is indeterminated inside an "interval thickeness of the universe" ($h/2\pi = \hbar$, or Planck's constant).