# The rotating lepton model: Electron and positron catalysis of chemical and nuclear synthesis

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## Professor Emeritus Constantinos Vayenas from the University of Patras and PhD student Dionysios Tsousis from Stanford University discuss electron and positron catalysis in the CERN $e^+e^-$ annihilation experiments via the Rotating Lepton Model

Electrons and positrons play a central role in heterogeneous catalysis (1,2) and electrochemistry (3,4) since they can interact directly via electrostatic interactions with molecular or ionic reactants, intermediates, and products. Electrochemistry's entire science and technology is based on electrostatic electron – or positron-atom interactions.

Interestingly, it has also been known for some years from the positron-electron annihilation experiments (5) that beams of electrons and positrons can produce significant amounts of a variety of hadronic particles (5,6), hadrons and bosons "in a vacuum".

The mechanism of this startling behaviour has been unclear for many years. One might initially argue that the energy released from the exothermic positron-electron neutralisation is somehow converted to the masses of the plethora of products observed, among which the Z boson is the dominant product (Figure 1). However, no physical mechanism is known for producing hadrons and bosons from energy alone.

### The elementary particles

Careful examination of the decay products of all known particles reveals that the ultimate final dissociation products of all known composite particles are only five, i.e., the positron, the electron and the three neutrinos with masses $m_1$, $m_2$, and $m_3$. (7,8,9) These are the only real elementary ("atomic" in the Democritian sense) particles. Neutrinos are also commonly classified in terms of their "flavor", i.e., e-neutrinos, μ-neutrinos and τ-neutrinos, depending on the particle (e, μ or τ) appearing with them upon detection.

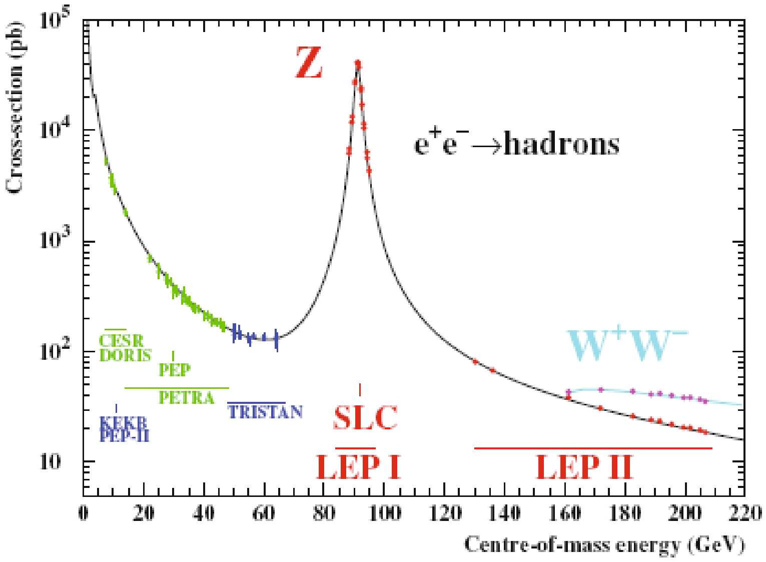



Fig 1. Positron-electron annihilation products observed at CERN (6)

The reason for this simultaneous emergence is discussed in the last section. However, as shown recently and analysed here based on the structure of hadrons and bosons revealed by the Rotating Lepton Model (RLM) (9,10,11), the fundamental neutrino classification in terms of their masses (i.e. $\nu_1$, $\nu_2$ and $\nu_3$) is more fundamental rather than that according to their "flavors".

## Microscopic reversibility and the Rotating Lepton Model

Since a combination of neutrinos, positrons, and electrons is the final product of the dissociation of all composite particles (hadrons, bosons), it follows from the principle of microscopic reversibility that all composite particles can be constructed by combining positrons, electrons, and neutrinos.

There is a critical difficulty with this simple view having to do with the range of masses of neutrinos ($10^{-3}$ to $10^{-1}$ eV/$c^2$), hadrons (1 to 10 GeV/$c^2$) and bosons (80-120 GeV/$c^2$) (Fig. 2) and with the fact that quarks are commonly perceived to be the components of hadrons.

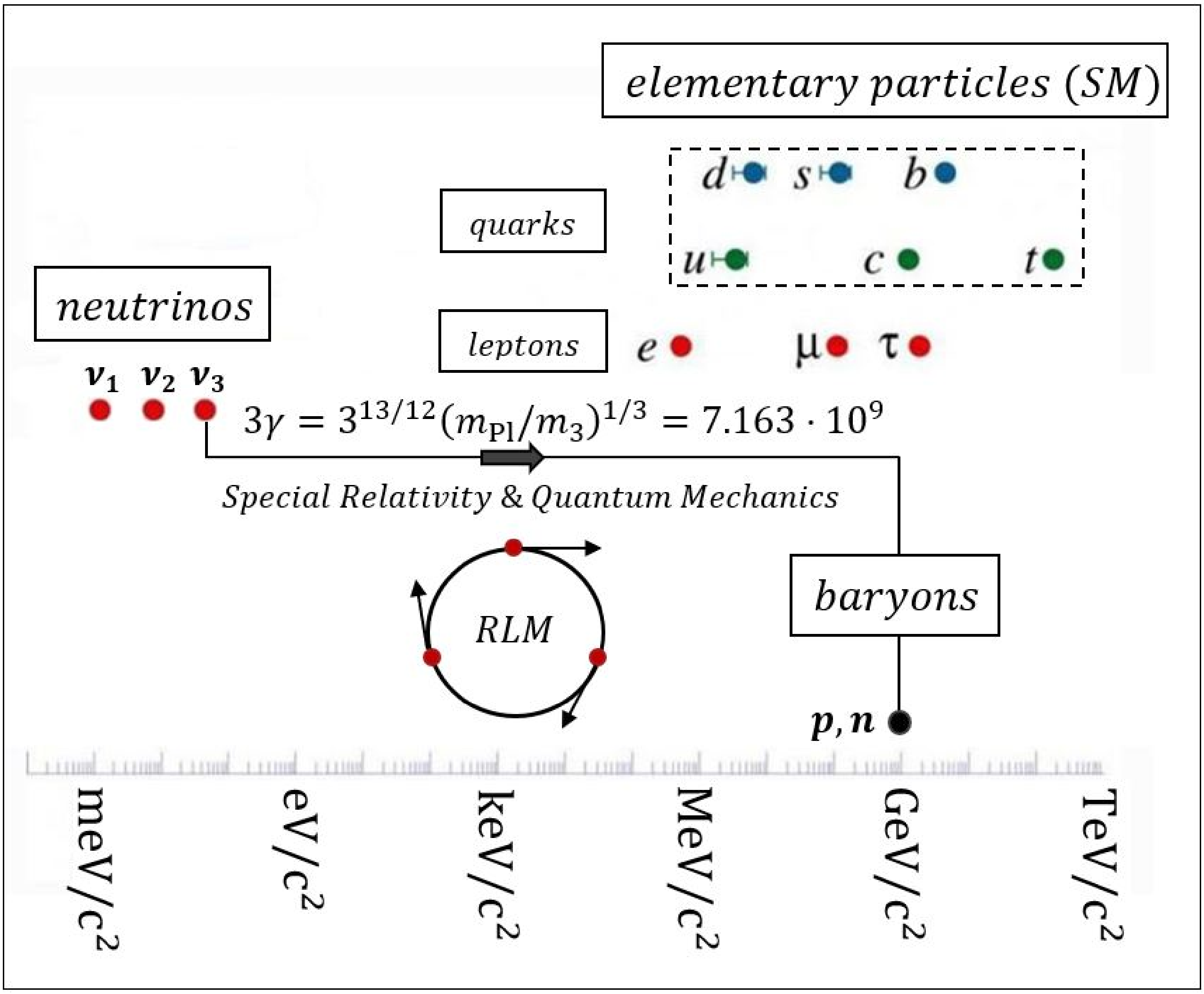



Fig 2. Rest masses of the Standard Model (SM) Elementary Particles and the three neutrino eigenstates. (13,14) The arrow shows how the Rotating Lepton Model (RLM) via Special Relativity increases the heaviest neutrino mass from the rest eigenstate mass value $m_3$ (~45 meV/c2) to the relativistic mass value, $\gamma m^3$ ≈313 MeV/c2 of the s quark, which corresponds to one-third of the mass of the neutron formed (9)

As shown in Figure 2, Special Relativity, a basic component of the Rotating Lepton Model (RLM), directly solves this problem. In the RLM, hadrons, such as the neutron, are modelled as a triad of ultrafast relativistic gravitating neutrinos. The tremendous speeds
($\gamma \approx 10^{10}$ (9,10,11)) reached by the three rotating neutrinos cause their masses to increase (from ~$10^{-2}$ eV/$c^2$) by a factor of $\gamma$.

Thus, surprisingly, the neutrino masses reach the values of the quark masses, and, in this way, the masses of hadrons (baryons) are obtained (~1 GeV/$c^2$), which are ten orders of magnitude heavier than those of neutrinos. In this way, the RLM provides a quantitative fit to the masses of hadrons and the masses of bosons (such as the Z, W and Higgs bosons) which contain a rotating electron in their rotating ring (Fig. 3).

## Experimental validations of the RLM

The positron-electron annihilation (PEA) experiments carried out at CERN [(7)] provide direct proof of the validity of the RLM. As shown in Figure 1, the main product of the PEA is the Z boson. The RLM has already demonstrated this to comprise a rotating positron- electron-neutrino triad [(12)] (Fig 3). Furthermore, the computed via the RLM mass $m_Z=(m_{Pl}m_e m_\nu)^{1/3}\approx 92$ GeV/$c^2$ is in quantitative agreement with the location of the Z peak (Fig. 1).

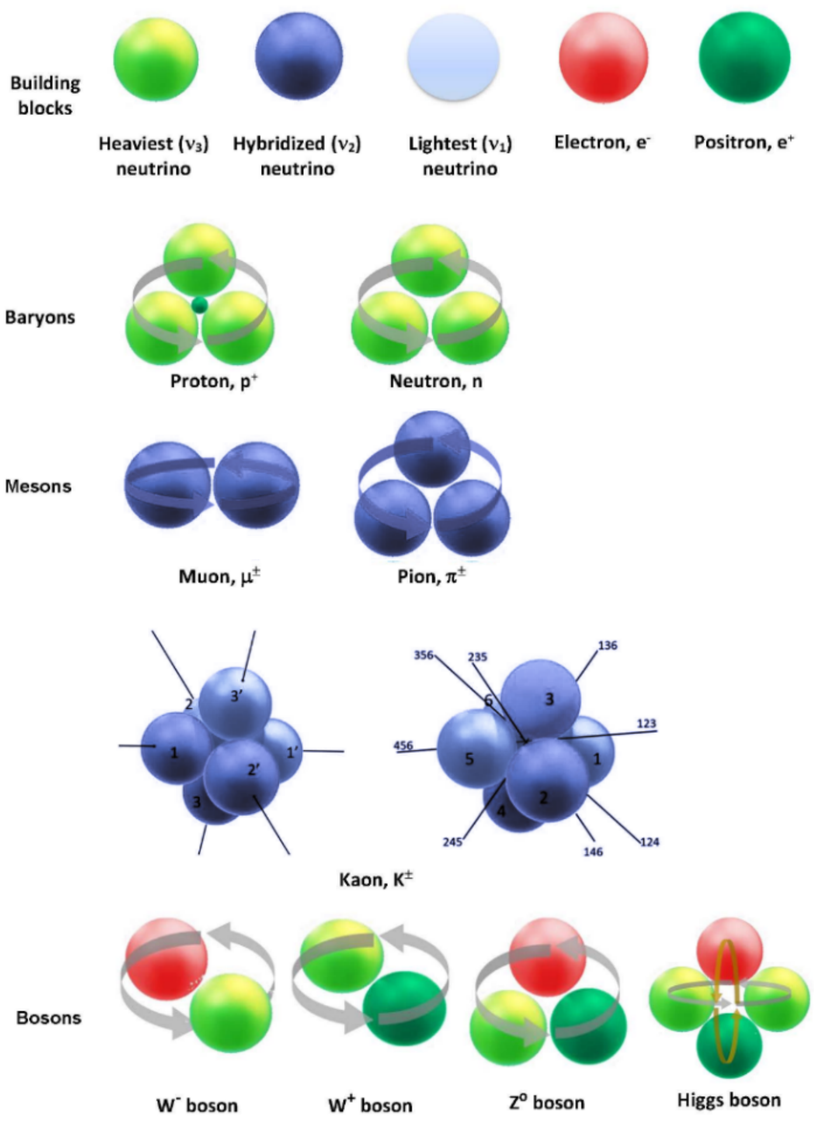



Figure 3. The elementary particles of the Rotating Lepton Model (RLM) (top line) and the RLM structures and composition of baryons, muons, pions, kaons and bosons (10)

A thorough validation of the RLM for a total of 25 composite particles (hadrons), including the proton, the neutron, bosons, and the deuteron nucleus (11), is shown in Figure 4. As shown in this Figure, all the corresponding points fall (within 2%) on the y=x line. The agreement is also quantitative. Figure 5 presents the RLM methodology. It comprises only three equations:

1. The equation of motion which accounts for special relativity via the relativistic masses, γmo, and utilises the gravitational particle masses in Newton's gravitational law. Gravitational masses are equal to inertial masses according to the equivalence principle, i.e., are equal to $\gamma^3 m_o$ where $\gamma(=(1-v^2/c^2)^{-1/2})$ is the Lorentz factor.

2. The de Broglie wavelength equation which states that each particle's angular momentum, $\gamma m_o vr$, equals the Planck constant ħ. There are only two unknowns in these two equations, i.e., γ and r, the radius. The solution of these equations together with the energy balance equation of fig.5 gives:

(1)

$$\gamma = 3^{1/12}(m_{Pl}/m_o)^{1/3}\ ;\ E = 3\gamma m_o c^2 = 3^{13/12}(m_{Pl}m_o^2)^{1/3}c^2$$

and thus

$$m_n = 3^{13/12}(m_{Pl}m_o^2)^{1/3}$$

(2) For $m_o$=0.0437 eV/c2 (within the mass range measured at Superkamiokande), this gives the experimental neutron mass of 939.565 MeV/c2.

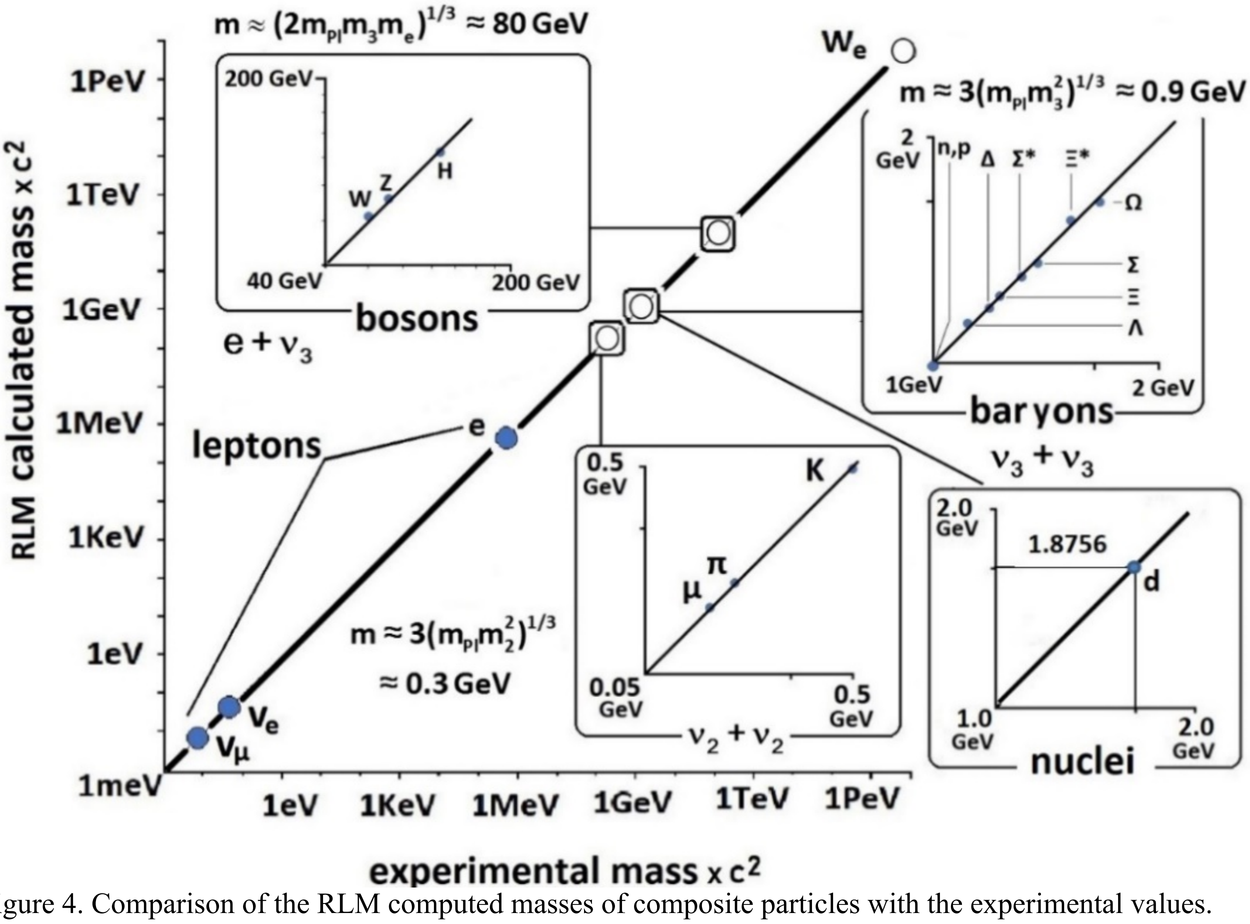



Figure 4. Comparison of the RLM computed masses of composite particles with the experimental values. The agreement is better than 2% without any adjustable parameters. The three approximate mass expressions shown in the Figure provide the order of magnitude of hadron and boson masses. (10,11)

## Neutrino rest masses computation

Conversely, one may rewrite equation (2) as:

$$m_o = \frac{m_n^{3/2}}{3^{13/8}\, m_{Pl}^{1/2}} = 0.0437\ \ eV/c^2$$

(3)

This allows for the computation of the heaviest neutrino mass, m3, which agrees with the value obtained at the Superkamiokande facility. (13)

## Structural information

Figures 3,4, and 5 underline the usefulness and importance of the RLM. They also show that:

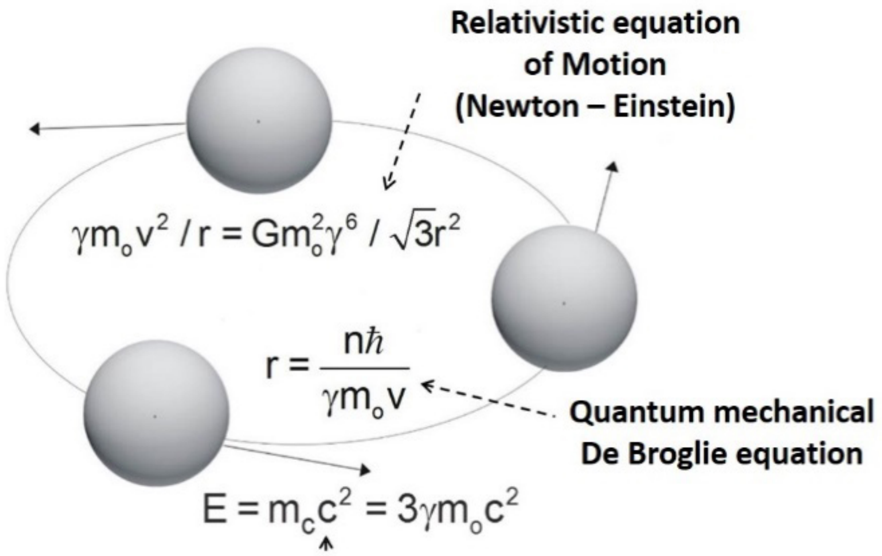
(a). Bosons contain rotating electrons in their structure, and this leads to their significantly larger (by a factor of $(m_e/m_{\nu 3})1/3=10^2$) values of boson masses vs hadron masses.

(b). The Z boson is a rotating $e^+$-e— ν3 triad, and this explains why it is the dominant product of the PEA experiments formed by the interaction of e+-e– pairs with ambient neutrinos.

(c). From the structure of the W boson (i.e. a rotating $e^+$-$\nu_3$ pair), it follows why an electron (or positron) is always appearing simultaneously with each observed $\nu_3$ neutrino.

In summary, the CERN positron- electron annihilation experiments shed new light on the interactions between neutrinos, positrons and electrons and confirm the mechanism of the Rotating Lepton Model by showing that the Z boson is a rotating positron-electron-neutrino ($m_3$) ($e^+e^-$ $\nu_3$) particle.

The neutrino in the Z boson structure is already rotating at a tremendous speed. Thus, upon Z boson decomposition, it can accelerate many more neutrinos to highly relativity speeds, thus further catalysing hadronization.




Energy balance for the computation of the mass of a composite material (e.g. neutron)

for n=1 it is $m_n = 3^{13/12}(m_{Pl} m_o^2)^{1/3}$ or $m_n = 3^{13/12}\left(\frac{\hbar c}{G}\right)^{1/6} m_o^{2/3}$

where $m_{Pl}=(\hbar c/G)^{1/2}= 1.221 \cdot 10^{19}$ GeV/$c^2$ Planck mass

For $m_o$=0.0437 eV/$c^2$ Heaviest neutrino mass
$m_n$=939.565 MeV/$c^2$ Neutron mass

Figure 5. Combining Special Relativity and Quantum Mechanics in the RLM for computing the neutron mass (9,10,11)

Z boson-type bosons can also form via the interaction of electrons with ambient $m_2$ and $m_1$ type neutrinos, and this explains why each electron neutrino (which comprises a mixture of e–$\nu_1$, e–$\nu_2$ and e–$\nu_3$ bosons) has an average mass between those corresponding to $m_1$, $m_2$ and $m_3$ type neutrinos. This appears to clarify the neutrino-flavor concept, i.e., an electron neutrino has emerged via the dissociation of a W boson. In contrast, a muon neutrino is the result of the dissociation of a pion complex, and a tau neutrino is the dissociation product of a tau-neutrino complex.

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