

# Positron and electron catalysis of neutrino hadronization: How our universe was made

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6 January 2025

## **Constantinos G. Vayenas<sup>1</sup>, Dionysios Tsousis<sup>1,2</sup> and Eftychia Martino<sup>1</sup>, together, discuss how our Universe was made, focusing on positron and electron catalysis of neutrino hadronization**

The development of the Bohr model for the H atom (Fig. 1) has played a central role in reaching our current level of understanding of chemical synthesis.

In recent years, the development of the Rotating Lepton Model (RLM) of hadrons and bosons <sup>(1-4)</sup> provided an equally effective approach for modeling the structure and accurately computing the masses of subatomic particles, such as hadrons and bosons, nuclei and even cosmic rays. <sup>(4)</sup>

The RLM bears an important similarity with the Bohr model of the H atom, i.e., it comprises one or more rotating leptons on a circular orbit, gravitationally attracting themselves and not electrostatically as is the case of the Bohr model. In the case of the RLM, the rotating leptons are mostly neutrinos, which have extremely small ( $\sim 1-5 \text{ eV}/c^2$ ) rest masses. However, due to their lightness, these rotating neutrinos easily reach highly relativistic speeds, extremely close to the speed of light.

Thus, according to Einstein's Special Relativity, their relativistic and gravitational masses of  $\gamma m_0$  and  $\gamma^3 m_0$ , respectively, increase dramatically and reach values of the order of  $10^9 \text{ eV}/c^2$  and  $10^{28} \text{ eV}/c^2$ , respectively. This implies that the intraparticle gravitational forces reach the Strong Force value of  $\hbar c/r^2$ , which is  $10^{30}$  times stronger than the normal gravitational attraction at the same distance.

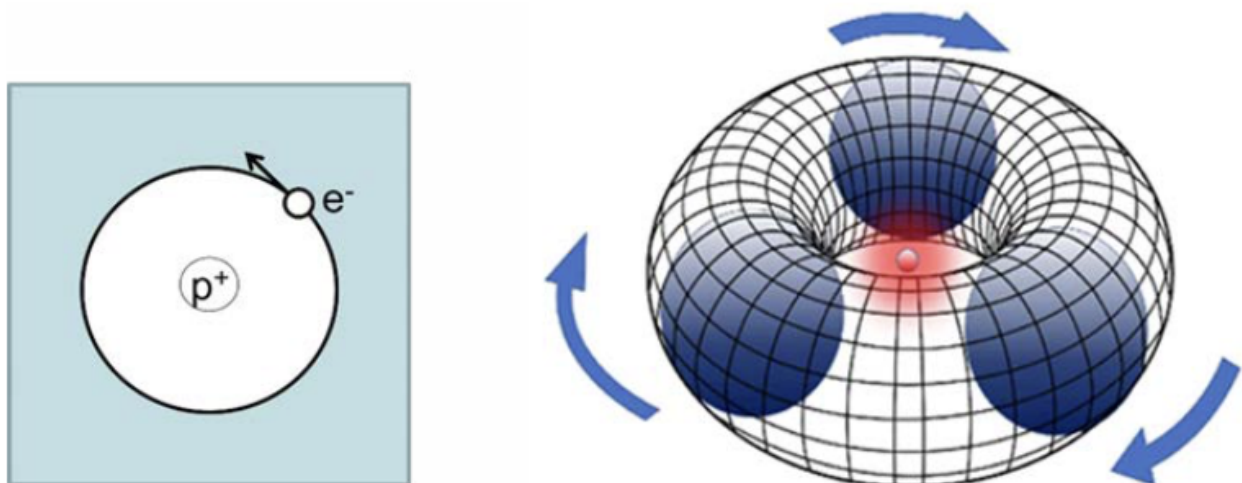


Figure 1: Rotating Lepton Models in Chemistry (Hydrogen atom, left) and in Physics (three gravitationally attracted relativistic neutrinos rotating around a positron and forming the proton, right).

## The mechanism of hadronization (or baryogenesis)

Careful examination of the decay products of several hundreds of composite particles, such as of hadrons (including baryons and mesons) <sup>(4, 7-8)</sup> has shown that the ultimate decay products of all composite particles are only the following five leptons: The electron ( $e^-$ ), the positron ( $e^+$ ) and the three neutrinos ( $\nu_1, \nu_2$  and  $\nu_3$ ), the masses of which were first measured by Kajita <sup>(9)</sup> and McDonald <sup>(10)</sup> in their pioneering work. These masses are of the order of 3 to 50  $\text{meV}/c^2$ , i.e., 12 orders of magnitude (a million million times) smaller than the masses of protons/neutrons ( $10^9 \text{ eV}/c^2$ ).

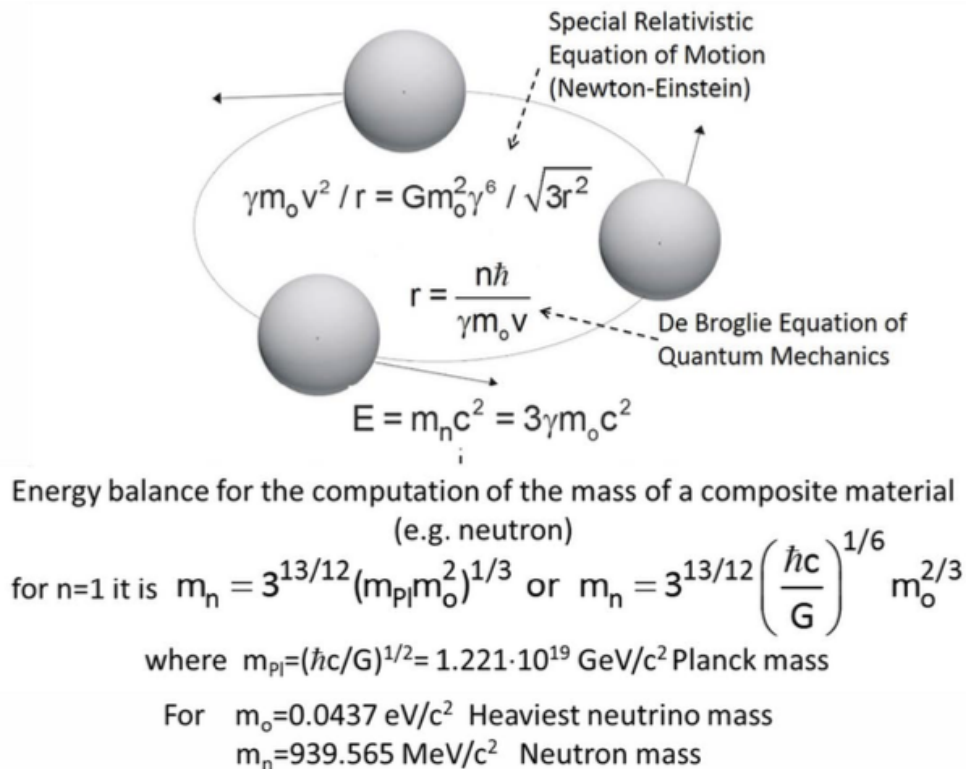


Figure 2. Combining Special Relativity (5,6) and Quantum Mechanics in the RLM for computing the neutron mass. (1-3)

A first question arising from these extremely demanding to measure and dramatically different mass values of neutrinos vs those of the basic constituents of atoms (i.e., protons, neutrons and electrons) is how the tiny masses of neutrinos are related to the huge (by neutrino standards) masses of our familiar electrons and protons which are typically 11 orders of magnitude bigger than those of neutrinos.

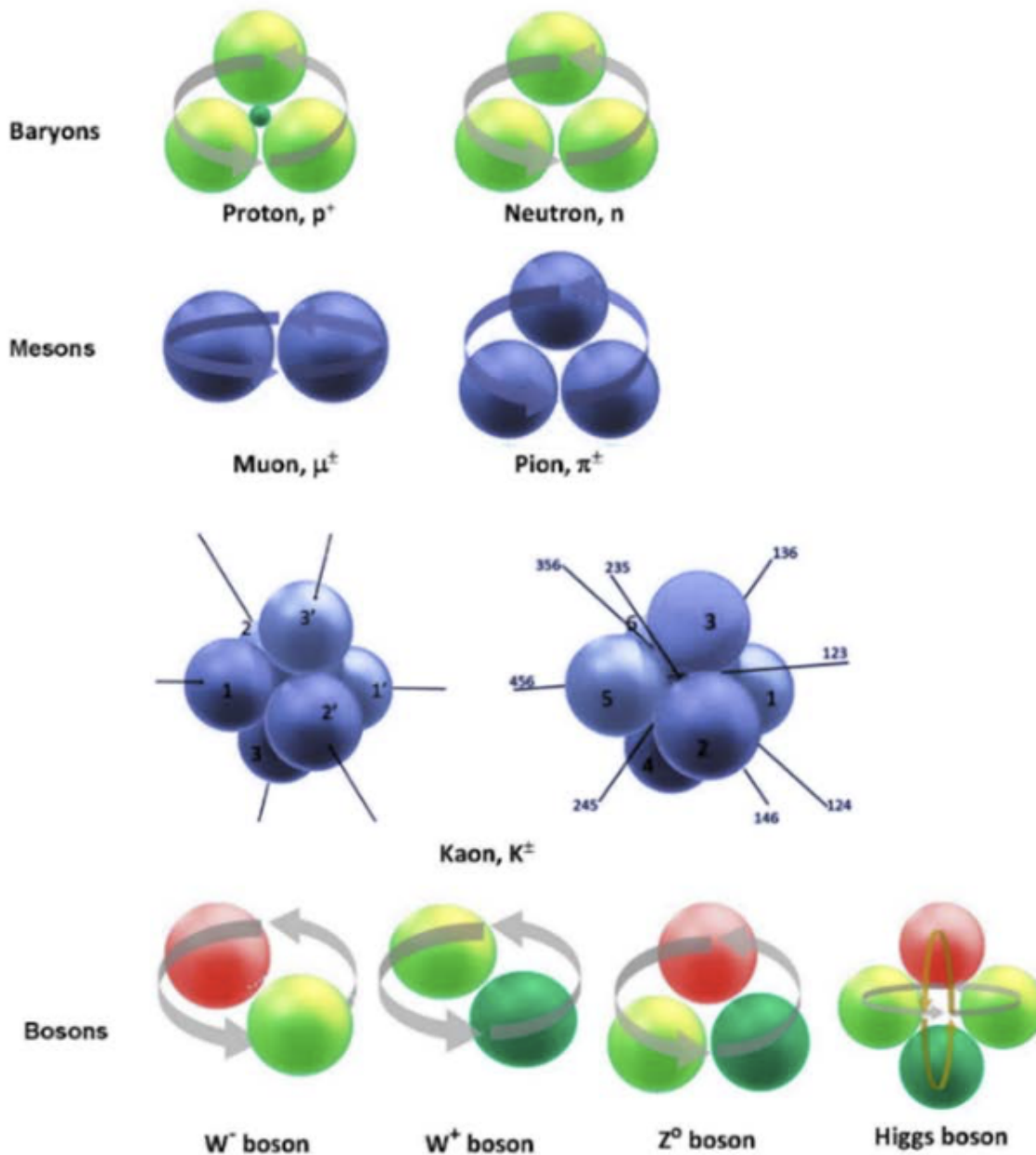


Figure 3. The elementary particles of the Rotating Lepton Model (RLM). (top line) and the RLM structures and composition of baryons, muons, pions, kaons and bosons. (6)

The answer to this question is obtained by the ingenious 1905 masterpiece of Einstein, i.e., by Special Relativity, which, in simple words, dictates that what is really important in this world is not what we measure about ourselves but instead what the others observe about us.

Thus, the measured relativistic mass,  $\gamma m_0$ , of a particle, e.g., a neutrino, of rest mass  $m_0$ , travelling with a Lorentz factor of  $10^{10}$  is of the order of  $10^9 \text{ eV}/c^2$ , i.e.,  $1 \text{ GeV}/c^2$ , i.e., of the order of proton and neutron masses. <sup>(11)</sup> At the same time, its gravitational mass,  $\gamma^3 m_0$  <sup>(5)</sup> reaches the Planck mass. <sup>(1-4)</sup> This provides the key idea of the Rotating Lepton Model (RLM) of composite particles which is a simple Bohr-type model of three gravitating rotating neutrinos moving with speeds very close to the speed of light. <sup>(1-4)</sup> This appears to be how the matter of our Universe has been made (or is being made even today according to the pioneering CERN experiments). <sup>(12)</sup>

The three basic equations of the RLM are given in Figure 2. They represent Newton's gravitational Law coupled with Einstein's special relativity and with the de Broglie equation of quantum mechanics.

In addition to these three scientific giants, there are two more exceptional scientists – philosophers who are worth mentioning, i.e., Plato with his famous phrase “Everything consists of triangles” and his student Aristotle with his equally prophetic “The cyclic motion is the origin of everything”, both exactly confirmed today by the RLM geometry.

Figure 3 shows the geometries of the most common hadrons and bosons used to compute their masses via the RLM, while Figure 4 compares these computed masses with the experimental ones. <sup>(4)</sup> Agreement is typically better than 2%.

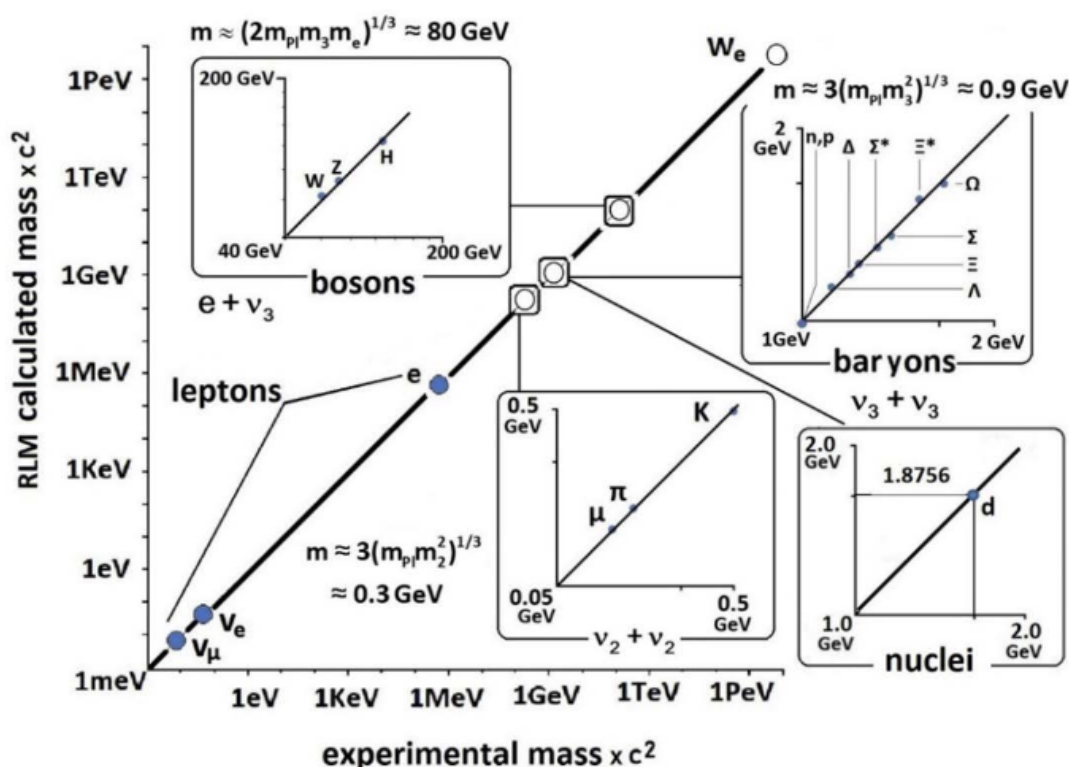


Figure 4. Comparison of the RLM computed masses of composite particles with the experimental values. Agreement is better than 2% without any adjustable parameters. The three approximate mass expressions shown in the Figure provide the order of magnitude of hadron and boson masses. (4)

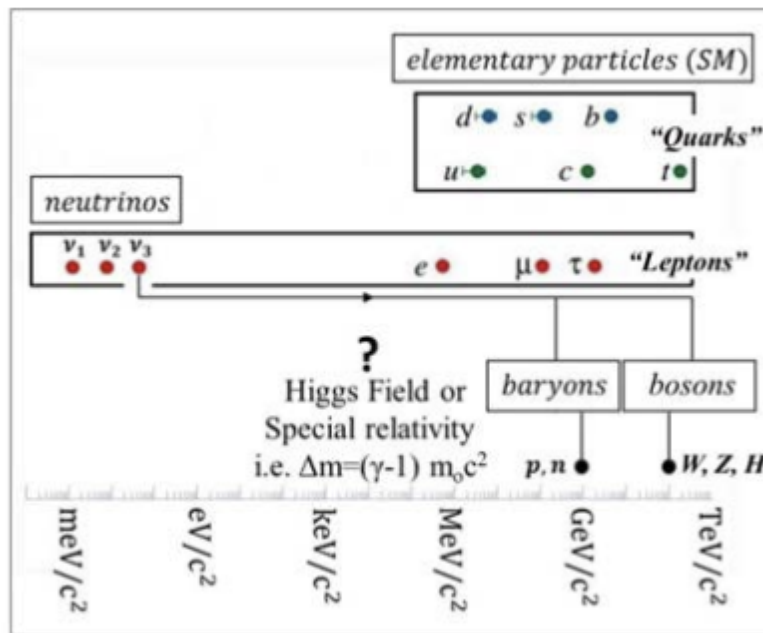


Figure 5. Rest masses of the Elementary Particles of the Standard model (SM) and the three neutrino eigenstates. (3,9) The arrow shows how the Rotating Lepton Model (RLM) via Special Relativity increases the heaviest neutrino mass from the rest eigenstate mass value  $m_3$  ( $\sim 45 \text{ meV}/c^2 \sim 2$ ) to the relativistic mass value,  $\gamma m_3 \approx 313 \text{ MeV}/c^2$  of the s quark, which corresponds to one third of the mass of the neutron formed. (4)

## Gravitational catalysis

A basic question since the conception of the RLM is how the neutrinos reach or have reached the highly relativistic speeds which, via Einstein's special relativity<sup>(5)</sup>, bring their masses from rest masses ( $\sim 10^{-2} \text{ eV}/c^2$ )<sup>(4,13)</sup> to the highly relativistic masses ( $\sim 10^9 \text{ eV}/c^2$ ) of those rotating in protons and neutrons.<sup>(4)</sup> The answer has been provided by some recent works<sup>(1-4)</sup>, as shown in Figure 5. It results from an initial catalytic gravitational acceleration of neutrinos by positrons (and/or) electrons to highly relativistic velocities followed by the steady-state gravitational attraction by the other co-rotating neutrinos (Fig. 6). This two-step gravitational catalysis concept appears to be quite effective.<sup>(4)</sup>

The validity of the RLM is confirmed emphatically from a recent important and, until recently, unexplained CERN experiment, shown in Figure 7, in which positrons and electrons are cofed in a "vacuum" chamber which, unavoidably, contains trillions of neutrinos. Thus, the Z boson peak in Figure 7 can be immediately understood by the fact that, as shown recently<sup>(13)</sup>, the Z boson is a rotating electron-positron-neutrino structure.

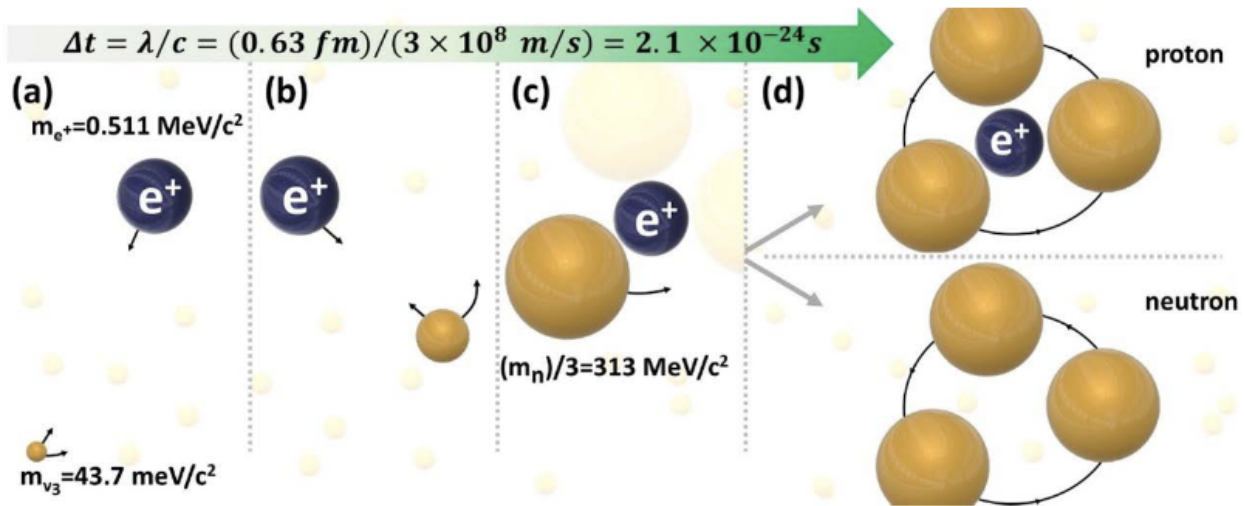


Figure 6. Gravitational catalysis of hadronization by positrons (or electrons). (a) A tiny neutrino at rest is attracted and accelerated by an ambient positron to relativistic ( $\gamma \gg 1$ ) velocities. Its gravitational mass,  $\gamma m_0$ , thus increases dramatically (reaching the Planck mass), as it also starts rotating around the positron (b). Eventually, it joins two similar relativistic neutrinos, forming a proton or a neutron;  $m_{\nu_3}$  is the heaviest neutrino mass, and  $m_n$  is the neutron mass.

## Authors

1. University of Patras
2. Stanford University

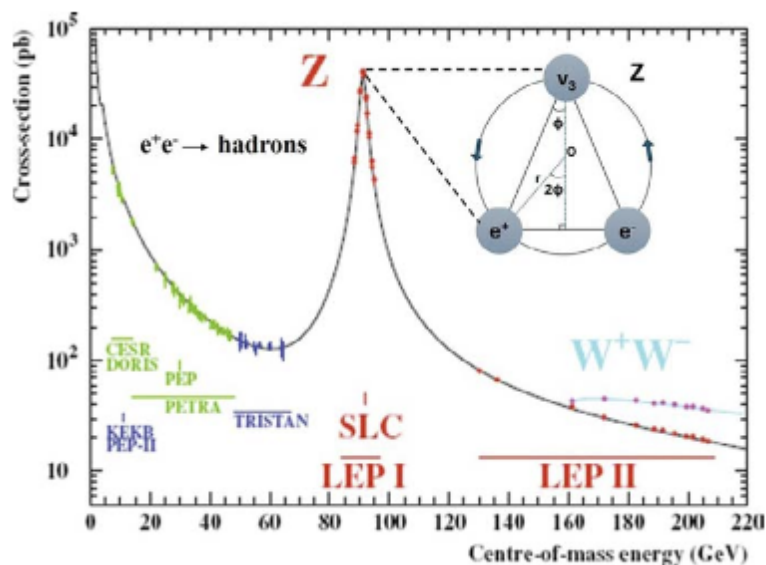


Figure 7: Validation of the RLM via key CERN experiment.

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