Supersymmetric Light and Dark Matter

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Particles occupy mass levels within three geometric sequences that descend from the Planck Mass. Every third level in each sequence is a superlevel of type 1. Every fifth level in each sequence is a superlevel of type 2. The charged leptons in partnership with pseudoscalar mesons are arranged symmetrically about closely coincident superlevels of type 1. The quarks, in weak isospin doublets, are arranged symmetrically about closely coincident superlevels of type 2. A symmetrical pattern of three-sequence coincident superlevels of type 1 extends over many orders of magnitude. The electron and the up quark both participate in partnerships with pseudoscalar mesons that are arranged symmetrically about the centre of the pattern. The model admits of the partnership of an electron neutrino of mass of 10.9 meV with a scalar of mass ~2×10^7 GeV, and of the partnership of a 15.9 keV fermion, conjectured to be the sterile right-handed electron neutrino, with a scalar of mass ~16 GeV.

1. Introduction

In the Planck Model [1], particles occupy mass levels within each of three geometric sequences that descend from the Planck Mass. Sequence 1 is of common ratio 1/π, Sequence 2 is of common ratio 2/π and Sequence 3 is of common ratio 1/e. Every third level in each sequence is a type 1 superlevel. Every fifth level in each sequence is a type 2 superlevel. Partnerships involving the fundamental particles have been shown to be arranged symmetrically about coincident superlevels [2]. We will identify symmetrical patterns of closely coincident superlevels by calculation and then show how the fundamental fermions of the Standard Model and their partners are arranged on them. The model requires the existence of fundamental particles that may constitute dark matter.

2. The arrangement of coincident superlevels

The 'superlevel coincidence proximity' will first be calculated for superlevels of type 1. Values of n_1 and n_3 are calculated for all integer values of n_2 between 0 (Planck Mass) and 200 (7 x 10^{-12} eV).[2] At each value of n_2, each of the three values (of n_1, n_2 and n_3) is subtracted from the nearest integer that is a multiple of 3. The absolute values of the three differences are added, resulting in the superlevel coincidence proximity. The closest superlevel coincidences are of the smallest proximity value.

The type 1 superlevel coincidence proximity is plotted as a function of n_2 in Figure 1. A cyclic pattern results from the interplay of Sequences 1, 2 and 3. The superlevel coincidence proximity calculated for type 2 superlevels is shown in Figure 2. Several superlevel coincidences occur in each pattern at values of n_2 between that of the top quark (85.9) and that of the electron (114.1). These two

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[2] n_1, n_2 and n_3 are level-numbers within Sequences 1, 2 and 3

particles, the most and least massive of the particles of known mass, are arranged symmetrically about Level 100 in Sequence 2. Level 100 participates in a close three-sequence type 2 superlevel coincidence, as shown in Figure 2. That coincidence is (40, 100, 45) in Sequences 1, 2 and 3.

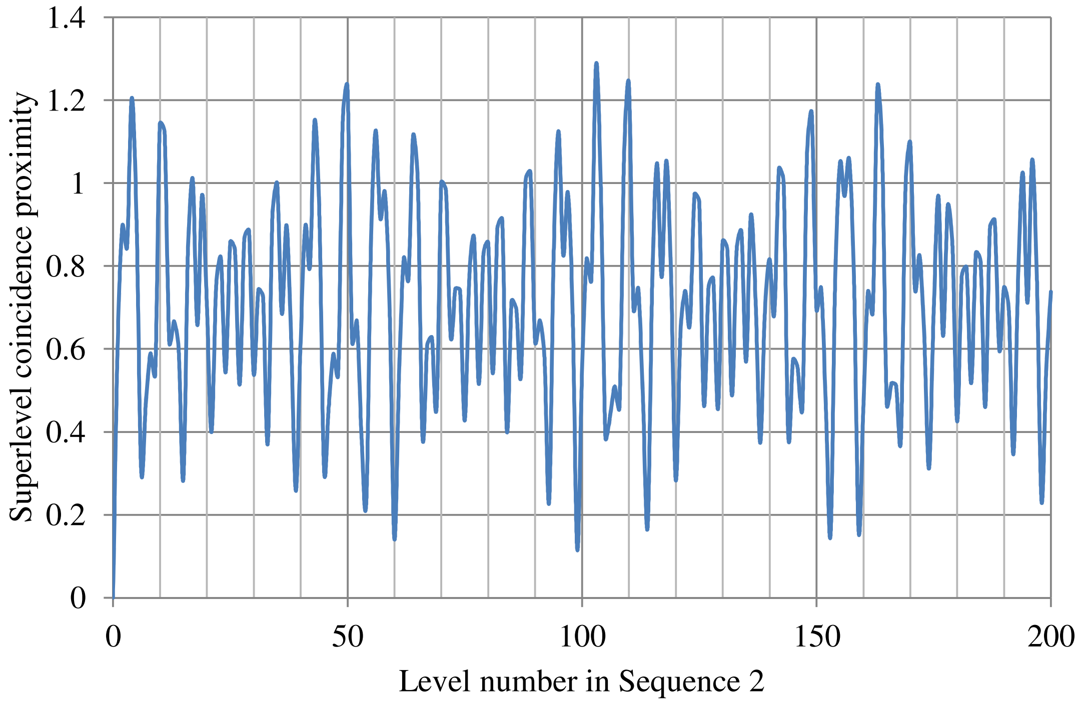

Figure 1: Type 1 superlevel coincidences, shown in Sequence 2

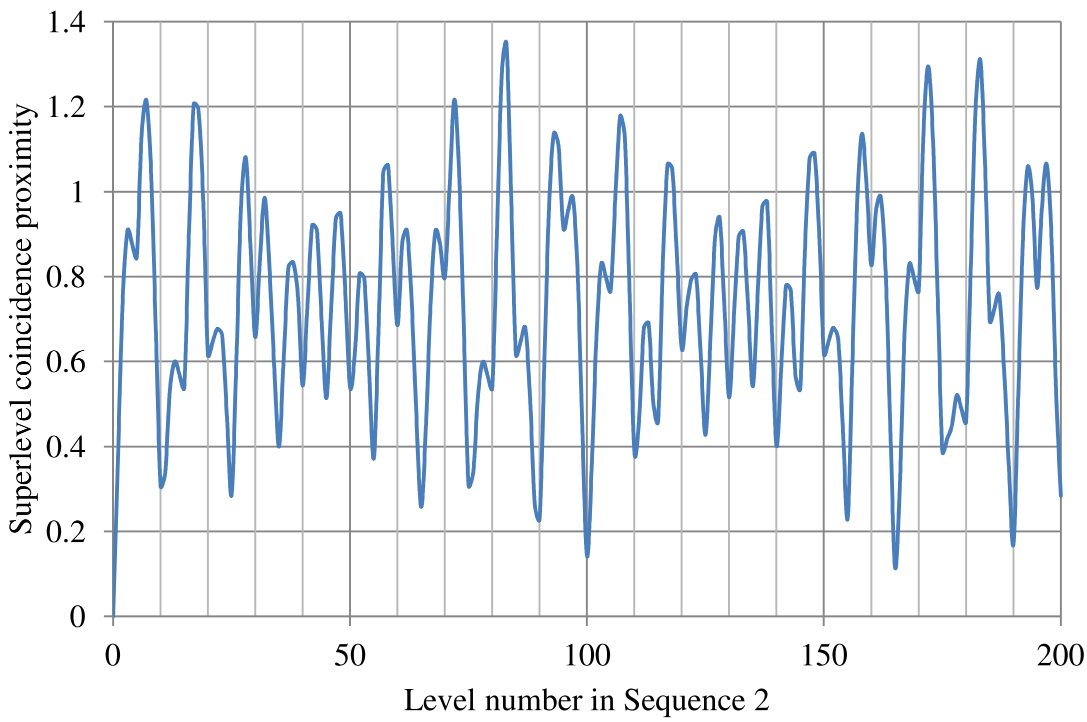

Figure 2: Type 2 superlevel coincidences, shown in Sequence 2

3. A particle mass framework

The Bohr radius, a_0, is a key parameter of the Planck Model:

$$a_0 = (\pi/2)^{125}.\, l_{Planck} \tag{1}$$

Since, in Planck units, $a_0 = 1/m_e\alpha$, where m_e is the mass of the electron and α is the fine structure constant, it follows that

$$m_e = \alpha^{-1}(2/\pi)^{125}.\, m_{Planck}. \tag{2}$$

As the electron lies on the type 1 superlevel coincidence (45, 114, 51), as shown in Figure 3, its precise location (on a superlevel coincidence) relative to Level 125 in Sequence 2 must define the fine structure constant.

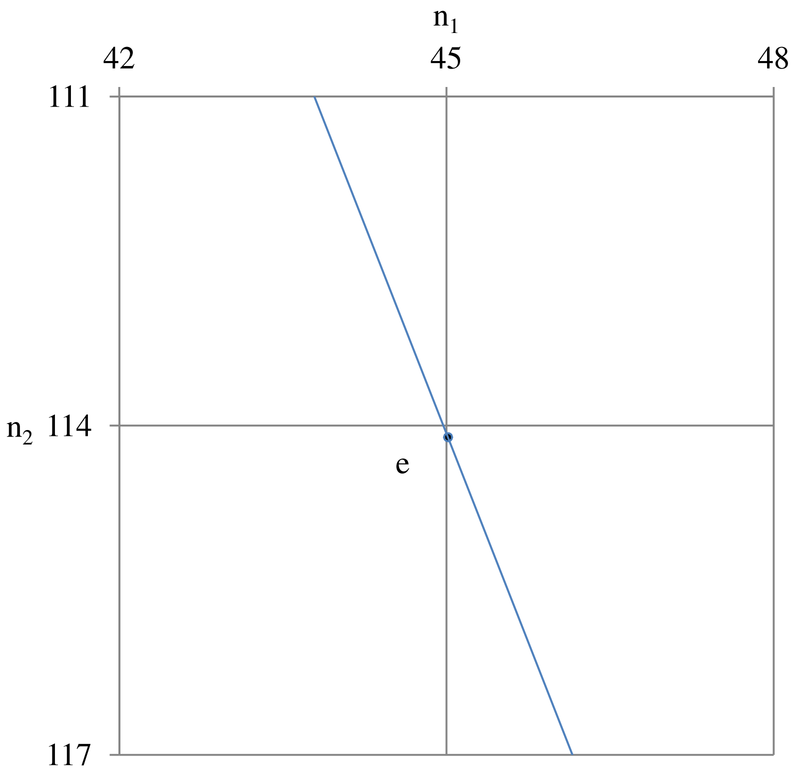

Figure 3: The electron on the type 1 superlevel coincidence (45, 114) in Sequences 1 and 2. In a two-dimensional graph such as this, particles are constrained to lie on a straight line, shown in blue, since the level numbers in the two sequences are in constant ratio. The electron is located on the three-sequence type 1 superlevel coincidence (45, 114, 51).

In the Planck Model [1], the masses of the electron and the up-type quarks are related to the Planck Mass through multiplication by powers of $(2/\pi)^{25}$ and α, as shown in Table 1. It is clear that the electron and the top quark are centred exactly on Level 100 in Sequence 2. The electron mass and the GUT scale are related by a factor $(2/\pi)^{100}$.

Particle/scale	Mass	Relationship with Planck scale in the Planck Model [1]	Mass in the Planck Model
electron	0.5110 MeV	$m_{electron} = \propto^{-1} \left(\frac{2}{\pi}\right)^{125} m_{Planck}$	0.5111 MeV
up quark	$2.3^{+0.7}_{-0.5}$ MeV [3]	$m_{up} = \propto \left(\frac{2}{\pi}\right)^{100} m_{Planck}$	2.177 MeV
charm quark	1.275 ± 0.025 GeV [3]	$m_{charm} = \propto^{2} \left(\frac{2}{\pi}\right)^{75} m_{Planck}$	1.271 GeV
top quark	173.07 ± 0.52 ± 0.72 GeV [3]	$m_{top} = \propto \left(\frac{2}{\pi}\right)^{75} m_{Planck}$	174.1 GeV
GUT scale	2.1×10^{16} GeV	$m_{GUT} = \propto^{-1} \left(\frac{2}{\pi}\right)^{25} m_{Planck}$	2.092×10^{16} GeV

Table 1: Particle masses in the Planck Model

The factor α relates the mass of the electron to the scale of Level 125 in Sequence 2, and also sets the values of the up-type quark masses, as shown in Figure 4. The masses of the up and top quarks result from the symmetrical disposition of the quarks relative to the electron. The mass of each down-type quark results from the symmetrical arrangement of each quark doublet about a type 2 superlevel [1]. The up – down, strange – charm and bottom – top quark doublets may be seen from Figure 4 to be centred on the approximate type 2 superlevel coincidences (110, 50), (100, 45) and (90, 40), respectively, in Sequences 2 and 3. The doublets are centred on the three-sequence type 2 superlevel coincidences (45, 110, 50), (40, 100, 45) and (35, 90, 40): see Figure 5. These are the closest three-sequence type 2 superlevel coincidences that occur at mass scales between those of the electron and the top quark.

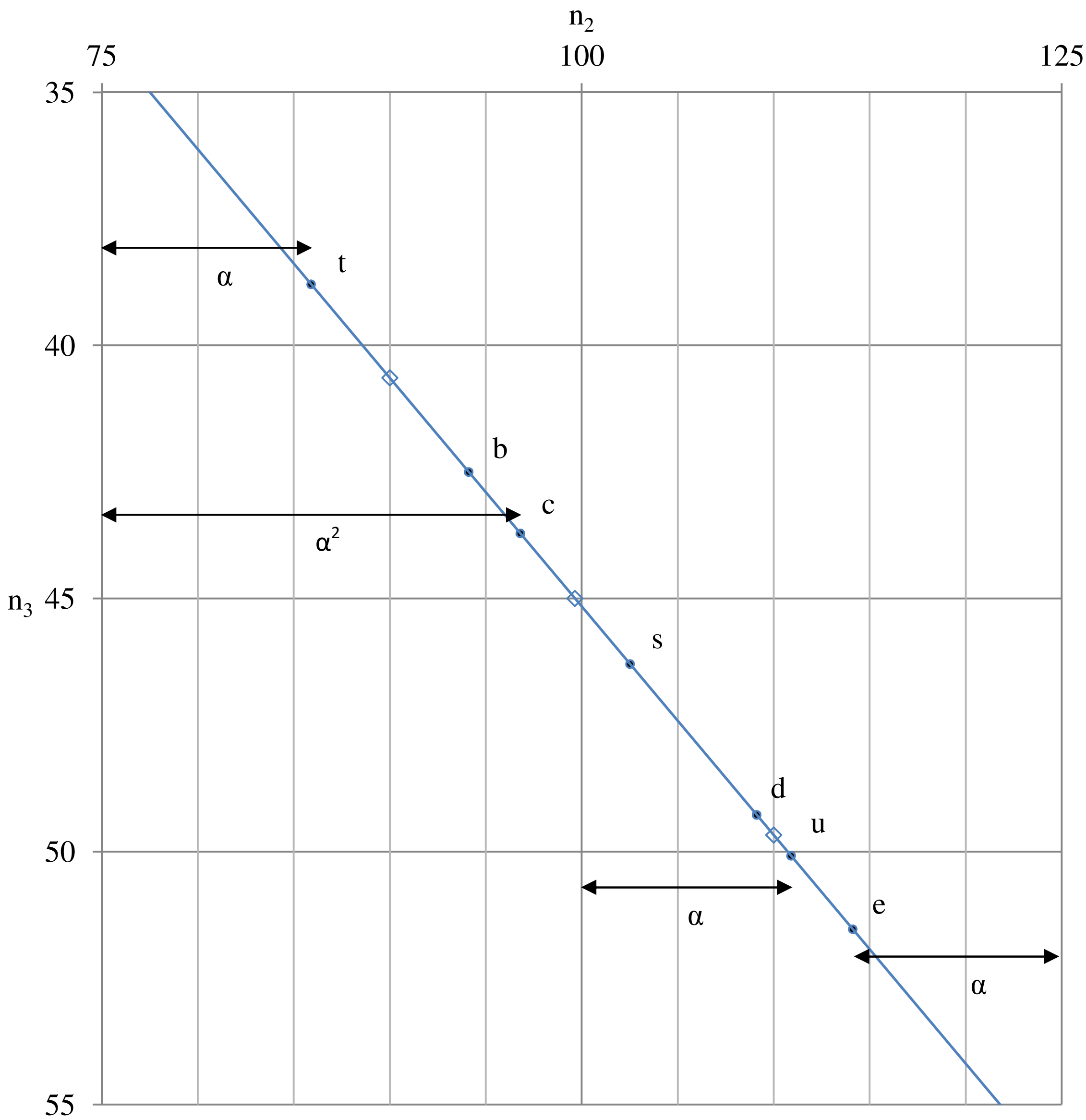

Figure 4: The arrangement of the electron and the quarks within Sequences 2 and 3. All levels shown are superlevels of type 2. A diamond marks the centre of each quark doublet. The whole arrangement is centred on the type 2 superlevel coincidence (40, 100, 45).

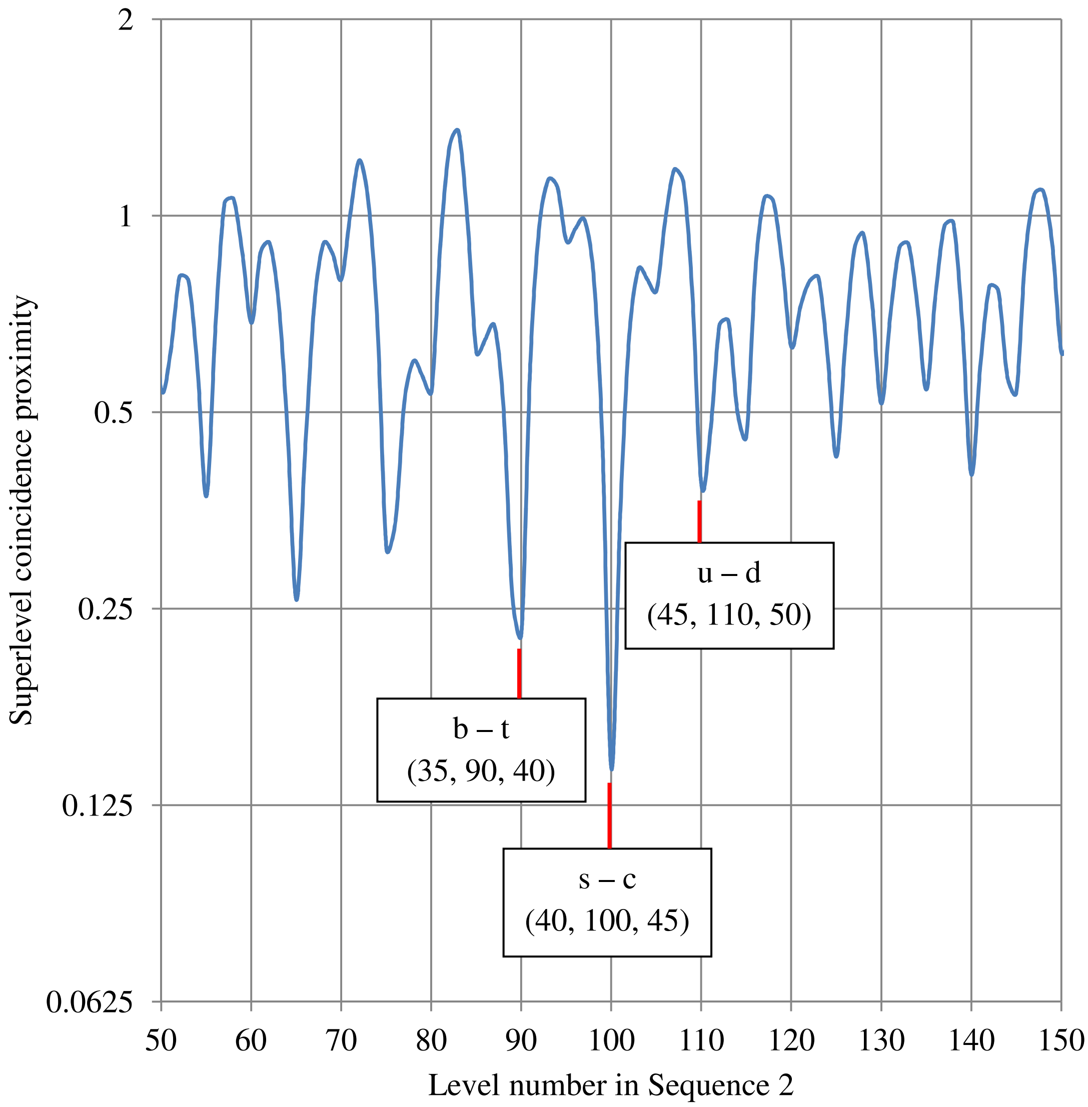

Figure 5: The quark doublets on type 2 superlevel coincidences, shown in Sequence 2

The charged leptons are partnered by charged pseudoscalar mesons [1]. The electron and its partner, the K^- meson, are shown on the levels of Sequences 1 and 2 in Figure 6. The electron is located on the type 1 superlevel coincidence (45, 114, 51). The K^- meson is located on the type 1 superlevel coincidence (39, 99, 45). The two particles are arranged symmetrically about the two-sequence type 1 superlevel coincidence (42, 48) in Sequences 1 and 3.

The muon and its partner, the π^- meson, and the tau lepton and its partner, the D^- meson, are shown on the levels of Sequences 1 and 2 in Figure 7. Each partnership is symmetrically arranged about a type 1 superlevel in Sequence 2. The two partnerships are symmetrically arranged about the type 1 superlevel coincidence (39, 99, 45), the domain of the K^- meson.

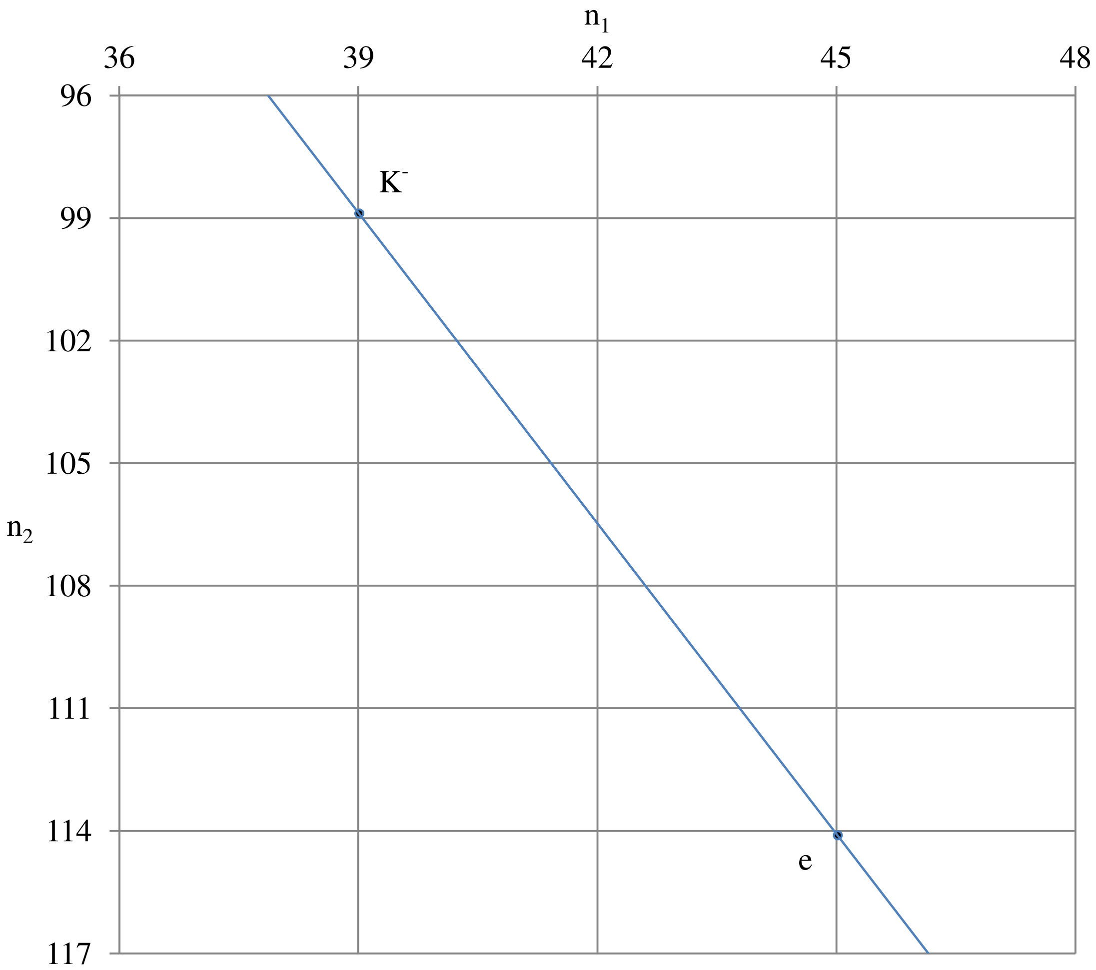

Figure 6: The electron and the K^- meson within Sequences 1 and 2. The electron occupies the type 1 superlevel coincidence (45, 114, 51). The K^- meson occupies the type 1 superlevel coincidence (39, 99, 45). The arrangement of the two particles is centred on (42, 106.5, 48).

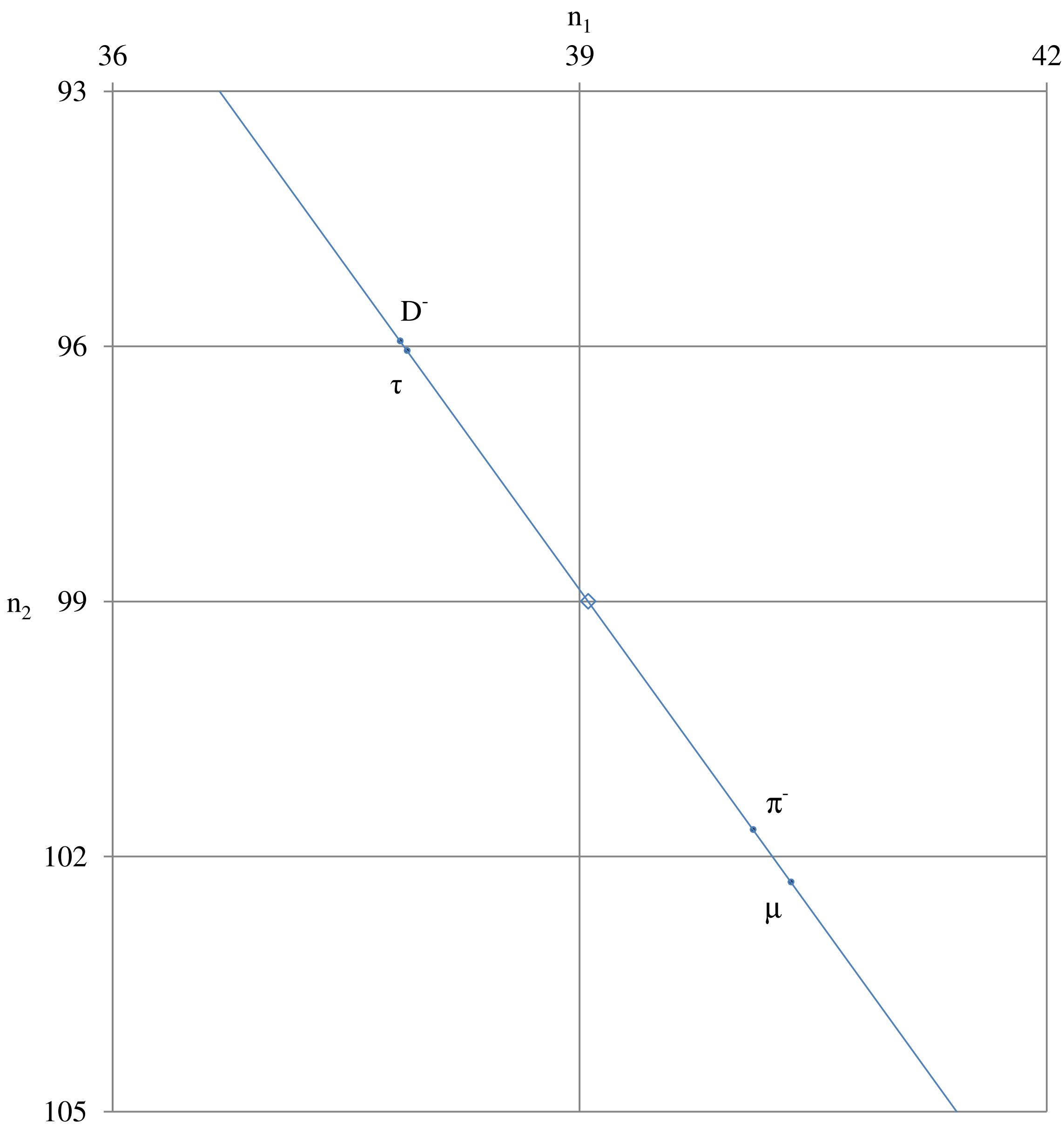

Figure 7: The muon, the tau lepton and their pseudoscalar partners in arrangement about the type 1 superlevel coincidence (39, 99, 45). A diamond marks the centre of the arrangement.

Atomic nuclei occupy mass levels [4]. The proton (a spin-½ fermion) and the ^{56}Fe nucleus (a spin-0 boson, with the highest binding energy per nucleon of any atomic nucleus), occupy Levels 44 and 40, respectively, in Sequence 3. These two levels are symmetrically arranged about the type 1 superlevel coincidence (36, 93, 42): see Figure 8. The two-sequence type 1 superlevel coincidence (93, 42) in Sequences 2 and 3 is the closest superlevel coincidence known.

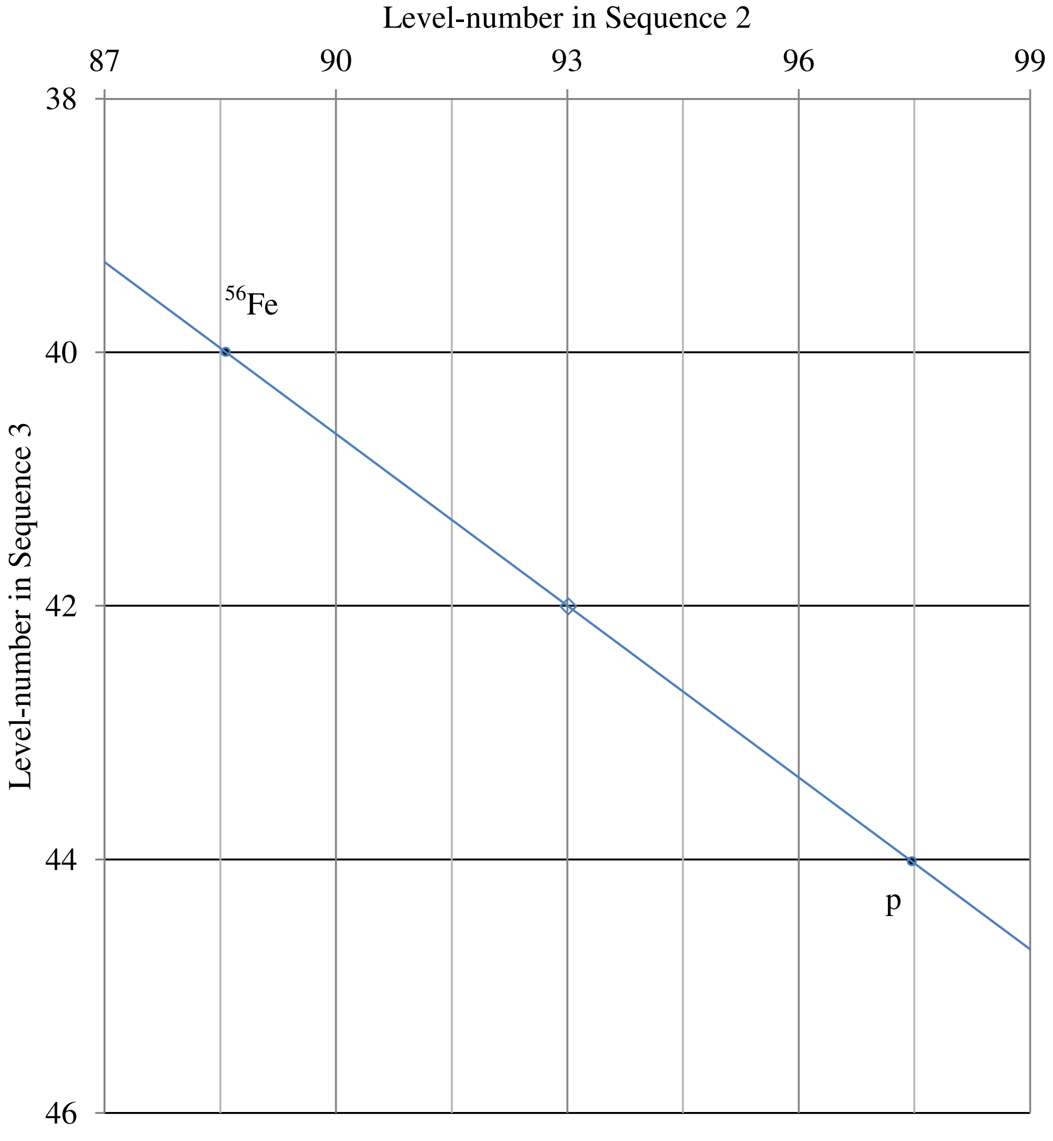

Figure 8: The proton and the ^{56}Fe nucleus in symmetric arrangement about the type 1 superlevel coincidence (36, 93, 42). A diamond marks the centre of the arrangement.

The charged leptons, the proton and their partners occupy or are symmetrically arranged about the three-sequence type 1 superlevel coincidences (45, 114, 51), (39, 99, 45) and (36, 93, 42), as shown in

Figure 9. These are the closest three-sequence type 2 superlevel coincidences that occur at mass scales between those of the electron and the top quark.

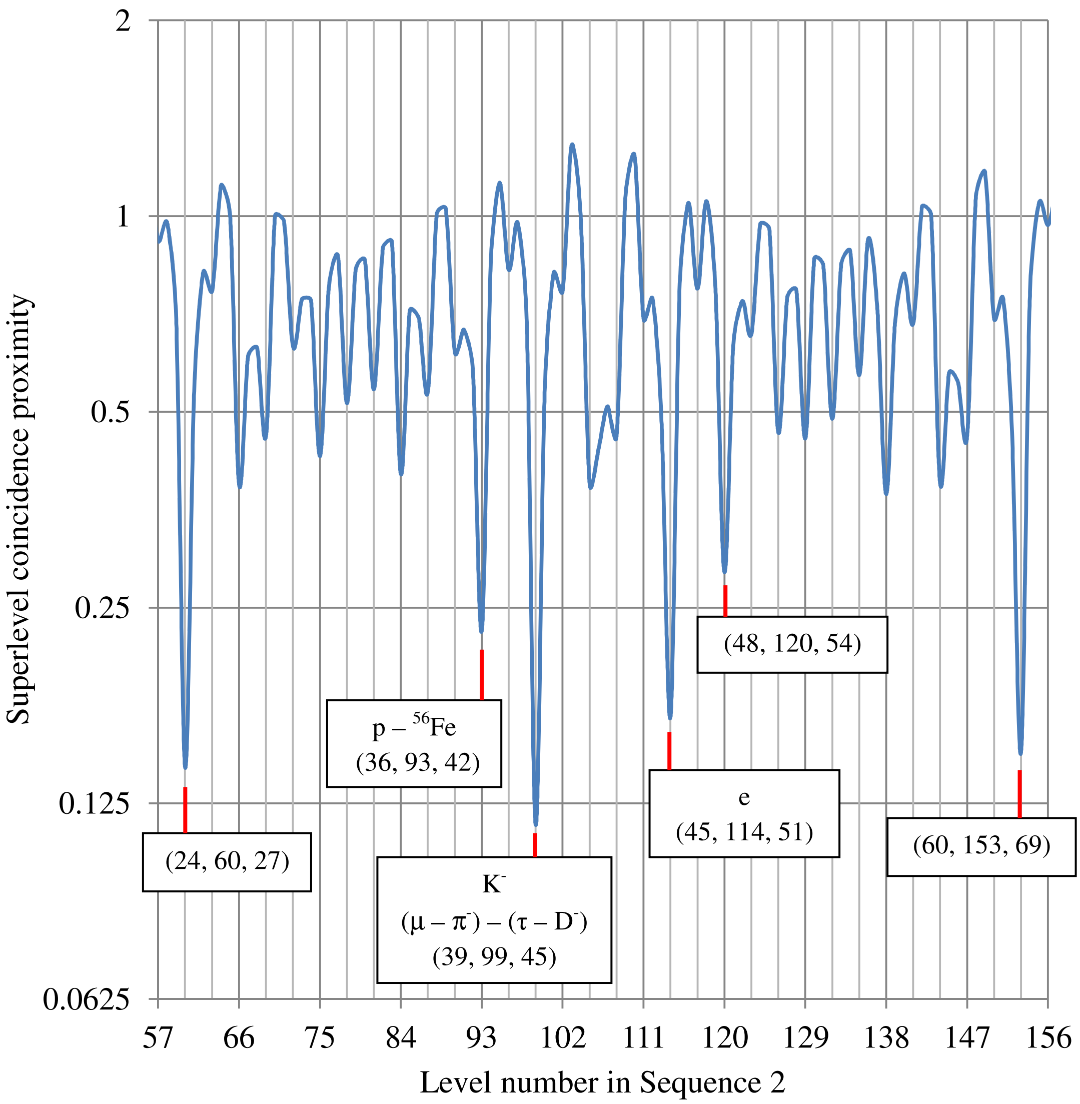

Figure 9: The occupation of type 1 superlevel coincidences by the charged leptons, the proton and their partners, shown in Sequence 2. Partnerships are indicated by dashes. The K^- meson partners the electron. Six close superlevel coincidences occur within the pattern shown.

In the Supersymmetric Planck Model [2], the down-type quarks are partnered by neutral pseudoscalar mesons, while the up and charm quarks are partnered by charged pseudoscalar mesons in partnership with charged leptons [2]. The up quark is partnered by the charged pion in partnership with the muon. The u – (μ – π^-) partnership, like the partnership of the electron and the K^- meson, is centred on the type 1 superlevel coincidence (42, 48) in Sequences 1 and 3, as shown in Figure 10. This coincidence lies at the centre, (42, 106.5, 48), of the symmetrical arrangement of three-sequence type 1 superlevel coincidences shown in Figure 9.

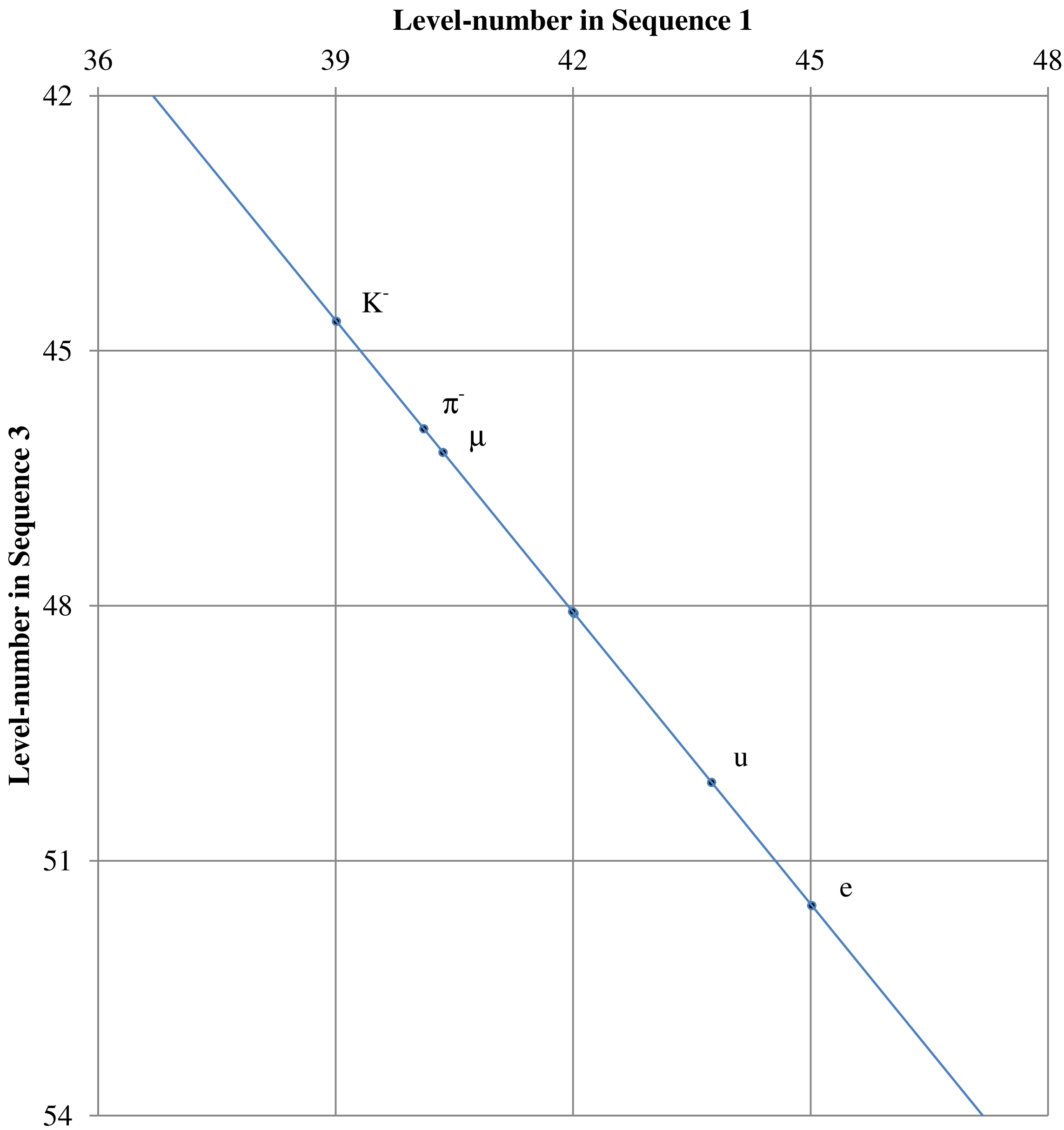

Figure 10: The symmetrical arrangement of the e – K⁻ and u – (μ– π⁻) partnerships about the type 1 superlevel coincidence (42, 48) in Sequences 1 and 3. A dot marks the centre of each partnership.

The close type 1 superlevel coincidence (60, 153, 69) featured in Figure 9 has been associated with the neutrino mass scale [2], with the mass of the electron neutrino being given by

$$m_{neutrino} = \propto^{-2} (2/\pi)^{175} m_{Planck}, \tag{3}$$

which has the value 10.9 meV. Since the superlevel coincidence (42, 48) in Sequences 1 and 3 has been shown to be pivotal in two fundamental partnerships characterised by ΔJ = ½, it seems reasonable to suggest that the type 1 superlevel coincidence (24, 60, 27), which is symmetrically opposed to the type 1 superlevel coincidence (60, 153, 69), is the domain of the sneutrinos. The electron sneutrino mass is ~2 × 10^7 GeV.

Figure 9 features another symmetrical pair of type 1 superlevel coincidences: (48, 120, 54) and (36, 93, 42). We will conjecture that (48, 120, 54) is the domain of the sterile right-handed neutrinos. A right-handed electron neutrino with mass given by

$$m_{r-h\ neutrino} = \alpha^2(2/\pi)^{100}.\, m_{Planck}, \tag{4}$$

would occupy the vacant type 1 superlevel coincidence (48, 120, 54) and have a mass of 15.9 keV. The fermion would lie close to Level 48 in Sequence 1 and actually occupy Level 55 in Sequence 3. Sterile neutrinos with keV-scale masses are candidates for warm dark matter [5]. A fermion of mass ~15 keV, possibly a sterile neutrino, could account for the dark matter in galaxies [6]. In the model developed, the type 1 superlevel coincidence (24, 60, 27) is the domain of the right-handed sneutrinos. The mass of the right-handed electron sneutrino is ~16 GeV. This particle may be a component of dark matter. Data from the direct detection experiments, DAMA/LIBRA, CoGeNT, and CRESST-II favour a dark matter particle with a mass of approximately 10-15 GeV [7].

The left and right-handed electron neutrinos of the model lie in symmetrical arrangement on the levels of Sequences 2 and 3, as shown in Figure 11.

4. Discussion

The charged leptons and their pseudoscalar partners are arranged on or symmetrically about the two closest type 1 superlevel coincidences that occur at mass scales between those of the electron and top quark. The two coincidences are arranged symmetrically about (42, 106.5, 48), which lies at the centre of a symmetrical pattern of three-sequence type 1 superlevel coincidences that results from the interplay of Sequences 1, 2 and 3 and extends over many orders of magnitude. The quarks, in weak isospin doublets, are arranged about the three closest type 2 superlevel coincidences that occur at the scales of particles of known mass. The three coincidences are arranged symmetrically about the type 2 superlevel coincidence (40, 100, 45). The pattern of three-sequence type 2 superlevel coincidences that results from the interplay of Sequences 1, 2 and 3 is symmetrical about (70, 177.5, 80), which occurs at a scale of 2 × 10^{-7} eV. An examination of Figures 1 and 2 reveals that the symmetrical arrangement of coincident superlevels of type 1 about Level 106.5 in Sequence 2 is similar to the arrangement of coincident superlevels of type 2 about Level 177.5 in Sequence 2. It is about the centre of the type 1 pattern, though, that the lightest fundamental fermions of each type and their partners are arranged symmetrically.

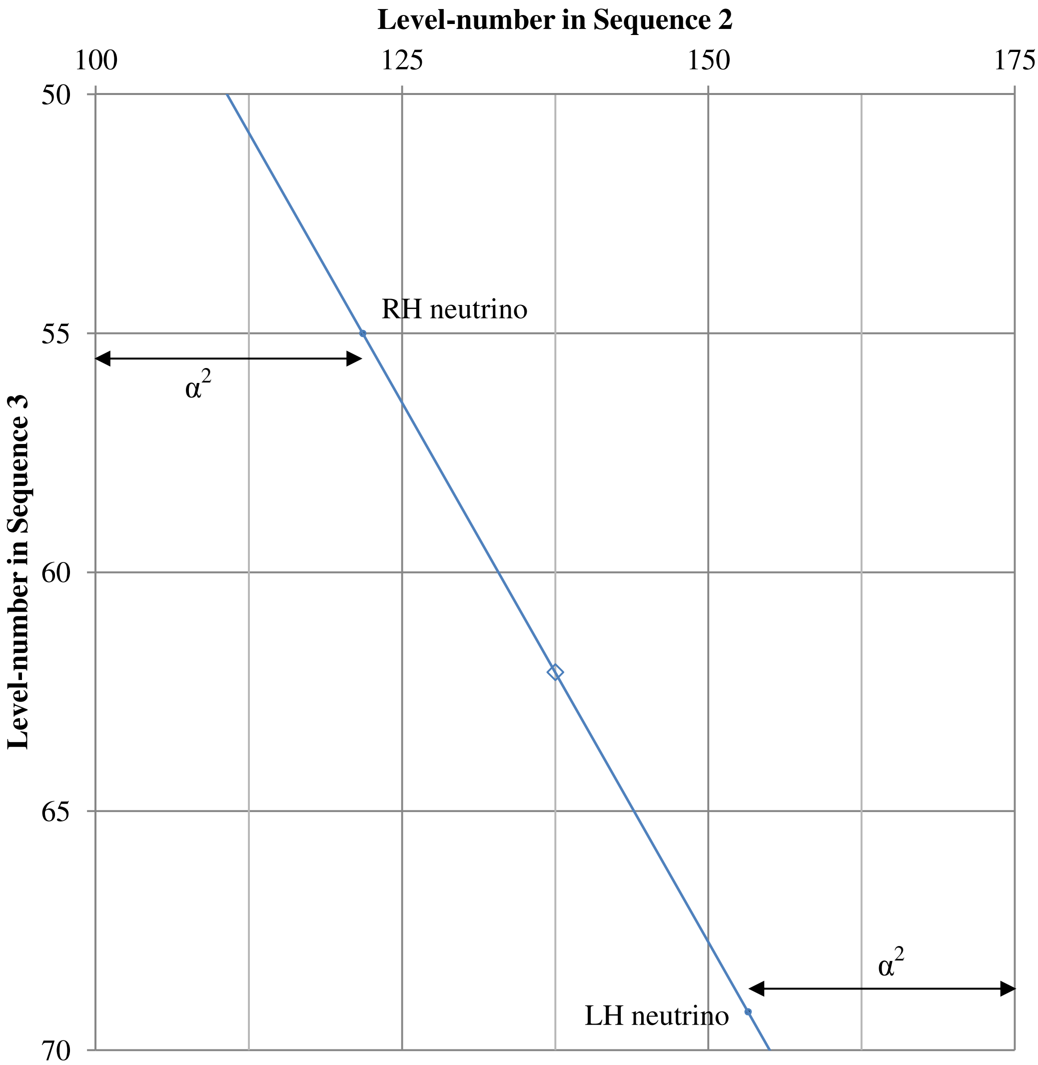

Figure 11: The symmetrical arrangement of the conjectured left and right-handed electron neutrinos within Sequences 2 and 3. A diamond marks the centre of the arrangement.

5. References

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