

7.1 keV and 35 GeV dark matter: more signs of supersymmetry

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A 7.1 keV dark matter fermion in partnership with a 35 GeV scalar WIMP would join the electron, the up quark and their previously hypothesised supersymmetric partners in a spectacular arrangement on the mass levels of the Supersymmetric Planck Model. All three partnerships are arranged symmetrically about the precise centre, at the scale of 16 MeV, of a symmetrical pattern of coincident mass levels that extends over 35 orders of magnitude. The implied dynamical supersymmetry-breaking scale λ coincides with coincident mass levels at the centre of another symmetrical pattern. The investigation has revealed new evidence of quark-lepton symmetry.

1. Introduction

An unidentified emission line at $E = 3.5\text{-}3.6$ keV in inner galactic X-ray spectra has recently been detected by two groups [1, 2]. The signal may result from the decay of a sterile neutrino or some other particle of mass $m = 2E = 7.1$ keV. At the same time, an analysis of γ -ray emission from the central region of the Milky Way has revealed an excess in the range 1-3 GeV that could result from the annihilations of 30-40 GeV WIMPs [3]. The spectrum predicted from a 35.25 GeV dark matter particle annihilating to $b\bar{b}$ agrees well with observations.

The electron and the up quark have both been shown to participate in partnerships characterised by $\Delta J = \frac{1}{2}$ [4], in which the particles are arranged symmetrically about the supersymmetry-breaking mass scale 16 MeV. That scale lies at the precise centre of a symmetrical pattern of coincident mass levels that extends over many orders of magnitude [5]. The mass levels lie within three sequences, each of which descends from the Planck Mass and may derive from an extra-dimensional geometry [6]. We have conjectured that the right-handed sterile neutrino and its superpartner are arranged similarly to the partnerships involving the electron and the up quark, about the centre of the pattern of coincident mass levels. Here, we will show that a 7.1 keV fermion and a 35 GeV scalar would be arranged precisely in this way. We will show that the implied dynamical supersymmetry-breaking scale λ occupies a special location within the space defined by the mass level network.

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We will then provide new evidence for quark-lepton symmetry. First, the Supersymmetric Planck Model is outlined.

2. The Supersymmetric Planck Model

All massive particles lie on levels within the three Planck sequences, which descend in geometric sequence from the Planck Mass. Sequence 1 is of common ratio $1/\pi$, Sequence 2 is of common ratio $2/\pi$ and Sequence 3 is of common ratio $1/e$. The sequences may derive from the geometry of spacetime [6]. Mass levels within the three sequences are assigned the level-numbers n_1, n_2 and n_3 . A particle occupies a level, or sublevel of fractional level-number, within each of the three sequences. Many particles clearly occupy coincident mass levels [7]. Broken symmetries are manifested on the mass levels. For example, isospin doublets are arranged symmetrically about mass levels [8, 9]. The quarks are arranged in weak isospin doublets, symmetrically about superlevels, whose level-numbers, in this case, are multiples of 5 [10]. Hadronic broken supersymmetry has been observed [11]. Charged lepton-pseudoscalar meson broken supersymmetry is clear to see on superlevels whose level-numbers are multiples of 3 [6].

The Bohr Radius, a_0 , is an important scale in the Supersymmetric Planck Model. It is given by

$$a_0 = \left(\frac{\pi}{2}\right)^{-125} l_p = 52.9 \times 10^{-12} \text{ m} \quad (1)$$

where l_p is the Planck Length, $1.616199(97) \times 10^{-35}$ m [12]. On the basis of (1), the mass of the electron is given by

$$m_e = \alpha^{-1} \left(\frac{\pi}{2}\right)^{-125} m_p = 0.511 \text{ MeV} \quad (2)$$

where m_p is the Planck Mass, $1.220932(73) \times 10^{19}$ GeV [12]. The masses of the up-type quarks then follow from symmetry within Sequence 2 [10]. The mass of the up quark is given by

$$m_u = \alpha \left(\frac{\pi}{2}\right)^{-100} m_p = 2.18 \text{ MeV} \quad (3)$$

The superpartners of the electron and the up quark have both been identified, the partnerships being centred on Level 106.5 in Sequence 2 [4]. This level (a half-superlevel, scale 16 MeV) is coincident with the superlevel coincidence (42, 48) in Sequences 1 and 3, and lies at the centre of a symmetrical arrangement of coincident superlevels, within Sequences 1, 2 and 3, that extends over 35 orders of magnitude [5].

3. The charged leptons and their partners

The charged leptons are partnered by charged pseudoscalar mesons, the partnerships being arranged symmetrically about Type 1 superlevels, whose level-numbers are multiples of 3, in Sequences 1 and 2. The partnerships of the electron and muon with the K^- meson and the π^- meson, respectively, are shown in Figure 1. The electron and the K^- meson are shown arranged symmetrically about Level 42 in Sequence 1, while the muon and the π^- meson are shown arranged symmetrically about Level 102 in Sequence 2.

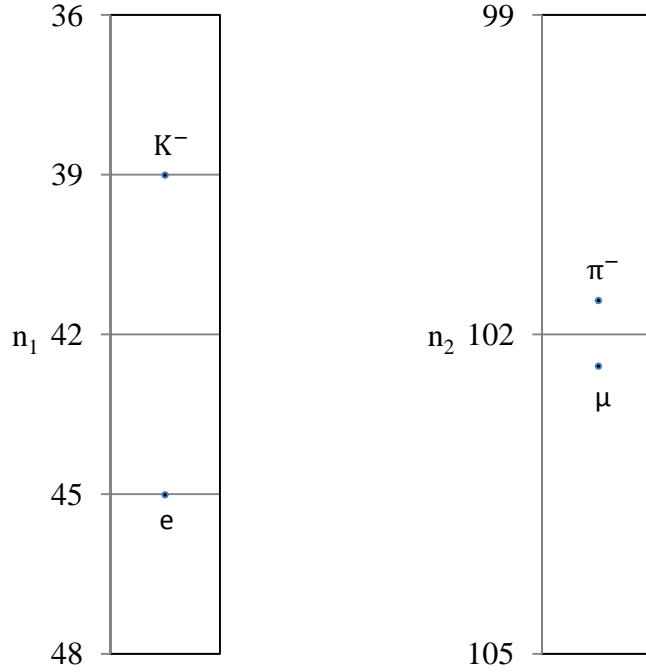


Figure 1: the electron and muon in symmetrical arrangement with the K^- and π^- pseudoscalar mesons, respectively, on the Type 1 superlevels of Sequences 1 and 2.

The coincidence (42, 106.5, 48), about which the lightest charged lepton and its spin-0 partner are arranged symmetrically, lies at the centre of a symmetrical pattern of triple Type 1 superlevel coincidences. The pattern, shown in Figure 2, was found by computing the ‘superlevel coincidence proximity’ at integer values of n_2 . For every such value of n_2 , each of the numbers n_1 , n_2 and n_3 is subtracted from the nearest integer that is a multiple of 3.² 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 electron and the K^- meson are associated with the two close triple Type 1 superlevel coincidences (45, 114, 51) and (39, 99, 45), respectively, which lie either side of Level 106.5 in Sequence 2. The values of n_2 for the two particles are 114.1 and 98.9. The mean value of n_2 is 106.5.

² n_1 and n_3 are calculated using the equations $n_1 = n_2 \ln(\pi/2) / \ln(\pi)$ and $n_3 = n_2 \ln(\pi/2)$

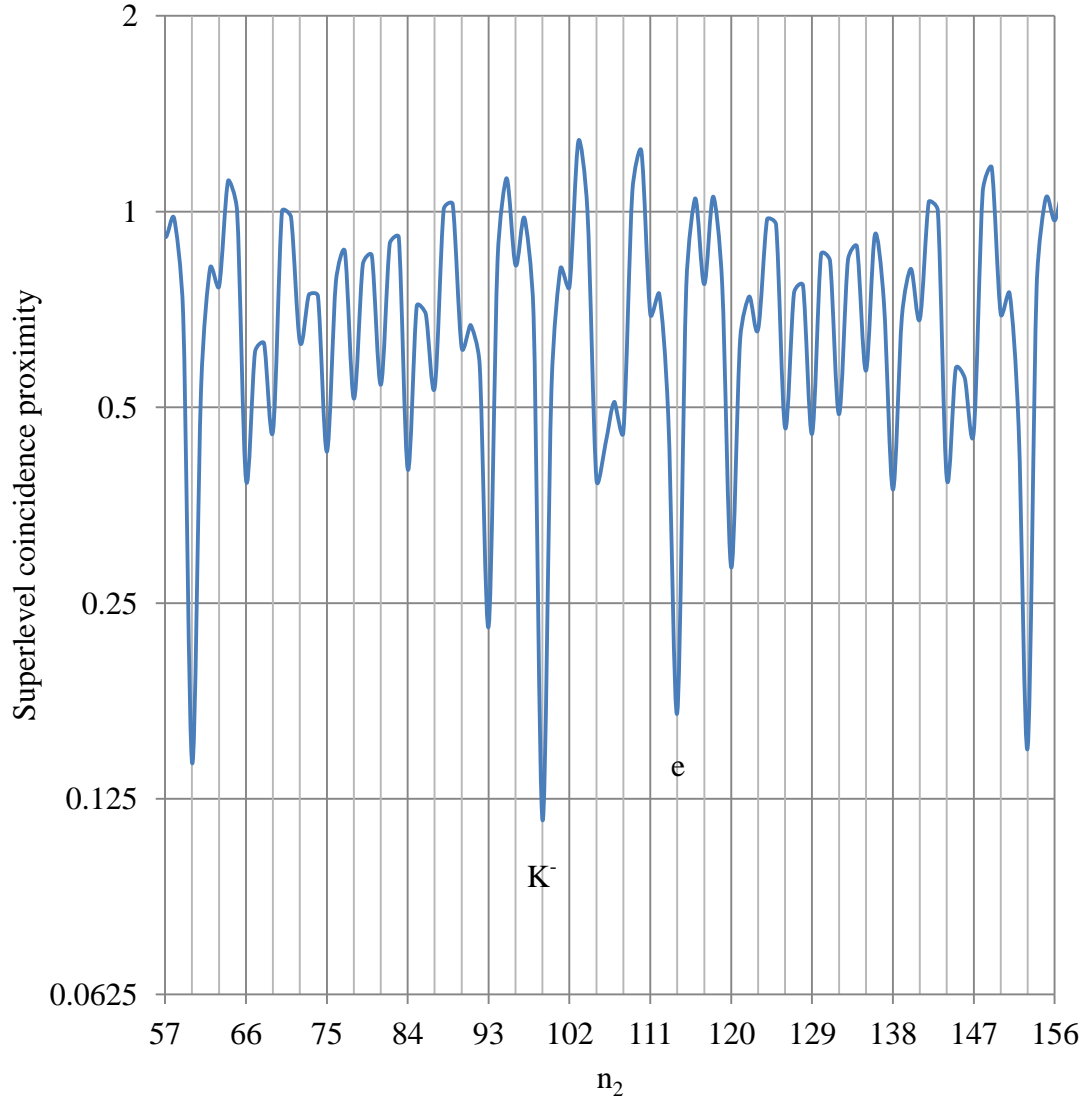


Figure 2: Triple Type 1 superlevel coincidences, shown in Sequence 2. Minima in superlevel coincidence proximity occur at coincident superlevels. The pattern is symmetrical about Level 106.5 in Sequence 2, which is coincident with (42, 48) in Sequences 1 and 3. The electron and its partner, the K^- meson, occupy closely coincident superlevels either side of Level 106.5.

4. The quarks and their partners

The up quark is partnered by the charged pion in association with the muon. The partnership is written as $u - (\mu - \pi^-)$. Like the partnership involving the lightest charged lepton, the partnership involving the lightest quark is arranged symmetrically about (42, 106.5, 48), at the centre of the symmetrical pattern of triple Type 1 superlevel coincidences, as shown in Figure 3.

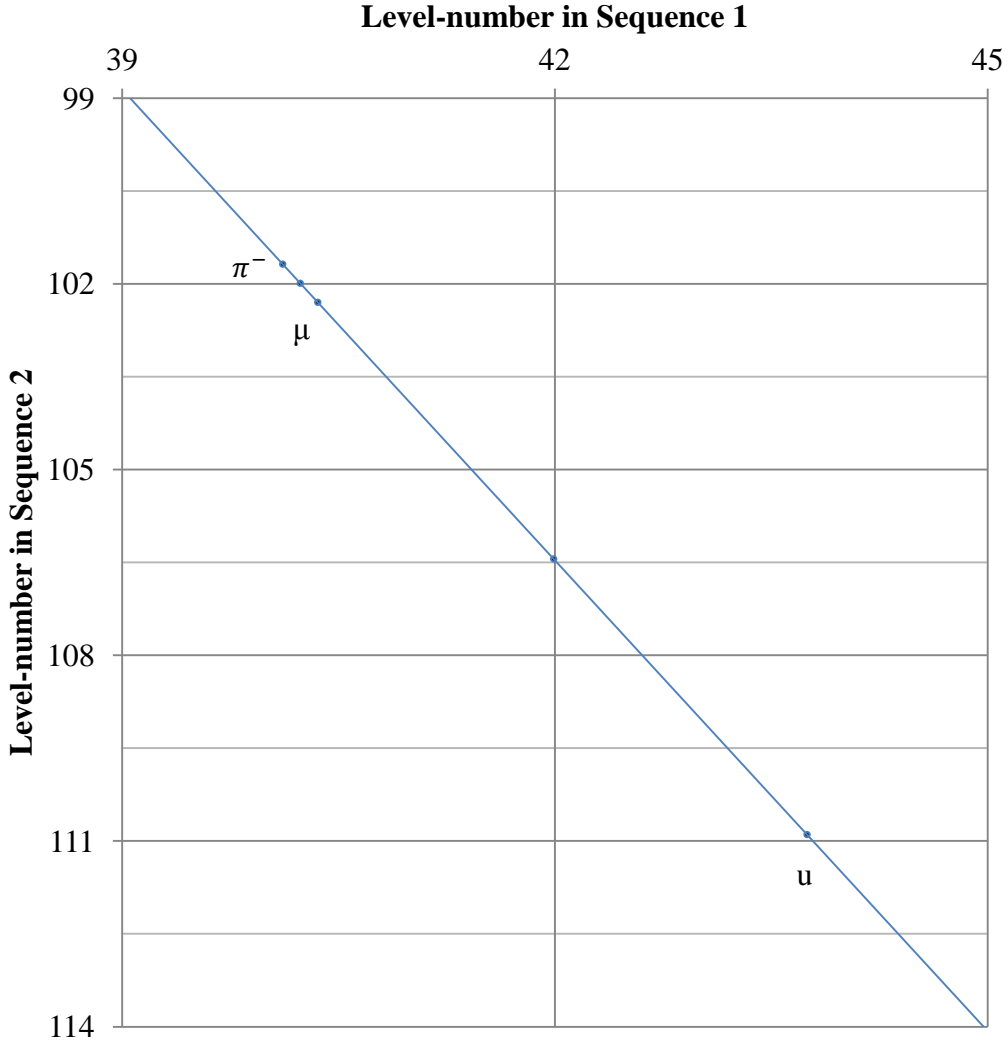


Figure 3: The up quark in partnership with the muon and charged pion on the Type 1 superlevels of Sequences 1 and 2. The $\mu - \pi^-$ partnership is represented in mass by the geometric mean of the two masses, which is marked with a dot. The $u - (\mu - \pi^-)$ partnership is centred on the superlevel/half-superlevel coincidence (42, 106.5) in Sequences 1 and 2, and on Level 48, a superlevel, in Sequence 2, as is the $e - K^-$ partnership. Particles are constrained to lie on the blue line since level-numbers in the two sequences are in constant ratio.

The (up-type) charm quark is partnered by the D^- meson in association with the tau lepton, while the down quark and (down-type) strange quark are partnered by the neutral pseudoscalar mesons η and η' , respectively [4]. Evidently, the electric charge on the quark is correlated with the nature of the partnership. All supersymmetric partnerships involving the quarks are arranged symmetrically about coincident mass levels and superlevels.

5. The conjectured 7.1 keV dark matter particle and its partner

The partnership of a 7.10 ± 0.05 keV dark matter fermion and a 35 ± 1 GeV dark matter scalar would, like the partnerships involving the lightest charged lepton and the lightest quark, be centred on (42, 106.5, 48) in Sequences 1, 2 and 3. The geometric mean of the two purported dark matter particle masses is 15.8 ± 0.3 MeV. The Level 106.5 mass is 15.85 MeV.

The three hypothesised supersymmetric relationships: $e - K^-$, $u - (\mu - \pi^-)$ and $X - X'$, where X is the 7.1 keV dark matter fermion and X' is its 35 GeV partner, are shown centred on (42, 48) within Sequences 1 and 3 in Figure 4.

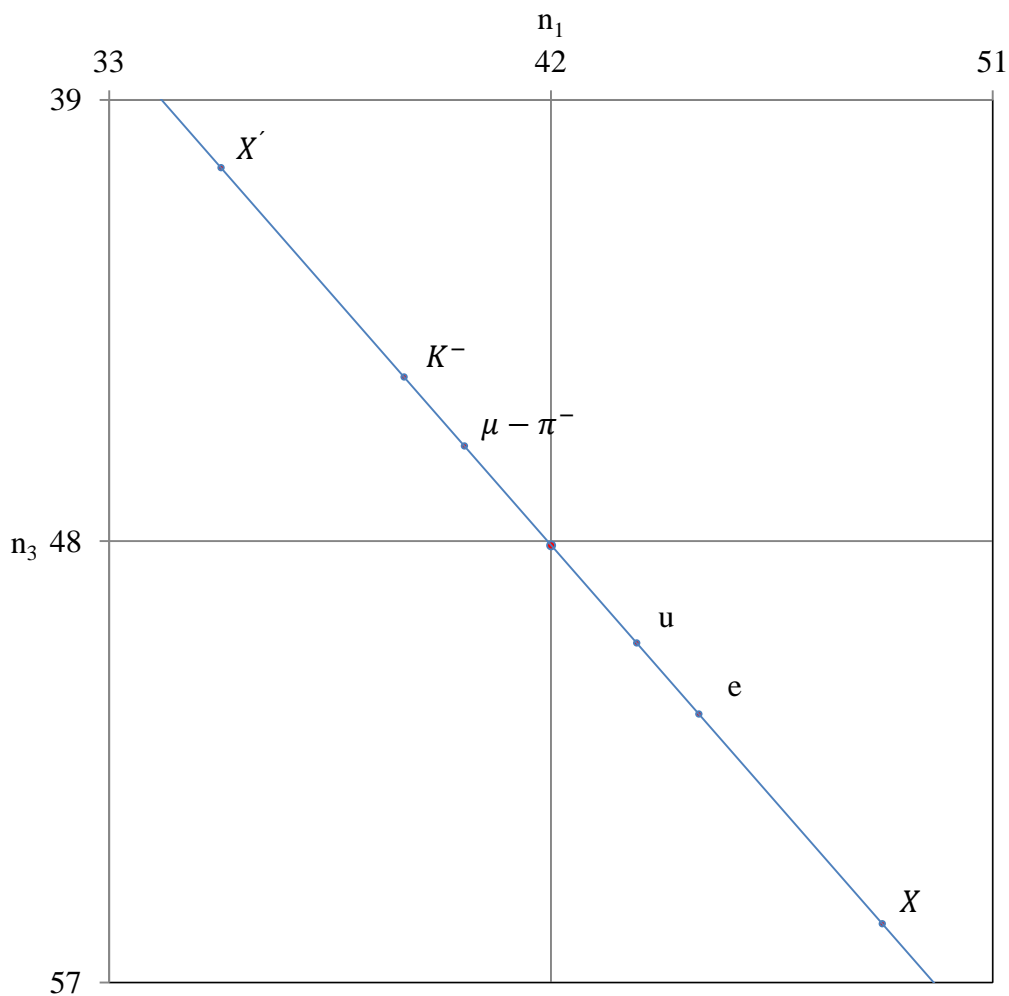


Figure 4: the electron, up quark and particle X (mass of 7.1 keV) in symmetrical arrangement with K^- , $\mu - \pi^-$ and X' (mass of 35 GeV), respectively, on the mass levels of Sequences 1 and 3. The red circle at (42, 48) marks the centre of each partnership. The $\mu - \pi^-$ partnership is represented by the geometric mean of the two masses.

6. The dynamical supersymmetry-breaking scale Λ

The lightest charged lepton and quark, and perhaps also the lightest right-handed neutrino, result from supersymmetry-breaking at the scale $m_{SUSY} = 16$ MeV. If we assume that the breaking of supersymmetry is communicated from a dynamical supersymmetry-breaking scale Λ , where

$$\Lambda = (m_{SUSY}m_P)^{1/2} \quad (4)$$

then we find that Λ has the value 4.4×10^8 GeV, which lies upon the close triple Type 1 superlevel coincidence (21, 54, 24), as shown in Figure 5. Curiously, the coincidence (21, 54, 24) is located equivalently to the electron, which lies upon the coincidence (45, 114, 51), within the repeating pattern of triple Type 1 superlevel coincidences.

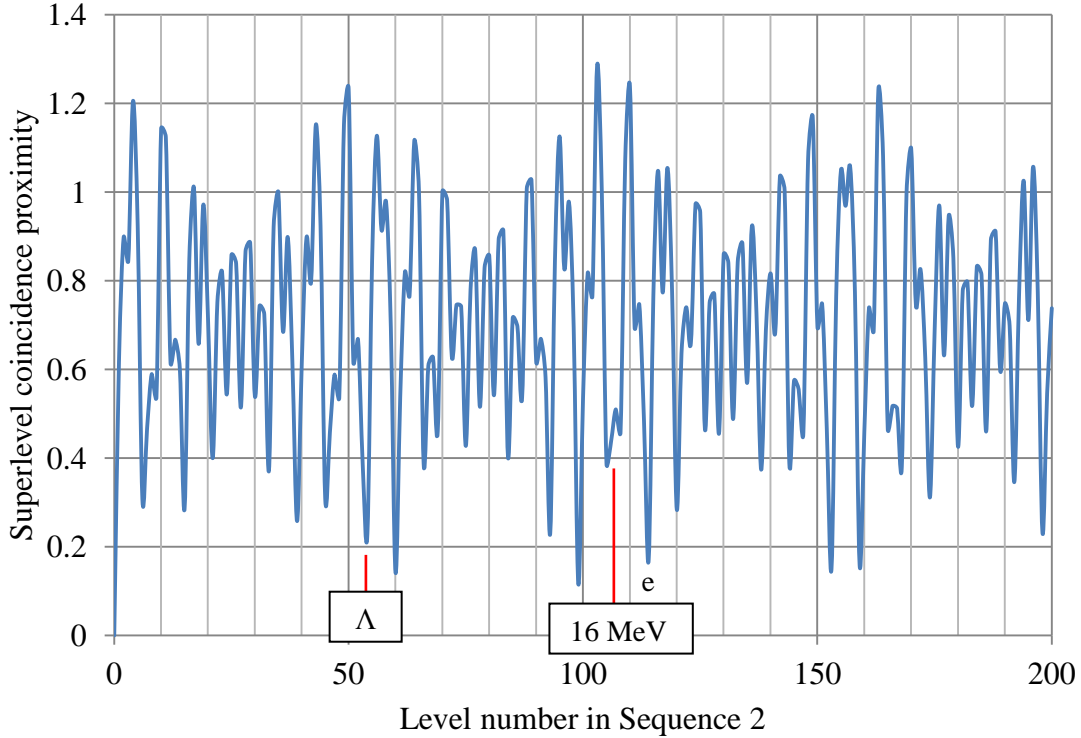


Figure 5: Supersymmetry-breaking scales within the pattern of triple Type 1 superlevel coincidences, shown within Sequence 2

Since m_{SUSY} is highly coincident with (42, 48) in Sequences 1 and 3, as shown in Figure 4, Λ is highly coincident with (21, 24) in Sequence 1 and 3. The two scales are shown in Figure 6, within a symmetrical arrangement that includes the Planck scale on the superlevels of Sequences 1 and 3.

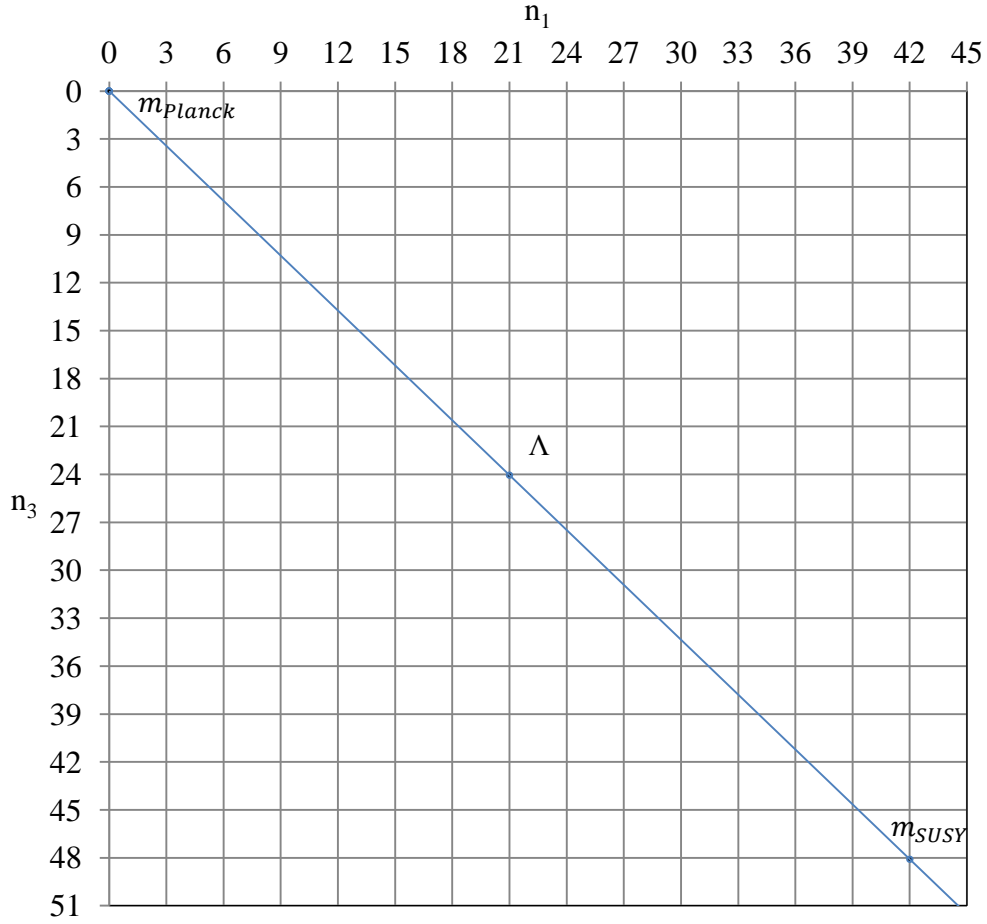


Figure 6: The dynamical supersymmetry-breaking scale Λ (4.4×10^8 GeV) and m_{SUSY} (16 MeV) on the Type 1 superlevels of Sequences 1 and 3

7. Quark-lepton symmetry

Particle X , of mass 7.10 ± 0.05 keV, is related in mass to the up quark through the equation

$$\frac{m_X}{m_u} = \pi^{-5.002(6)} \quad (5)$$

The up and down quarks, the electron and the conjectured particle X participate in a symmetrical pair of relationships:

$$\frac{m_e}{m_d} = \left(\frac{\pi}{2}\right)^{-5}; \quad \frac{m_X}{m_u} = \pi^{-5} \quad (6)$$

The first of these relationships, between the mass of the electron and the mass of the down quark, arises from symmetry between the electron and the up quark, and between the up and down quarks [13]. The four particles of (2) are shown upon the mass levels of Sequences 1

and 2 in Figure 7. Note the 2-fold rotational symmetry relating the electron and the up quark within the space delineated by Sequences 1 and 2.

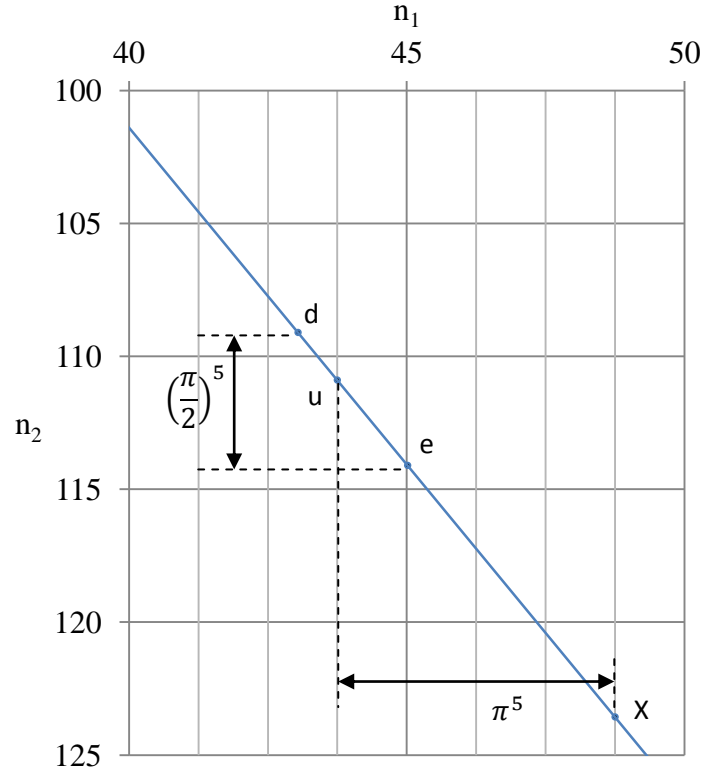


Figure 7: The locations of the up and down quarks, the electron and particle X within Sequences 1 and 2.

The mass of particle X is given by

$$m_X = \alpha \left(\frac{\pi}{2}\right)^{-100} \pi^{-5} m_P = 7.11 \text{ keV} \quad (7)$$

From the symmetrical arrangement of X and X' about Level 106.5 in Sequence 2, the mass of X' is given by

$$m_{X'} = \alpha^{-1} \left(\frac{\pi}{2}\right)^{-113} \pi^5 m_P = 35.3 \text{ GeV} \quad (8)$$

8. Masses of the Standard Model particles

Equations for the GUT scale and the electron mass [14], the up-type quark masses [10], the mass of the conjectured dark matter fermion, particle X, and the mass of the Z^0 vector boson are shown below. The masses of the down-type quarks follow from those of the up-type

quarks through symmetry in Sequences 2 and 3 [10]. The left-handed electron neutrino has been conjectured to occupy the close Type 1 superlevel coincidence (60, 153, 69) and to have the mass 10.9 meV [4].

$$m_{\text{GUT}} = \alpha^{-1} \left(\frac{\pi}{2}\right)^{-25} m_{\text{P}} = 2.09 \times 10^{16} \text{ GeV} \quad (9)$$

$$m_{\text{e}} = \alpha^{-1} \left(\frac{\pi}{2}\right)^{-125} m_{\text{P}} = 0.511 \text{ MeV} \quad (10)$$

$$m_{\text{X}} = \alpha \left(\frac{\pi}{2}\right)^{-100} \pi^{-5} m_{\text{P}} = 7.11 \text{ keV} \quad (11)$$

$$m_{\text{u}} = \alpha \left(\frac{\pi}{2}\right)^{-100} m_{\text{P}} = 2.18 \text{ MeV} \quad (12)$$

$$m_{\text{c}} = \alpha^2 \left(\frac{\pi}{2}\right)^{-75} m_{\text{P}} = 1.27 \text{ GeV} \quad (13)$$

$$m_{\text{t}} = \alpha \left(\frac{\pi}{2}\right)^{-75} m_{\text{P}} = 174 \text{ GeV} \quad (14)$$

$$m_{\text{Z}} = \left(\frac{\pi}{2}\right)^{-100} \pi^5 m_{\text{P}} = 91.2 \text{ GeV} \quad (15)$$

9. Conclusions

The purported dark matter particles with masses of 7.1 keV and 35 GeV are arranged symmetrically about the precise centre of a symmetrical pattern of coincident mass levels within the Supersymmetric Planck Model, as are the electron and its conjectured superpartner, and the up quark partnership.

The supersymmetry-breaking scale, $m_{\text{SUSY}} = 16 \text{ MeV}$, is associated with the lightest fundamental fermions. This low-energy supersymmetry-breaking is communicated from a dynamical supersymmetry-breaking scale $\Lambda = 4.4 \times 10^8 \text{ GeV}$. Both scales lie at highly symmetrical locations within the mass level network of the Supersymmetric Planck Model.

Supersymmetry-breaking occurs on many mass scales. The supersymmetry is broken on superlevels, levels and sub-levels. Coincident mass levels indicate favourable supersymmetry-breaking scales.

From its symmetry with the electron and up quark, and their partners, the 7.1 keV particle is a fermion, while the 35 GeV particle is a scalar.

The mass (7.11 keV) of the dark matter fermion is given by a simple equation, which is in line with those for the other fundamental fermions. The dark matter scalar is of mass 35.3 GeV.

The electron and up quark are arranged symmetrically on the mass levels of the Supersymmetric Planck Model.

10. References

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