

Phenomena of TeV-Scale Left-Right Supersymmetry

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A 1.5 TeV gluino and 35 TeV gravitino occupy mass/energy levels that descend from GUT scale and are incorporated within the sequences of the left-right symmetric Planck Model. The gluino is located in relation to both left and right-handed Higgs VEVs. Spin-3/2 baryon resonances occupy levels that descend from the gravitino mass and are incorporated within the Planck sequences. A symmetric arrangement of particles encompasses the Z' boson and the up-down quark doublet on the mass/energy levels.

Based on a calculated central value of 35 TeV for the gravitino mass, Ellis, Kane and Zheng [1] have predicted the gluino mass to be about 1.5 TeV in a top-down compactified M-theory approach of manifest relevance to the Planck Model [2, 3] and its left-right symmetric extension [4]. The left-right symmetric Planck Model was constructed on the basis of an analysis by Motl [5], which explained hints of certain signals seen at the LHC by a left-right symmetric extension of the Standard Model in which W' is of mass 2.1 TeV, Z' is of mass 2.9 TeV, H' is of mass 5.2 TeV and the right-handed Higgs VEV is about 7.7 TeV. In the left-right symmetric Planck Model, the two VEVs are related in size to each other and to GUT scale and, together the W - Z and W' - Z' doublets¹, lie on coincident mass/energy levels within two geometric sequences that are incorporated within the Planck sequences (of which see below). In this note, a 35 TeV gravitino and 1.5 TeV gluino are added to the Planck Model.

In the Planck Model, mass/energy levels descend in geometric sequence from Planck scale, 1.220910×10^{19} GeV [6]. There are three sequences: Sequence 1 of common ratio $1/\pi$, Sequence 2 of common ratio $2/\pi$ and Sequence 3 of common ratio $1/e$. The levels of each sequence number from Planck scale ($n=0$). In addition to levels of integer level-number, sublevels of fractional level-number also exist, e.g. half-levels and quarter-levels. Mass/energy scales are shown plotted within two-dimensional representations of the level structure. Since the level-numbers in the three sequences are in constant ratio, mass/energy scales will lie on a straight line in each representation. Where available, the values of particle mass used here are the evaluations of the Particle Data Group [7].

The left and right sectors of the model are shown in Figure 1 on mass/energy levels that descend from Planck scale. The scales shown coincide with the levels and half-levels of Sequence 2. A conjectured particle, or doublet, is included in the sequence: its mass was derived in [8]. The same scales are shown in Figure 2 on levels that descend from GUT scale and are incorporated within the Planck

¹ The Planck Model does not distinguish between W^+ and W^- .

sequences; now, the scales coincide with levels within Sequence 1. The 35 TeV gravitino is included in Figure 2: it occupies a level that is incorporated within Sequence 2.

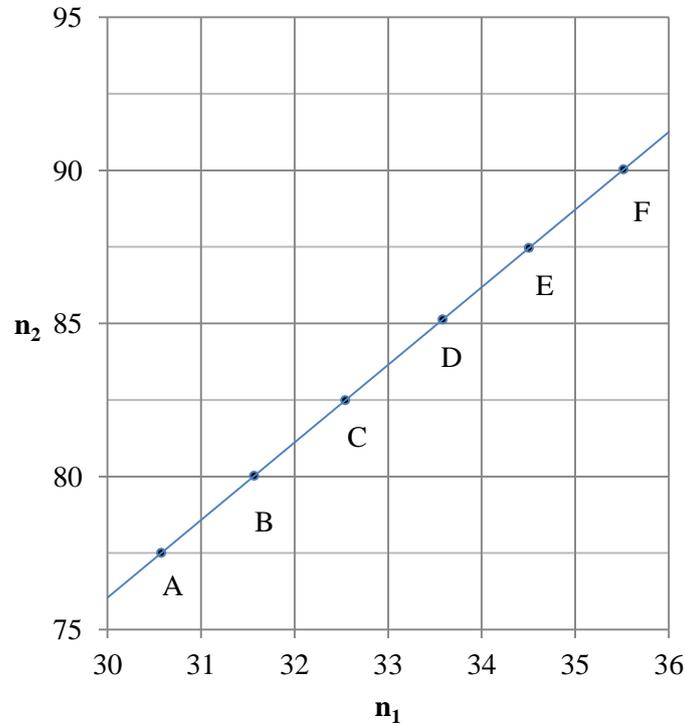


Figure 1: The left and right sectors of the model on the mass/energy levels (and sublevels) of Sequences 1 and 2, which descend from Planck scale with common ratio $1/\pi$ and $2/\pi$, respectively. A doublet is represented by the geometric mean of the two masses.

- A ν_R , 7.7 TeV
- B W'-Z', 2.5 TeV
- C Conjectured particle(s), 0.81 TeV [8]
- D ν_L , 246 GeV
- E W-Z, 85.6 GeV
- F b-t, 26.9 GeV

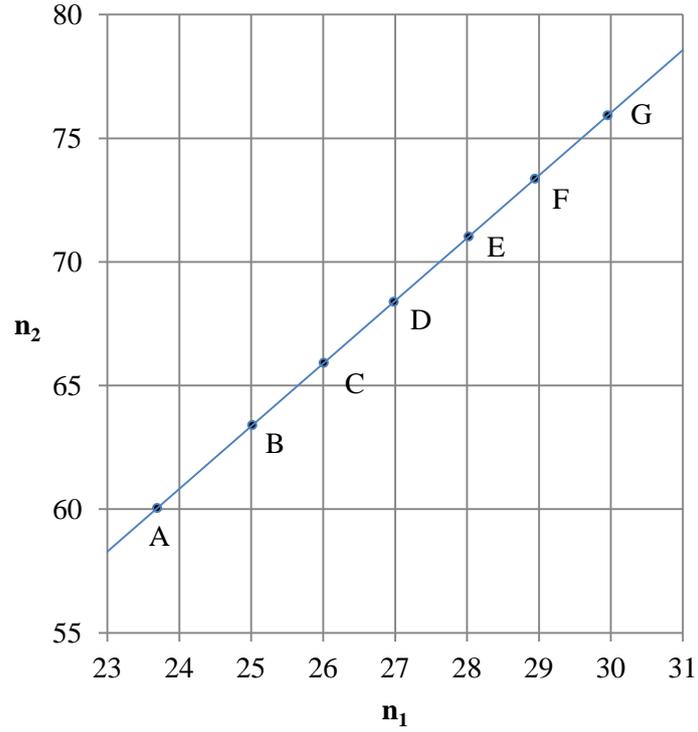


Figure 2: The left and right sectors of the model on mass/energy levels that descend from GUT scale (2.1×10^{19} GeV) in geometric sequences of common ratio $1/\pi$ and $2/\pi$, i.e. they are incorporated within Sequences 1 and 2. The 35 TeV gravitino is included.

- | | |
|---|---------------------------------------|
| A | \tilde{G} , 35 TeV |
| B | ν_R , 7.7 TeV |
| C | W'-Z', 2.5 TeV |
| D | Conjectured particle(s), 0.81 TeV [8] |
| E | ν_L , 246 GeV |
| F | W-Z, 85.6 GeV |
| G | b-t, 26.9 GeV |

The 1.5 TeV gluino lies on a level in Sequence 1, between the left and right-handed VEVs, as shown in Figure 3. The same scales are shown in Figure 4 on levels that descend from GUT scale, and are incorporated within the Planck sequences; now, the gluino occupies a level within Sequence 2.

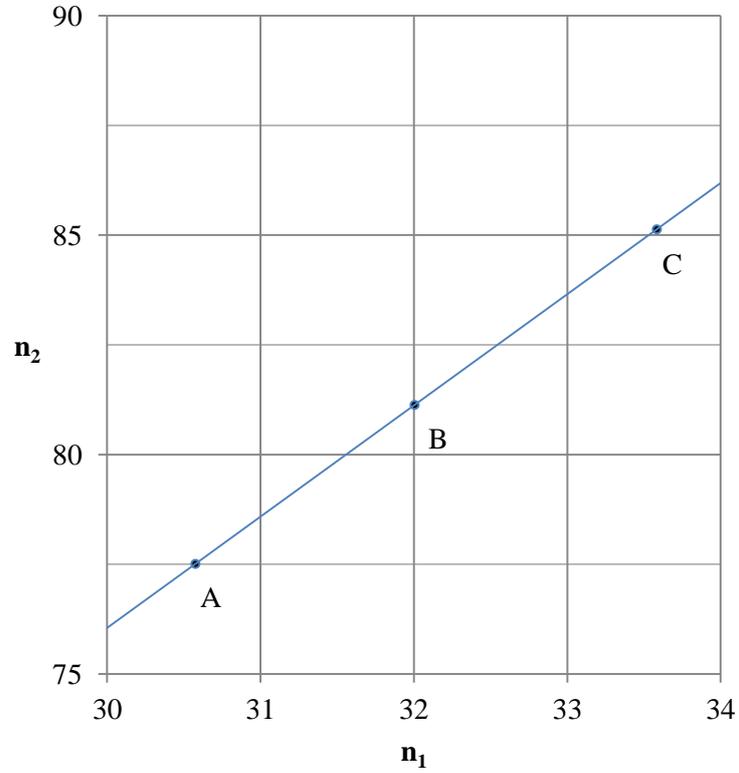


Figure 3: The gluino in relation to the left and right-handed Higgs VEVs on the mass/energy levels (and sublevels) of Sequences 1 and 2, which descend from Planck scale with common ratio $1/\pi$ and $2/\pi$, respectively.

- | | |
|---|-----------------------|
| A | ν_R , 7.7 TeV |
| B | \tilde{g} , 1.5 TeV |
| C | ν_L , 246 GeV |

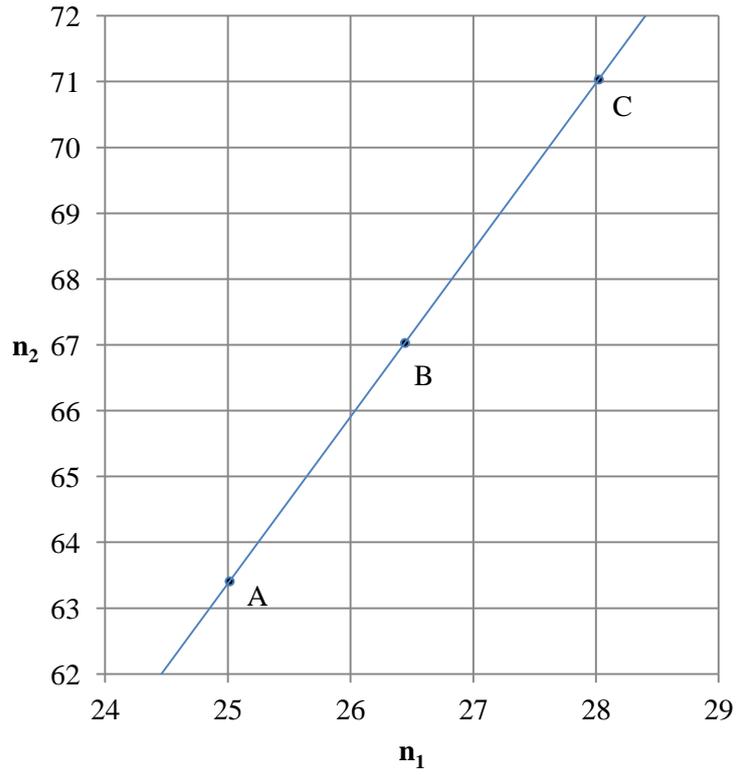


Figure 4: The gluino in relation to the left and right-handed Higgs VEVs on mass/energy levels that descend from GUT scale in geometric sequences of common ratio $1/\pi$ and $2/\pi$, i.e. they are incorporated within Sequences 1 and 2.

- | | |
|---|------------------------------|
| A | $\nu_R, 7.7 \text{ TeV}$ |
| B | $\tilde{g}, 1.5 \text{ TeV}$ |
| C | $\nu_L, 246 \text{ GeV}$ |

Narrow spin-3/2 N , Δ , Λ , Λ_c and Λ_b baryon resonances are shown in Figure 5 on mass/energy levels (and sublevels) that descend from the gravitino mass in geometric sequences of common ratio $2/\pi$ and $1/e$, i.e. they are incorporated within Sequences 2 and 3. Other spin-3/2 resonances seem to occupy higher order sublevels, e.g. $1/32$ -levels.

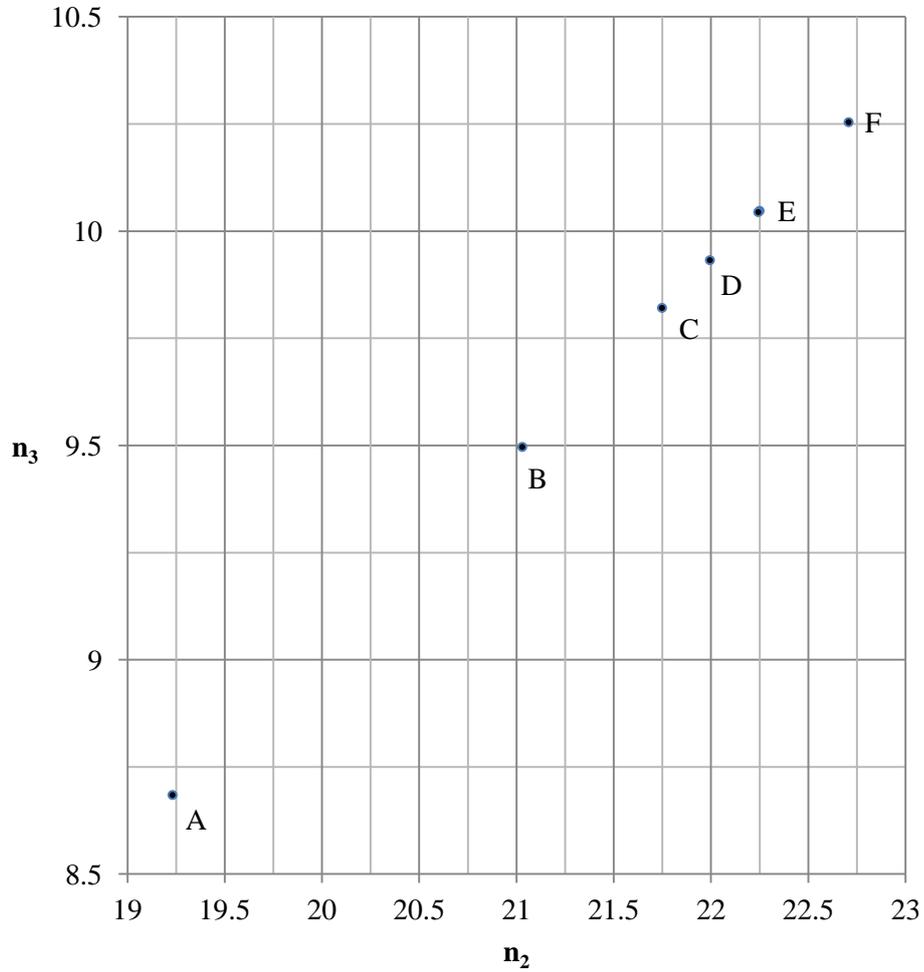


Figure 5: Spin-3/2 N , Δ , Λ , Λ_c and Λ_b baryon resonances on levels (and sublevels) that descend from 35.0 TeV in geometric sequences of common ratio $2/\pi$ and $1/e$. All N and Δ resonances of Breit-Wigner full width ≤ 200 MeV and the lightest Λ , Λ_c and Λ_b baryons are shown.

A	$\Lambda_b(5920)^0$, 5920 MeV
B	$\Lambda_c(2625)^+$, 2628 MeV
C	$N(1900)$, 1900 MeV
D	$N(1700)$, 1700 MeV
E	$N(1520)$, 1515 MeV; $\Lambda(1520)$, 1520 MeV
F	$\Delta(1232)$, 1232 MeV

Two geometric sequences, of common ratio $1/\pi$ and $2/\pi$, descend from 2.9 TeV, the Z' mass, and contain the Z boson, the quarks in doublets, ground state flavourless vector mesons and the muon, on coincident levels and sublevels, as shown in Figure 6.

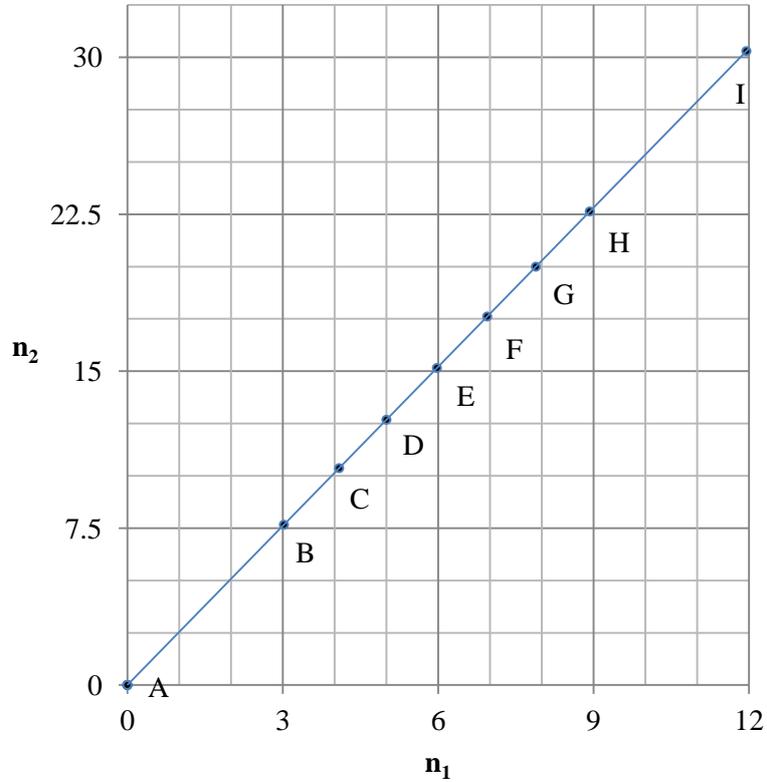


Figure 6: Particles of the Standard Model in symmetric arrangement on levels (and sublevels) that descend from 2.9 TeV in geometric sequences of common ratio $1/\pi$ and $2/\pi$, i.e. they are incorporated within Sequences 1 and 2.

A	Z' , 2.9 TeV
B	Z , 91.2 GeV
C	b-t, 26.9 GeV
D	Υ ($b\bar{b}$), 9460 MeV
E	J/Ψ ($c\bar{c}$), 3097 MeV
F	ϕ ($s\bar{s}$), 1019 MeV
G	s-c, 348 MeV
H	μ , 106 MeV
I	u-d, 3.3 MeV

The arrangement of particles displayed in Figure 6, without the Z' boson and the quarks but with the B_s^* vector meson and the tau lepton, was found early in this project on the levels and sublevels of a sequence of common ratio $2/\pi$ that encompasses the Z boson and the muon [9]. The particles in that early arrangement are now known to occupy coincident levels and sublevels within the arrangement of Figure 6, as shown in Figure 7.

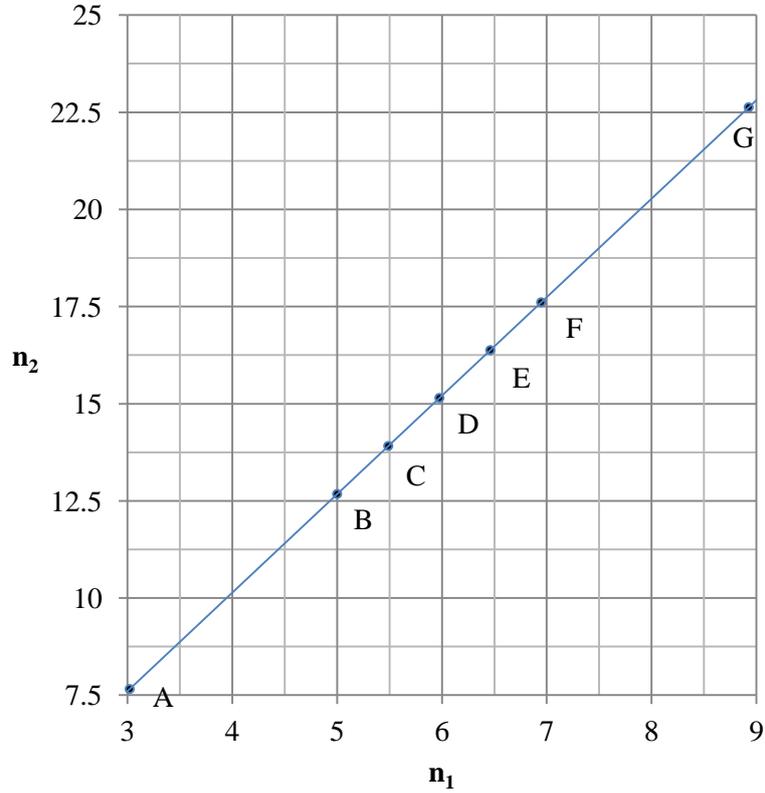


Figure 7: Detail of Figure 6, including the B_s^* vector meson and the tau lepton. Particles of the Standard Model in symmetric arrangement on levels (and sublevels) that descend from 2.9 TeV (the Z' boson mass) in geometric sequences of common ratio $1/\pi$ and $2/\pi$.

A	Z , 91.2 GeV
B	$\Upsilon (b\bar{b})$, 9460 MeV
C	$B_s^* (s\bar{b})$, 5415 MeV
D	$J/\Psi (c\bar{c})$, 3097 MeV
E	τ , 1777 MeV
F	$\phi (s\bar{s})$, 1019 MeV
G	μ , 106 MeV

Two particle mass relationships, first revealed in [9], are apparent from the arrangement of Figure 7:

$$m_\tau = (m_\phi m_{J/\psi})^{1/2} \quad (1)$$

$$m_\mu = \left(\frac{\pi}{2}\right)^{-25/4} m_\tau \quad (2)$$

The masses of both muon and tau lepton are related to the masses of vector mesons. The two charged leptons complement the symmetrical arrangement of vector states. The mass of the electron is related to Planck scale [3]:

$$m_e = \alpha^{-1} \left(\frac{\pi}{2}\right)^{-125} m_{\text{Planck}} \quad (3)$$

I would encourage the reader to validate (1), (2) and (3) for themselves. The mass of the electron is also related to GUT scale [3]:

$$m_e = \left(\frac{\pi}{2}\right)^{-100} m_{\text{GUT}} \quad (4)$$

The scale, ~2300 TeV, of electroweak symmetry breaking, calculated by applying the 10D/4D correspondence to the Big Bang [10], is shown in Figure 8 on mass/energy levels that descend from Planck scale. The scale of electroweak symmetry breaking coincides with Level 65 in Sequence 2.

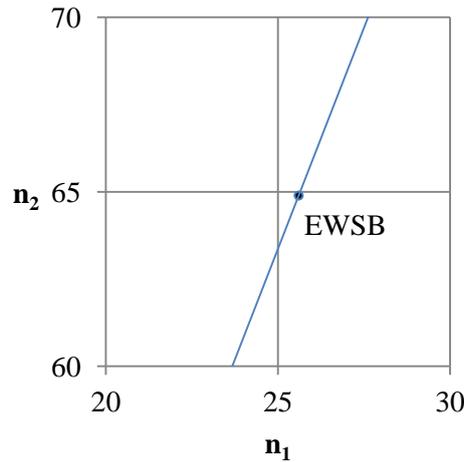


Figure 8: The scale (2300 TeV) of electroweak symmetry breaking on the mass/energy levels of Sequences 1 and 2, which descend from Planck scale with common ratio $1/\pi$ and $2/\pi$, respectively.

The scale of electroweak symmetry breaking is shown in relation to the electron on mass/energy levels that descend from GUT scale and are incorporated within the Planck sequences in Figure 9. It is clear that $m_{EWSB} \sim \pi^{-20} m_{GUT} \sim (\pi/2)^{-50} m_{GUT}$.

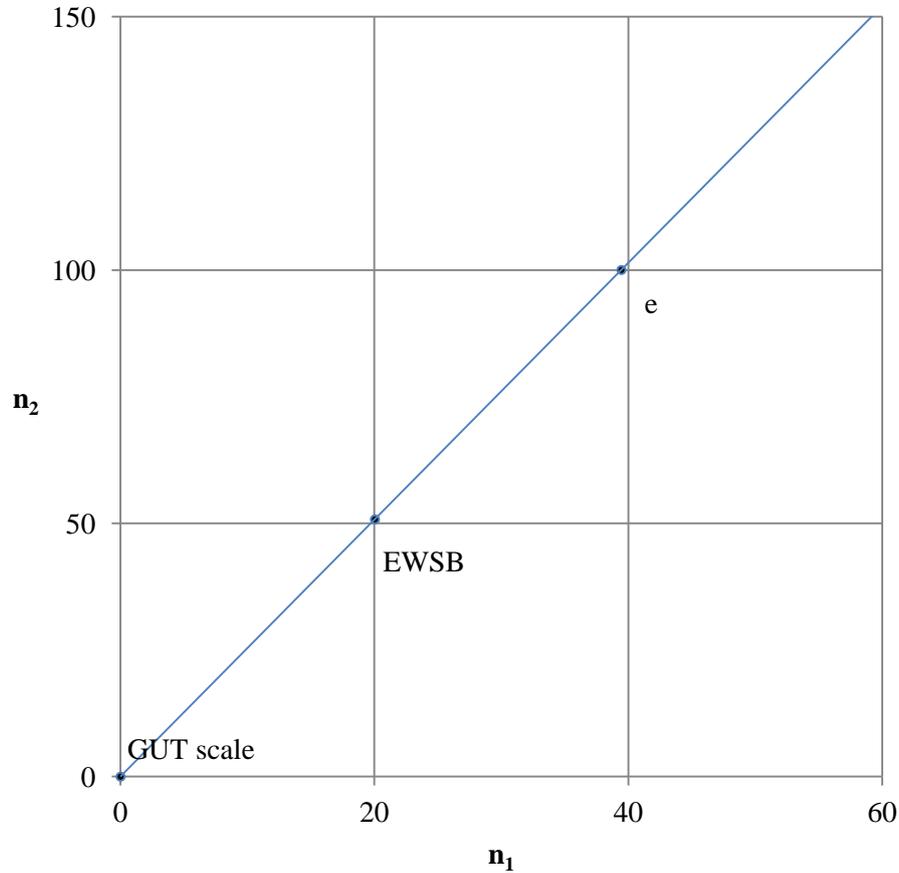


Figure 8: The scale (2300 TeV) of electroweak symmetry breaking and the electron on mass/energy levels that descend from GUT scale (2.1×10^{19} GeV) in geometric sequences of common ratio $1/\pi$ and $2/\pi$, i.e. they are incorporated within Sequences 1 and 2.

References

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