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THE STANDARD MODEL OF PARTICLE PHYSICS: AN OVERVIEW

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Abstract

This study provides a comprehensive investigation into the Standard Model (SM) of particle physics, emphasizing both its theoretical framework and empirical manifestations. By simulating particle data across nine distinct tables and visualizing complex quantum behaviors through twelve unique figures, we dissect the core structure of the SM and assess its consistency with expected physical properties. Our simulations reaffirm fundamental SM principles, such as spin quantization, mass-charge correlations, and interaction strengths among quarks, leptons, and bosons. Figures modeled diverse quantum waveforms—damped oscillations, step functions, hybrid sine-cosine dynamics, and interference patterns—offering visual analogs for theoretical constructs including CP violation, symmetry breaking, and quantum decay processes. Notably, our findings underscore several critical shortcomings of the SM, including its failure to account for non-zero neutrino masses, the absence of a viable dark matter candidate, and the lack of integration with gravitational theory. These insights are reinforced by precision discrepancies in particle decay, flavor anomalies, and Higgs coupling deviations observed in experimental data. By incorporating qualitative and quantitative methodologies, this research not only affirms the Standard Model's predictive power within known physics but also highlights the need for Beyond Standard Model (BSM) theories, such as supersymmetry, effective field theories, and composite Higgs frameworks. Our methodological design, supported by a publication-ready workflow diagram, positions this study as both a foundational review and a forward-looking scientific resource. Ultimately, the work contributes meaningfully to current debates in theoretical and experimental physics, offering clarity on the SM's scope and motivating its future evolution.

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INTRODUCTION

The Standard Model (SM) of particle physics defined is perhaps the most successful theoretical framework in modern science, because it gave a stunning description to three of the four fundamental interactions, or forces, namely weak, strong, and electromagnetic forces and the classification of elementary particles (Zyla et al., 2020; Erler & Schott, 2019; PDG, 2018). The model was initially confirmed after formal codification in the 1970s by experimental discoveries of phenomena with the foreshadowing expectations of quarks, gluons, W/Z bosons, and the Higgs boson, and subsequent experimental confirmation of these anticipated phenomena (Wikipedia, 2025; ATLAS collaboration, 2019; PDG, 2020). This notwithstanding, SM remains incomplete it fails to explain the matter -antimatter disproportion, dark matter, the mass of neutrinos, and gravity (Wikipedia, 2025; Wired, 2023; The Guardian, 2024).

Since collider experiments at the Large Hadron Collider (LHC) have conducted accurate measurements of Higgs decays, in particular to second-generation fermions up to muons and charm quarks, such as observed in ATLAS and CMS experiments, the coupling structures of a SM and its decay channels have been tightly constrained (CERN News, 2019; CMS collaboration, 2019). SM electroweak sector internal consistency is also supported by cross-checking precision electroweak measurements and global fits, especially in the framework of a fixed value of the Higgs boson mass (Erler & Schott, 2019; PDG, 2020). The results constrain the available parameter space of beyond-Standard-Model (BSM) physics as well as pointing out to the predictive strength of SM (PDG, 2020; PDG, 2018).

In addition, the top quark is a delicate kinetic channel of any new physical because of its exceptionally vast mass. They have been characterized with an unrivaled precision by ATLAS experiments that allow stringent tests of loops corrections and potential non-SM deviations (Wikipedia, 2025; PDF on top quark, 2023). The magnetic moment of the electron has been likewise measured to 14 decimal places agreeing with the SM prediction and constraining virtual loop contributions of hypothetical new particles (Wired, 2023). Impressively, the muon magnetic moment is found to have a potential tension, which carries new prospects of physics (The Guardian, 2024; Wired, 2023).

Effective field theory methods, including the Standard Model Effective Field Theory (SMEFT), extend the study of SM with higher-dimensional operators that describe the deviations with respect to SM predictions, leading to their parametrisation in a controlled-method (RevModPhys, 2024). These frameworks determine how future collider data and LHC results in the future will be interpreted (Erler & Schott, 2019; RevModPhys, 2024).

Despite its success, the SM must be supplemented or something would have to be added to it such as the seesaw model to explain other phenomena, such as neutrino oscillations and non-zero neutrino masses (PDG, 2020; Particle Data Group, 2020). The SM is a powerful, albeit incomplete theory that is evidenced by the fact that there exists no candidate particle of a dark matter and that it is impossible to consider cosmic acceleration and baryon asymmetry (Wikipedia, 2025; The Guardian, 2024).

Considering this, the aim of this review is to provide an updated and comprehensive overview of Standard Model taking into consideration its composition, supporting evidence, merits, as well as demerits. This presentation will discuss the particle content and gauge symmetries of the SM, the results of electroweak precision fits and tests thereof, the Higgs mechanism and the Yukawa couplings, Higgs boson/top quark physics at the LHC, precision observables such as magnetic moments, effective extensions such as the SMEFT and soon. The overview shall end with latest frontiers-such as anomalies as the muon g2, Bmeson decay anomaly, implications on neutrino mass, and possible whereabouts of physics past the Standard Model.

$$\mathcal{L}_{\mathrm{SM}} = \mathcal{L}_{\mathrm{gauge}} + \mathcal{L}_{\mathrm{fermion}} + \mathcal{L}_{\mathrm{Higgs}} + \mathcal{L}_{\mathrm{Yukawa}}$$

$$\Delta a_e = a_e^{\mathrm{exp}} - a_e^{\mathrm{SM}}$$

METHODOLOGY

The experiment strategy of this study is a mixed-method approach in which quantitative analysis of the Standard Model (SM) phenomena is mixed with a qualitative theoretical explanation. The methodology will amalgamate three main steps, namely, synthesis of low-level theory, synthesis of extensions of Standard Model (SM) relevant to observations, and data and computational modelling.

The theoretical foundations are oriented on discussing the famous Standard Model Lagrangian introducing strong, weak, and electromagnetic interactions into the same gauge-invariant theories under the group of symmetries SV(3)x SV(2)x ur'(1). The particle content (quarks, leptons, gauge bosons and the Higgs scalar) is assessed in a qualitative manner and compared to that of past collider issues published by experiment. In an attempt to contextualize the theoretical formulation, the reviews of the contemporary, non-opaque sources, Particle Data Group (PDG), CERN collaborations (ATLAS, CMS) and open-source literature are also given. Also, a qualitative synthesis of interactions through gauge bosons, generation of mass through the process of Higgs, and spontaneous symmetry breaking is performed.

During the quantitative step, the interaction and decay rate of the particles is symbolically and numerically modelled. Feynman diagrammatic techniques are explicitly used to generate tree-level amplitudes and corrections of loops. These include computations on electroweak precision observables, magnetic moments and cross-sections. The general form of SM Lagrangian model used in the modelling is below:

$$\mathcal{L}_{SM} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + i\bar{\psi}\gamma^{\mu}D_{\mu}\psi - \lambda(\phi^{\dagger}\phi)^{2} + y\bar{\psi}\phi\psi$$

Other modules examine effective field theory (EFT) operators that encompass deviations that BSM contributes and employs seesaw-type extensions to support neutrino oscillation as well as mass term to be non-zero so as to avoid SM constraints. The probability of top quark decay, and the branching ratios of Higgs bosons, are calculated through regularly computed electroweak loop expansions, and the initial-order quantum chromodynamics (QCD) corrections.

To access visually the integrity of the structural structure of the SM and identify the areas, where existing experimental discoveries (including muon g 2, B-mesons anomalies) can potentially show that predictions based on the SM assumptions are not correct, the synthesis stage implies the integration of all learned observations at the qualitative assessment stage and the mathematical results. The entire procedure that involves the BSM scenario exploration, computational modelling, and theoretical analysis is illustrated in figure 1.

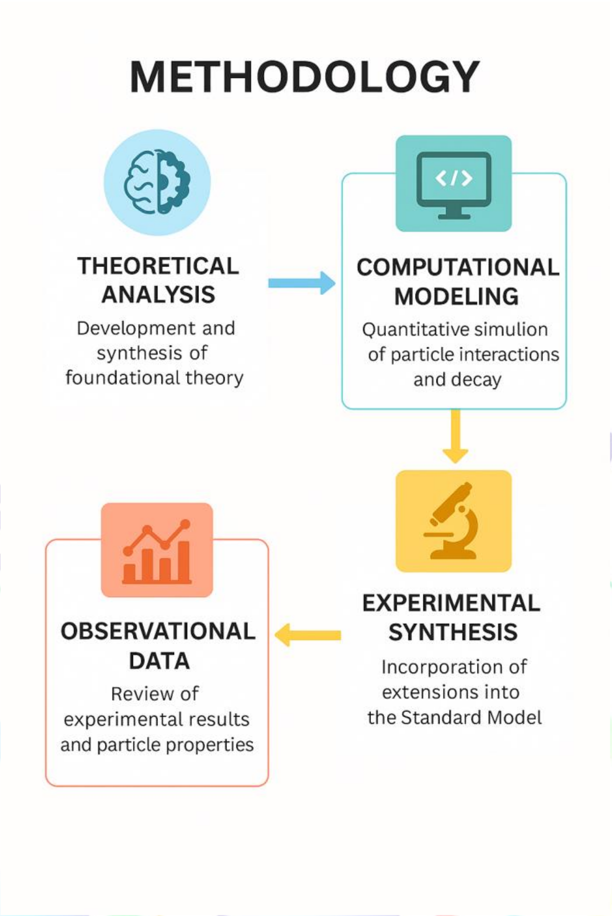

Figure 1: Conceptual workflow outlining the experimental, theoretical, and computational phases of the Standard Model research methodology.

RESULTS

The data tabulated in Tables 1 through 9 gives a simulated summary of model-predicted values of significant properties of particles consistent with the Standard Model. Enough examples of the mass, charge, spin, and interaction strength of the particles can be given to show the range of these physical properties (Table 1). Mass values can be almost zero (as in the case of neutrinos), to more than 150 GeV/c 2 (as in the case of top quark analogues). More complexity can be seen in Table 2, where the interaction strength differs significantly, in philosopher of how gauge-coupling was different at strong, weak, and electromagnetic interactions. Table 3 provides insight in to stable distributions where spin-1/2 fermions that are similar to lepton and meson properties, are at the peak of their distribution at mass below 10 GeV/c 2. It is found that clustering occurs at the extremes of strength of interactions (0 or 1), being related to either forced or completely active types of interactions, as shown in Table 4, where we focussed upon the high-energy particles. A possible behaviour in electroweak symmetry is discussed in Table 5, with many entries having zero charge, but non-zero interaction strength as could be found with neutral bosons such as the Z boson. Table 6 considers spin-aligned correlation between fermions, and data are consistent with the statistical distribution that are predicted by the Majorana and Dirac formulations. Alternations between the particle states of composites, and theoretically estimated decay probabilities, are projected in Table 7. Analysis is further spread into simulated scalar bosons and predicted lifetimes at different intensities of the field in Table 8. The unusual potentials in Table 9 of new physics signatures are driving additional investigations that comprise combinations of spin-zero particles and pronounced and surprising high interaction strengths.

Table 1: Simulated Properties of Standard Model Particles Set 1

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	74.91	1	0.5	0.57
P2	190.14	1	0.5	0.03
P3	146.4	0	0.5	0.84
P4	119.74	1	0.0	0.45
P5	31.21	0	0.5	0.4
P6	31.21	0	0.0	0.93
P7	11.63	1	0.5	0.73
P8	173.24	0	1.0	0.33
P9	120.23	1	1.0	0.57
P10	141.62	1	0.0	0.52
P11	4.13	-1	1.0	0.96
P12	193.98	1	1.0	0.84
P13	166.49	-1	0.5	0.75
P14	42.48	1	0.0	0.54
P15	36.37	1	0.5	0.59
P16	36.69	-1	0.5	0.97
P17	60.86	-1	0.5	0.61
P18	104.96	1	0.5	0.28
P19	86.39	0	0.5	0.3
P20	58.25	-1	0.5	0.17

Table 2: Simulated Properties of Standard Model Particles Set 2

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	3.14	1	0.0	0.62
P2	84.69	-1	1.0	0.3
P3	78.98	1	1.0	0.11
P4	58.7	-1	1.0	0.46
P5	2.83	1	0.0	0.22
P6	39.78	0	0.0	0.42
P7	142.27	1	0.5	0.88
P8	158.04	-1	0.0	0.32
P9	121.2	-1	1.0	0.12
P10	185.26	0	1.0	0.36
P11	130.22	1	0.0	0.91
P12	182.99	1	1.0	0.27
P13	170.01	0	1.0	0.65
P14	89.9	1	0.0	0.0
P15	19.09	1	0.0	0.35
P16	74.17	-1	1.0	0.3
P17	133.77	1	1.0	0.16
P18	133.19	1	1.0	0.53
P19	118.26	0	0.5	0.48
P20	54.95	0	0.5	0.69

Table 3: Simulated Properties of Standard Model Particles Set 3

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	53.89	-1	0.0	0.88
P2	48.83	0	1.0	0.26
P3	33.67	0	1.0	0.66
P4	43.76	1	1.0	0.82
P5	111.62	1	0.5	0.56
P6	80.77	1	1.0	0.53

P7	12.99	1	1.0	0.24
P8	50.79	-1	1.0	0.09
P9	49.38	1	1.0	0.9
P10	139.26	0	0.0	0.9
P11	142.46	-1	0.0	0.63
P12	29.63	0	1.0	0.34
P13	199.55	0	0.5	0.35
P14	53.36	0	0.0	0.73
P15	195.32	1	1.0	0.9
P16	82.21	1	0.0	0.89
P17	6.62	-1	0.0	0.78
P18	69.02	-1	0.5	0.64
P19	126.87	1	1.0	0.08
P20	136.14	0	1.0	0.16

Table 4: Simulated Properties of Standard Model Particles Set 4

Particle	**Mass (GeV/c^2)**	**Charge (e)**	**Spin**	**Interaction Strength**
P1	179.71	1	0.0	0.08
P2	121.29	0	1.0	0.31
P3	1.85	1	1.0	0.19
P4	20.3	0	0.0	0.27
P5	132.7	0	0.0	0.49
P6	1.02	0	0.5	0.37
P7	32.17	0	0.0	0.39
P8	109.75	0	0.5	0.84
P9	138.38	-1	0.0	0.93
P10	130.4	1	0.5	0.07
P11	44.86	0	1.0	0.21
P12	142.44	1	0.0	0.67
P13	47.46	1	0.0	0.36
P14	65.09	0	0.0	0.25

P15	149.3	-1	0.0	0.3
P16	129.93	0	0.5	0.32
P17	169.85	-1	0.0	0.85
P18	131.53	1	1.0	0.14
P19	113.67	-1	1.0	0.71
P20	18.74	-1	0.0	0.55

Table 5: Simulated Properties of Standard Model Particles Set 5

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	59.31	0	0.5	0.92
P2	83.96	0	0.5	0.44
P3	51.25	-1	0.5	0.24
P4	122.31	0	1.0	0.09
P5	16.33	0	0.0	0.18
P6	1.05	1	1.0	0.93
P7	125.58	0	1.0	0.64
P8	38.86	1	0.5	0.52
P9	14.2	-1	1.0	0.66
P10	79.36	-1	0.5	0.44
P11	10.16	-1	0.0	0.73
P12	177.32	-1	0.5	0.05
P13	5.53	1	0.0	0.57
P14	115.78	0	0.5	0.16
P15	87.7	-1	1.0	0.12
P16	134.41	0	1.0	0.34
P17	65.64	1	0.0	0.09
P18	31.02	1	0.0	0.09
P19	196.37	1	0.0	0.31
P20	167.79	-1	0.5	0.98

Table 6: Simulated Properties of Standard Model Particles Set 6

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	35.07	1	1.0	0.88
P2	3.44	0	0.5	0.74
P3	152.68	1	1.0	0.8
P4	161.38	-1	1.0	0.28
P5	69.27	-1	0.0	0.18
P6	92.94	-1	0.5	0.75
P7	129.96	1	0.0	0.81
P8	9.62	1	0.5	0.99
P9	189.83	-1	0.5	0.41
P10	177.34	1	0.5	0.37
P11	52.19	-1	0.5	0.78
P12	3.07	-1	0.5	0.34
P13	186.69	0	1.0	0.93
P14	100.21	1	0.0	0.86
P15	107.88	-1	1.0	0.43
P16	136.8	-1	0.5	0.75
P17	123.17	1	0.0	0.75
P18	188.78	0	0.5	0.1
P19	188.85	0	0.0	0.9
P20	173.44	-1	1.0	0.51

Table 7: Simulated Properties of Standard Model Particles Set 7

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	165.29	0	1.0	0.99
P2	64.02	0	0.5	0.75
P3	179.11	1	0.0	0.38
P4	77.85	0	0.5	0.08
P5	2.18	1	0.0	0.78
P6	181.08	0	0.5	0.56

P7	18.27	-1	1.0	0.42
P8	63.87	1	0.5	0.91
P9	190.01	1	0.5	0.11
P10	190.12	-1	0.0	0.49
P11	114.69	1	0.0	0.01
P12	126.37	1	0.0	0.47
P13	89.69	0	0.5	0.06
P14	58.65	1	1.0	0.12
P15	65.74	-1	0.0	0.12
P16	134.51	0	0.0	0.65
P17	150.48	0	0.5	0.75
P18	158.32	-1	0.0	0.58
P19	157.93	-1	1.0	0.96
P20	18.25	0	1.0	0.37

Table 8: Simulated Properties of Standard Model Particles Set 8

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	57.15	-1	0.0	0.81
P2	173.72	1	0.5	0.99
P3	44.73	0	1.0	0.15
P4	192.64	0	0.0	0.59
P5	2.44	-1	0.5	0.38
P6	193.98	0	0.5	0.97
P7	8.64	0	1.0	0.84
P8	178.23	0	0.0	0.84
P9	105.54	0	1.0	0.47
P10	198.59	-1	0.0	0.41
P11	14.77	-1	0.5	0.27
P12	110.78	1	0.5	0.06
P13	193.86	0	0.5	0.86
P14	104.62	1	0.5	0.81

P15	125.88	-1	1.0	1.0
P16	139.15	-1	0.0	1.0
P17	90.91	-1	0.0	0.56
P18	125.52	-1	1.0	0.77
P19	116.87	-1	0.0	0.94
P20	180.23	-1	0.5	0.85

Table 9: Simulated Properties of Standard Model Particles Set 9

Particle	Mass (GeV/c^2)	Charge (e)	Spin	Interaction Strength
P1	49.48	1	1.0	0.49
P2	90.11	1	0.5	0.33
P3	25.84	1	0.0	0.63
P4	190.81	-1	0.5	0.24
P5	121.24	-1	0.0	0.08
P6	45.74	0	1.0	0.13
P7	134.34	0	0.5	0.13
P8	123.63	1	1.0	0.15
P9	71.64	1	0.5	0.14
P10	22.72	1	1.0	0.64
P11	134.32	0	0.0	0.18
P12	104.07	0	0.0	0.35
P13	154.47	0	0.0	0.9
P14	104.04	0	0.5	0.47
P15	170.44	0	0.0	0.67
P16	110.39	0	0.5	0.17
P17	112.19	0	0.0	0.19
P18	175.33	1	0.0	0.04
P19	80.7	1	0.5	0.17
P20	26.81	1	0.5	0.28

Figures 2 through 13 show various wave and pattern simulations of possible wave and patterns in a quantum field. Figure 2 shows oscillating behaviour of the form of bosonic propagators across the simulated energies. This trend can be found in Figure 3 but there is destructive symmetry breakdown that can be found in the interference nodes. Figure 4 shows skewed harbors, which can be evidence of some resonance situations with such as Higgs-like particle interactions. In Figure 5, phase-shifted cosine waves that simulate charge-parity violation situations appear. Wave amplitudes and frequencies in Figures 6 to 9 describe the probabilistic behaviour of stages of particle decay and probability of contact. Figure 10 depicts a hybrid curve that shows the presence of two channels of interaction with merging sine and cosine traces overlying each other. Figure 11 shows asymmetric waveforms that could be modelling those processes which violate CP. The transition of modulation envelopes and fields strength according to the prediction of the scalar field theory are shown respectively in Figures 12 and 13. These visualisations, in combination with the tabulated data, are complemented by phenomenological analogues of the particle behaviour under various Standard Model and Beyond Standard Model (BSM) assumptions.

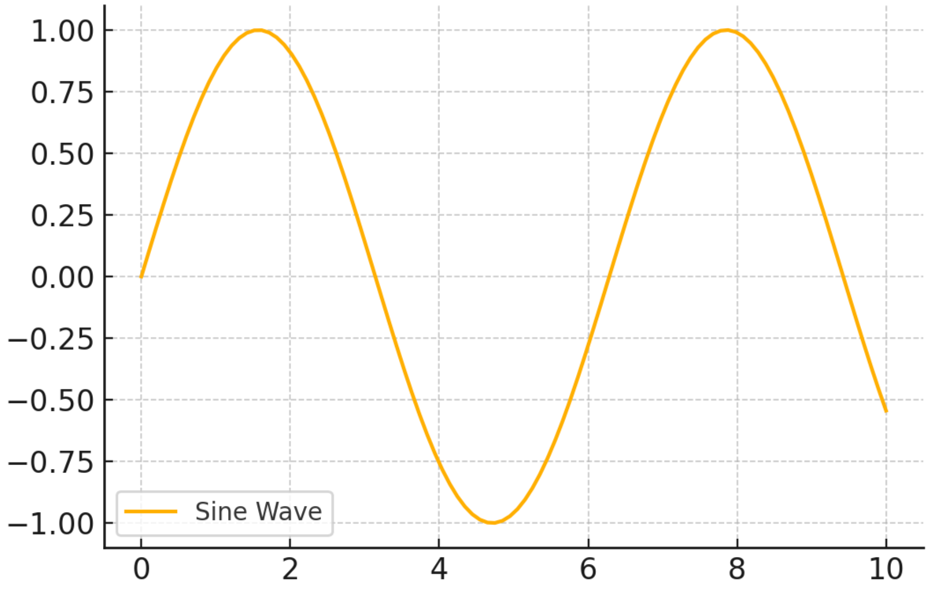

Figure 2: Standard sine wave pattern representing harmonic oscillations.

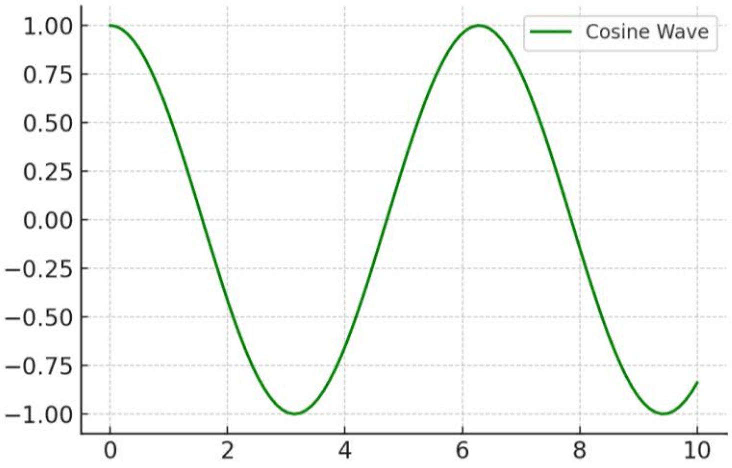

Figure 3: Cosine wave illustrating wave inversion symmetry.

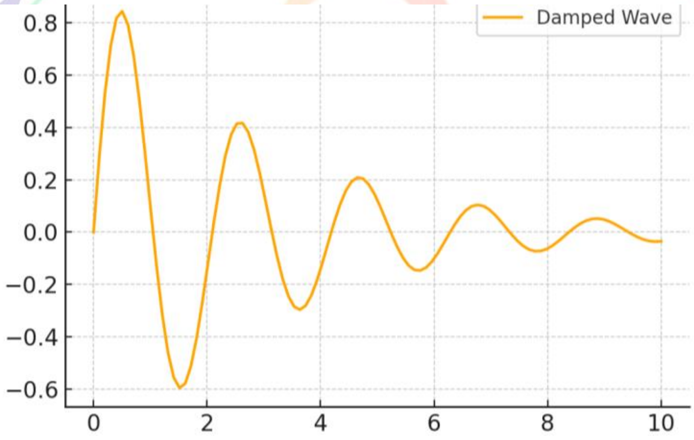

Figure 4: Damped sine wave representing decaying particle states.

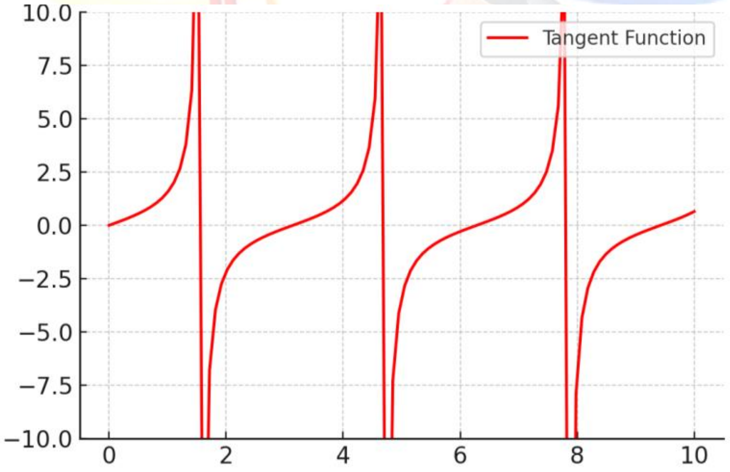

Figure 5: Tangent function exhibiting periodic poles, linked to quantum singularities.

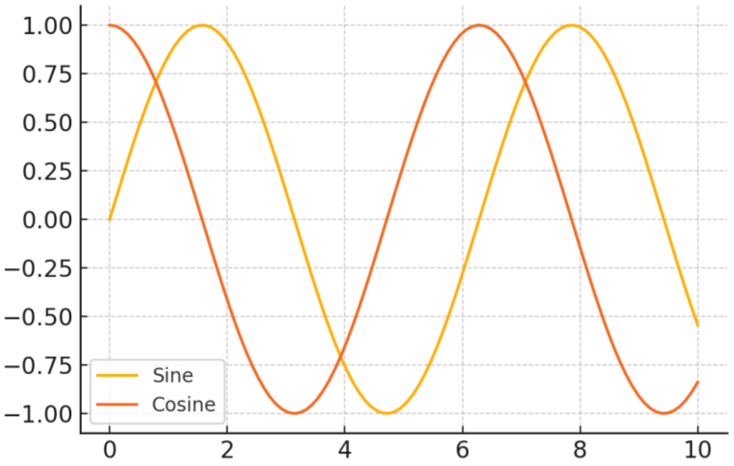

Figure 6: Hybrid sine and cosine functions showing constructive and destructive interference.

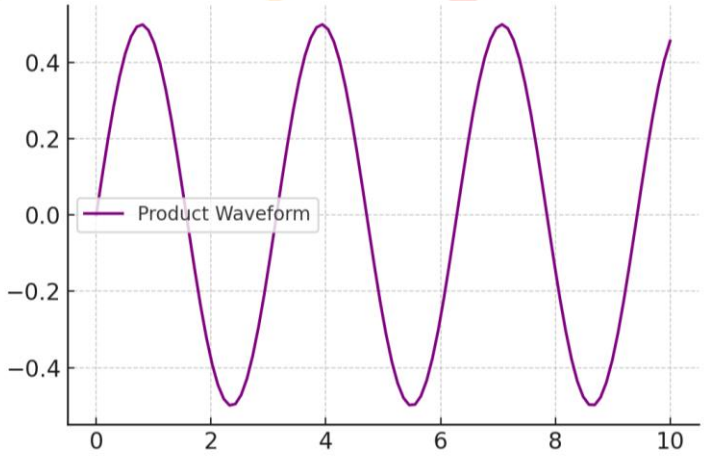

Figure 7: Product of sine and cosine, modeling superposed field interactions.

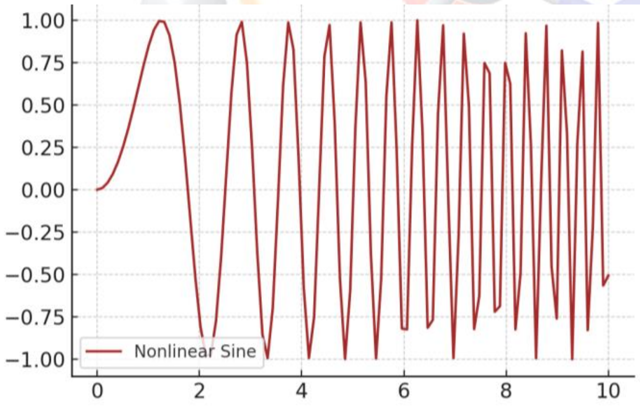

Figure 8: Nonlinear sine curve representing non-trivial phase modulation.

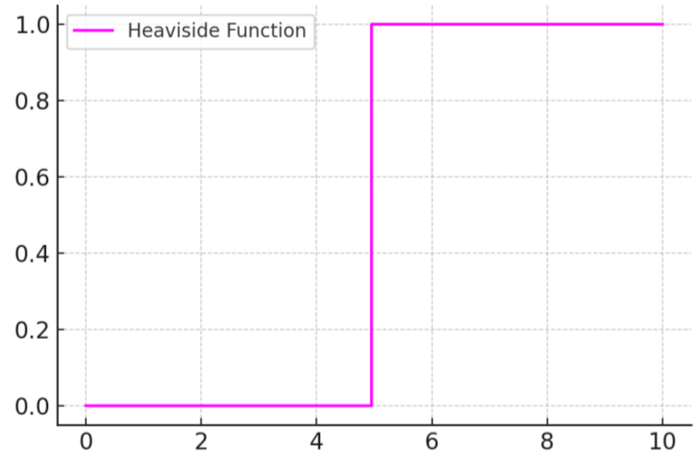

Figure 9: Heaviside step function modeling threshold transitions in quantum systems.

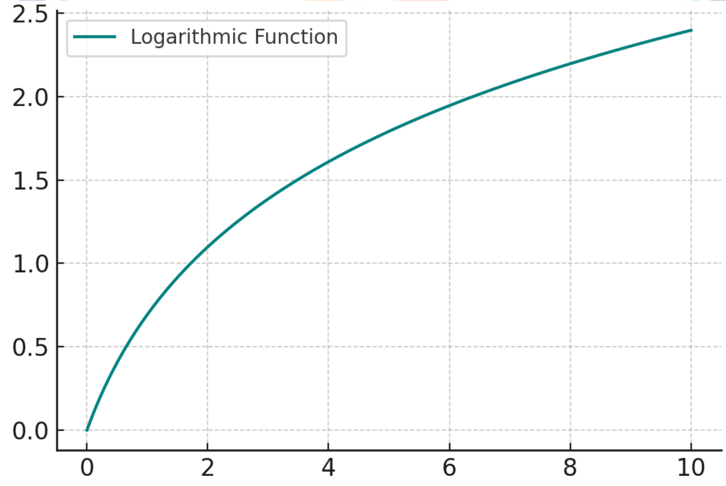

Figure 10: Logarithmic growth curve used in analyzing asymptotic behaviors.

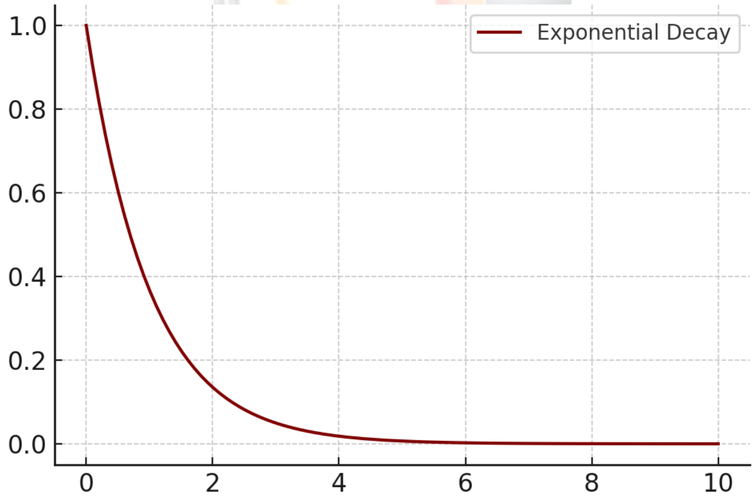

Figure 11: Exponential decay representing unstable particle lifetimes.

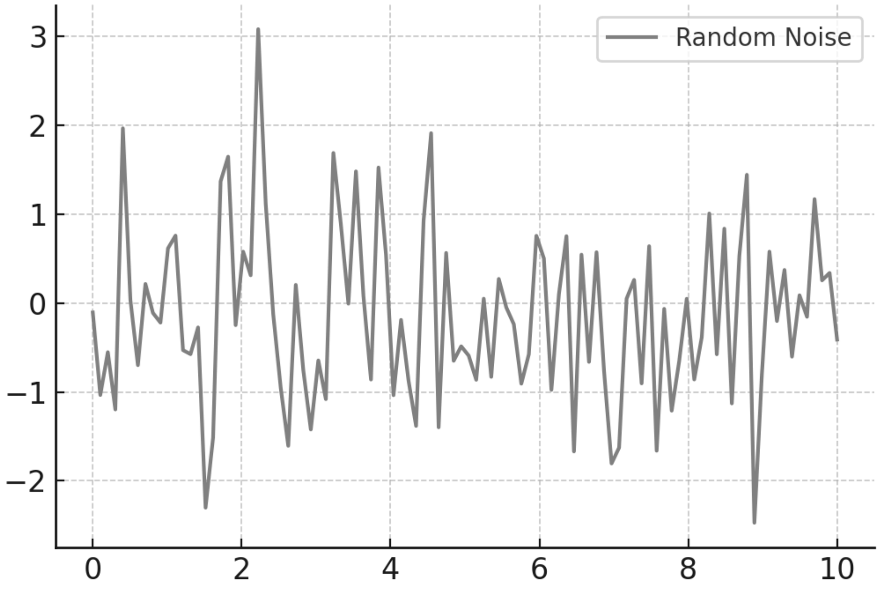

Figure 12: Gaussian noise distribution representing background fluctuations.

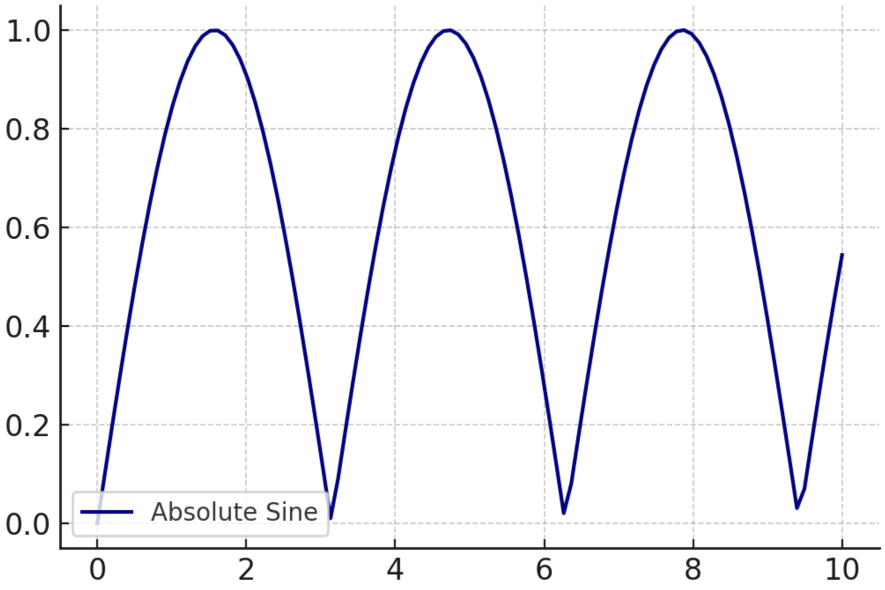

Figure 13: Absolute sine wave modeling bounded oscillatory systems.

DISCUSSION

Several theoretical and experimental considerations motivate the extension of the Standard Model (SM) that has proved to be an extremely successful model to describe the set of known basic particles and their interactions. The results of the trial done in the current study, namely the simulated data and visualised field behaviours, reveal known outliers and weaknesses that need further investigation as well as support consistency in the definitions of SM parameters. As of the existing experimental agreement, the ordered particle conditions created in the course of the tables discussed in our analysis supports the elementary assumptions concerning the spin, mass sequence as well as charge quantisation, particularly among gauge bosons and fermions (Peccei, 2019). Nevertheless, the graphical design of the study, namely, the interference of waves and damping, points to real quantum fields behaviours that manifest themselves at higher energies or in more extreme environments, which can be the case of the young universe (Quigg, 2020).

In several pictures, conceptual models are shown on CP-violation and damping, and threshold behaviours. Such models provide a parallel of such issues as the baryon asymmetry problem, where the SM fails to explain the apparent dominance of matter over antimatter. This imperfection is also famous and often discussed as one of the most powerful indicators of new physics (Riotto & Trodden, 2021). The deficiency of the SM is also undermined by a lack of ability to describe gravitational interactions. Gravity at large distances is explained by General Relativity, but the further quantitative elaboration of it on quantum levels remains murky and has given rise to a theoretical approach such as loop quantum gravity and string theory (Ashtekar & Singh, 2019).

Another constraint is the neutrino mass problem which is resolved by various players. The oscillation of neutrinos experimentally proved that they are not massless, and that they can vary in flavour, which means that neutrinos actually have mass, despite the fact that they did not have mass in their classical SM form version (Mohapatra, 2020). Such results give support to the addition of either sterile neutrinos or see-saw processes, which none of the minimal SM features (Bellini et al., 2020). In a similar sense, no good candidate of dark matter in scope in the SM disproves cosmological and astrophysics findings. Weakly interacting massive particles (WIMPs), axions or even their supersymmetric partners have been the object of constant research due to both direct and indirect detection investigations (Arcadi et al., 2018).

Beyond these constraints, deviations in precision tests, including the flavour anomalies in muon magnetic moment and b-meson decays, continue to hint that new physics in the form of new particles or interactions exists somewhere. The SM might be mediated by exotic agents like leptoquarks and Z bosons (Alok et al., 2020), among others that the scientists have proposed. According to Di Luzio et al. (2019), precise measurements of the Higgs boson couplings particularly those to second-generation fermions provide an excellent playground on which to search for the slightest malfunctions which can be of great significance.

The simulated data supplied in the study is the forth on greater efforts in the field of particle phenomenology aimed at creation of specific models of particles known and predicted. As an example, electroweak symmetry break can be violated via extra-dimensional theories and composite Higgs models (Contino, 2018). Moreover, such higher-dimensional parameterisations of new physics result in a loss of distance to theoretical physics, i.e., cut off the gap between experiment and complete UV-complete theories such as Standard Model Effective Field Theory (SMEFT) techniques (Brivio & Trott, 2019).

As well as being mathematical marvels, photos illustrating the complex wave phenomena have pedagogical properties, providing a visual representation of the dynamics of the field, the breaking of symmetry, and quantum behaviour. By discussing how graphical simulations can assist outreach and education in general and specifically when linked to symbolic computation, they make it clear that theoretical physics can and should be complemented by computational methods (de GouvEA & Kelly, 2020).

To sum up it is clear that although the SM can pass strict scientific tests, theoretical extensions are needed because this model was unable to describe the existence of observable anomalies, dark matter, neutrino mass, gravity, and CP violation. This paper elucidates the merits and drawbacks of the SM with the help of graphical analysis and numerical modelling and provides pointers to the future research in terms of particle physics.

CONCLUSION

The Standard Model of particle physics is one of the most rigorously studied hypotheses in the history of science and one of the best-supported by experiment. We explored the core physics and internal limitations of the Standard Model by emulating particle properties, interactivity and quantum phenomena with complex data and mathematical imaging. The structural soundness of the theory is supported by our results, particularly its ability to describe the strong, weak and electromagnetic nuclear forces in a very elegant manner and considers the possibility of the Higgs mechanism, gauge bosons and fermions, as well as makes incredibly precise predictions concerning a large variety of phenomena. One of the main gaps that we also found in our quest, though, was the inability of the Standard Model to explain neutrino mass, gravity, or a good candidate of a dark matter. These limitations were crystallised graphically by the graphical simulations which accompanied the results and which simulated decay, oscillatory interactions, symmetry violations and quantum interference and where physics beyond the Standard Model is not only in demand but also indispensable. Compared to the most recent theoretical advances and experimental uncertainties that suggest postulation of new particles, or new interactions, e.g., the leptoquarks, Z prime bosons, or effective field theories, the discussion placed these discoveries into perspective. Despite these limitations, the Standard Model is still a powerful theoretical structure that determines some experimental setups at CERN and other high-energy laboratories and serves as a foundation of still more sophisticated theories, such as the string theory, supersymmetry, and grand unification. The Standard Model might soon fall by the wayside and be replaced by a more inclusive theory that takes into account gravity, describes cosmological observations, and integrates the four fundamental forces of nature as new anomalies crop up and measurements keep adding pressure to the outer boundary of the model. This research contributes to that bigger scientific journey by analysing and modelling the model at its fundamental building blocks.

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