The Inconsistencies of The Standard Model of Particle Physics

Often regarded as the most successful framework for understanding the fundamental particles, the standard model is far from perfect

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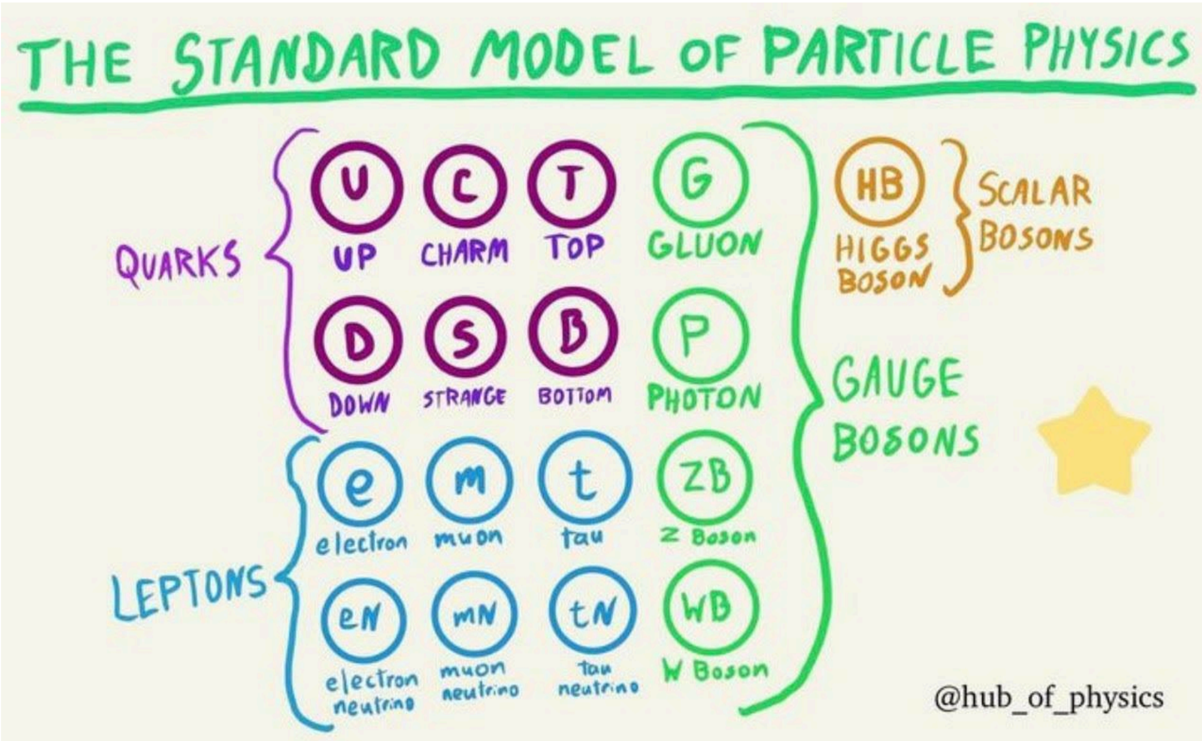

The Standard Model of Particle Physics | Sketch by Amirali Banani

Many of the scientific models that we follow—no matter how respected—are incomplete. The Standard Model of Particle Physics is no exception. In a field like a Particle Physics in which there is still much uncertainty, it is no surprise that its standard model is still lacking.

So far, sixteen particles constitute the standard model, with one—the Higgs Boson—responsible for giving mass to the other fundamental particles. Four groups of particles—Quarks, Leptons, Gauge Bosons, and Scalar Bosons—have been discovered to date, with more surely to be discovered in the future.

Despite currently being the supposed best theory to describe the basic building blocks of the universe, the model does come with its inconsistencies and is rather incomplete as it describes only 3 of the 4 fundamental forces that govern our universe. Specifically, while it explains the strong, weak, and electromagnetic forces, the model fails to explain the force of gravity in any shape or form. This means that the Standard Model cannot provide a complete picture of the universe on its own, and there must be another theoretical framework to account for gravity.

Secondly, the Standard Model fails to explain certain phenomena that have been observed in the universe. For example, the model predicts that neutrinos—a type of subatomic particle—should have no mass, but multiple experiments have shown that they actually do. The Standard Model also cannot explain dark matter or dark energy, the mysterious forms of matter that make up a significant portion of the universe's mass but do not interact with electromagnetic radiation.

Thirdly, the Standard Model does not provide a satisfactory explanation for the matter-antimatter asymmetry in the universe. According to the model, equal quantities of matter and antimatter should have been produced during the Big Bang, although today we observe a universe markedly dominated by matter. This matter-antimatter asymmetry is known as the Baryon Asymmetry Problem, and the Standard Model does not account for it.

Finally, the Standard Model fails to address certain philosophical and conceptual issues in Particle Physics. For example, it does not provide a satisfactory explanation for the Hierarchy Problem, which concerns why the Higgs boson—the particle that gives other particles mass—has a mass much smaller than the Planck scale, which is the scale at which quantum gravitational effects become significant. The Standard Model also does not address the question of why there are three generations of fundamental particles, or why the values of the fundamental constants of nature are what they are.

The point of this article is not to undermine the significance and success of the Standard Model, but merely to point out some of its flaws and inconsistencies. Nevertheless, despite its imperfections, the Standard Model is still the most successful theoretical framework established to date that has been able to predict and explain a wide range of phenomena in Particle Physics. Through further research and experimentation, we can acquire a greater understanding of phenomena in Particle Physics and therefore enhance the universality and accuracy of Particle Physics' most treasured model.