# Muons and New Physics

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## Abstract

Muons are somewhat like heavy electrons, but they briefly persist, whereas ordinary electrons have a long life. Why? Muon particles are beloved by the small army of experimental physicists at Fermilab and the LHC. Results outside expectations indicate that an upgrade to the standard particle physics model, and to its cosmological principle, is in order. This essay offers fresh perspectives on several key questions, and it points experimentalists toward a better model of fundamental physics.

Experimental particle physicists are challenged by the problems of insufficient paradigms, and weak powers of measurement at both extremes of the logarithmic size scale. Measurements of not-too-small-to-examine muons offer science a new portal into the foundations of vector reality at many dimensions smaller than single muons. The real goal is to attach our theoretical physics *"castles in the cloud"* to the ground of reality.

This attachment goal is a worthy endeavor, since knowledge of the smallest matter/energy units helps science also understand the dynamics of even the largest matter/energy components of the cosmos. Indeed, all astrophysics is a subset of physics.

# Revelations from the LHC and Fermilab

The LHC was designed to direct mighty flows of protons into targets, and thereby break loose exotic particles that would tell us what we don't know about the foundations of basic physics. To some degree that has happened. However, for each answer several core questions have arisen. New questions are OK in science, because every new problem is a new opportunity to learn more, and to envision more. Nevertheless, *high energy particle physics hasn't found much* new after the predicted *Higgs boson* was discovered in 2012.

A lack of critical "new stuff" in the *sub-atomic zoo* has led some physicists to suggest that there is much more to discover just beyond our instruments, both in quantity and in quality. Muons, being like electrons, but 200 times more massive, offer a target sufficiently massive to indirectly generate data for force particles within a much smaller logarithmic scale. Both General Relativity and Quantum theories are incomplete, and riddled with questionable math fixes (lambda, renormalization). Having a small but precise muon doorway into some big mysteries is most welcome. What can and will we find, or not find?

Muon results are still coming in from the Large Hadron Collider on the Swiss/Italian border, as well as from the Fermilab muon machine outside Chicago. Complementary and unexpected data anomalies may better point toward very important aspects of an emerging Theory of Everything.

In this realm, unexpected data appeared in 2001, but were only elevated to a higher sigma (or confidence) level in 2019, after the Fermilab muon machine went online. There are also 2014 data that point to possible new physics from what appeared at the Large Hadron Collider in its LHCb machine. Experimental physicists require an extremely high level of confidence in their data before they declare a new discovery. The latest data don't quite meet that level, but they are close. New verifications could increase the confidence from 3 sigma to 5 sigma. Then what?

*Here is what an LHCb scientist said* about where we stand now. Details of why he is so excited are contained in the linked article that includes this quote:

> Mitesh Patel, a particle physicist at Imperial College London and one of the leaders of the experiment, described the excitement he felt when the moment came to look at the result. "I was actually shaking", he said, "I realised this was probably the most exciting thing I've done in my 20 years in particle physics."

Turning next to the *g-2 muon experiment at Fermilab* in the United States, different anomalous measurements have recently been made and upgraded to a higher level of confidence. These data indicate possible major changes needed to the sub-atomic zoo of particle physics and to its *Standard Model*.

*Two physicists involved in this process said as follows*:

> Taken together, the LHCb and Fermilab results strengthen the case that we've observed the first evidence of the standard model prediction failing, and that there are new particles or forces in nature out there to be discovered.

## — Points to Ponder —

There are several points to ponder coming out of these new and highly precise measurements. The Standard Model (SM) has been so robust for about fifty years that any modification is a really big deal, or opportunity to probe the unseen.

### (1) Weaknesses acknowledged in the Standard Model:

As good as it is, the Standard Model is lacking in two critical areas, which opens the door to new physics: First, the SM does not incorporate accepted gravity models. Second, the SM cannot reconcile General Relativity and Quantum theories. Let's just say that the SM is a silver standard, but not yet the gold standard. New light is needed to create a golden 21st-century version.

## (2) What is the relationship between muon mass being 200 times greater than electrons, and different longevities?

Here is how *CERN explains what they found*. Reference also the link at the beginning of this first paragraph:

> The measurement made by the LHCb (*Large Hadron Collider beauty*) collaboration, compares two types of decays of beauty quarks. The first decay involves the electron and the second the muon, another elementary particle similar to the electron but approximately 200 times heavier. The electron and the muon, together with a third particle called the tau, are types of leptons and the difference between them is referred to as "flavours". The Standard Model of particle physics predicts that decays involving different flavours of leptons, such as the one in the LHCb study, should occur with the same probability, a feature known as lepton flavour universality that is usually measured by the ratio between the decay probabilities. In the Standard Model of particle physics, the ratio should be very close to one.
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> The new result indicates hints of a deviation from one: the statistical significance of the result is 3.1 standard deviations, which implies a probability of around 0.1% that the data is compatible with the Standard Model predictions. "If a violation of lepton flavour universality were to be confirmed, it would require a new physical process, such as the existence of new fundamental particles or interactions," says LHCb spokesperson Professor Chris Parkes from the University of Manchester and CERN.

## (2a) Earth's mass vs. high-energy neutrinos and small-energy neutrinos.

With reference to electrons and muons, there is an analogy between why *small neutrinos penetrate the Earth, but high energy neutrinos cannot*. Even the smallest neutrino is many dimensions larger than EM-neutral y/y particles. Mass/energy quantum-like units moving about the multiverse at high speeds can degrade large, energetic muon targets much faster than they can degrade electrons – although current theory hypothesizes that high-energy neutrinos interact with larger matter inside the Earth, and are thereby absorbed.

## (3) What about Lepton Flavor Universality?

Lepton Flavor Universality (LFU), as explained just above, is a central element in the ideology of the Standard Model. Science will simplify, but to oversimplify is worse than overelaboration.

To say that novel experimental results "violate" LFU within the Standard Model of particle physics is equivalent to saying that our growing bodies violate our juvenile clothing. All models need to reflect objective reality, not restrict our ability to embrace reality. Adult clothing on a grown body can be elegant. The same could be said for a parsimonious and elegant theory of physics covering logarithmic and vector dimensions.

## (4) Just what is there to be discovered, and how?

It's nice to take a peek at what's on the other side of our weak paradigms. Physics today is like the ship without a real rudder: You will always get to your destination, real or unreal. A more robust theory should provide both experimentalists and theorists with the needed "rudder" to get to the real core of reality.

In 2019 I wrote an important essay, "*Beyond the Future Circular Collider*." That important essay provides a framework for understanding and formulating the rudiments of a working theory of everything that we can know, or logically embrace. As part of this framework, the Large hadron's multiversal contribution to the matter/antimatter construction of our local universe is explained.

## (5) Supersymmetry.

Supersymmetry is supposedly where each particle has its identical companion, supposedly going back to the Big Bang era. In 2013 the *LHC could not find confirmation for supersymmetry*. This non-confirmation was demonstrated one year after 2012 when the Large hadron was confirmed. Just when physics was taking one step forward, it took one step back.

## (6) Dark matter and dark energy.

Both dark matter (DM) and dark energy (DE) are often written as Dark Matter and Dark Energy. This is one way to distinguish physics royalty from physics peasantry. How does this supposed royal blood in Physicsland match up with raw Reality?

The Large Hadron Collider [a proper name] was hopefully going to unlock the keys to comprehension of DM and DE. It does have a role in that quest, but only a role. For example, unseen and thus "dark" supersymmetric twins, as referenced above, were at one time hypothesized as the best answer to what constitutes DM. This experiment is one example of addition by subtraction. Gems can sometimes be identified by removing encrustations. Rarely is Nature less than what we think it is.

I have explained the authentic natures of DE and DM multiple times. For example, *here is one relevant essay*, and *here is another*. See my "Clark's Web Pages" section of *astronomy-links* for more explanations. The superior paradigm that will emerge only looks weird from inside an old-physics Platonic cave.