Answer to the surge

Scientists have shown that masking should get top priority on the list of essentials to handle the pandemic

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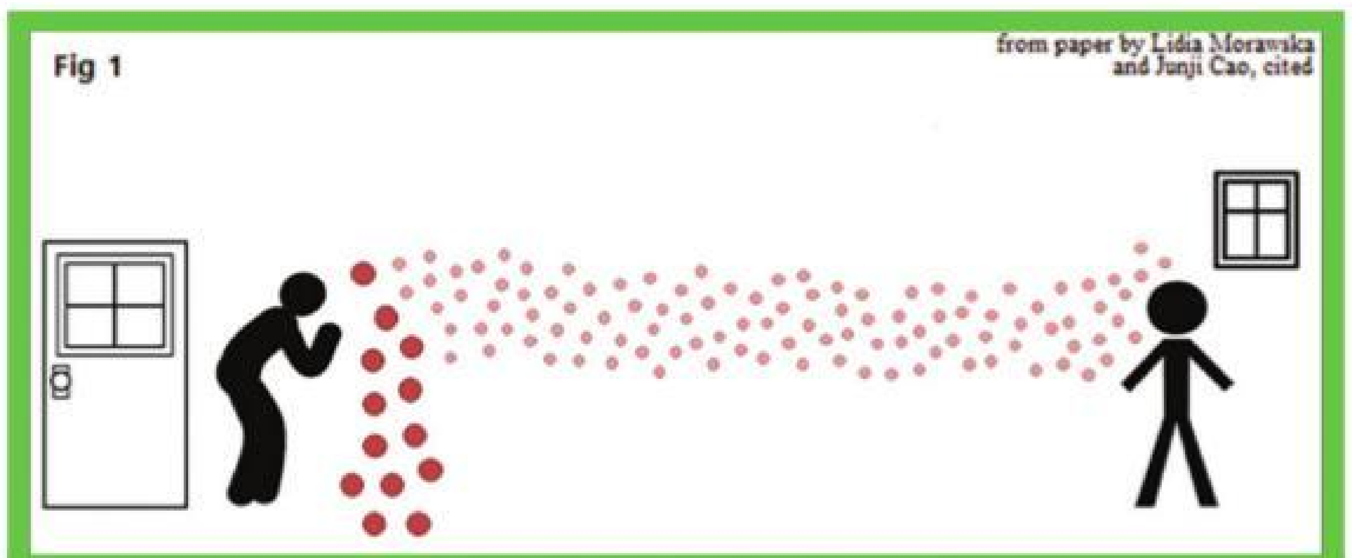
Just as India faces the second wave of Sars-CoV-2, prestigious medical journal, *The Lancet*, prescribes a number of urgent measures that we need to take. In particular, the report says that the spread of the virus is predominantly through aerosols, or in other words, it is airborne. The recommendations are thus, one, to promote wearing of masks and next, to avoid collections of people, particularly in closed spaces.

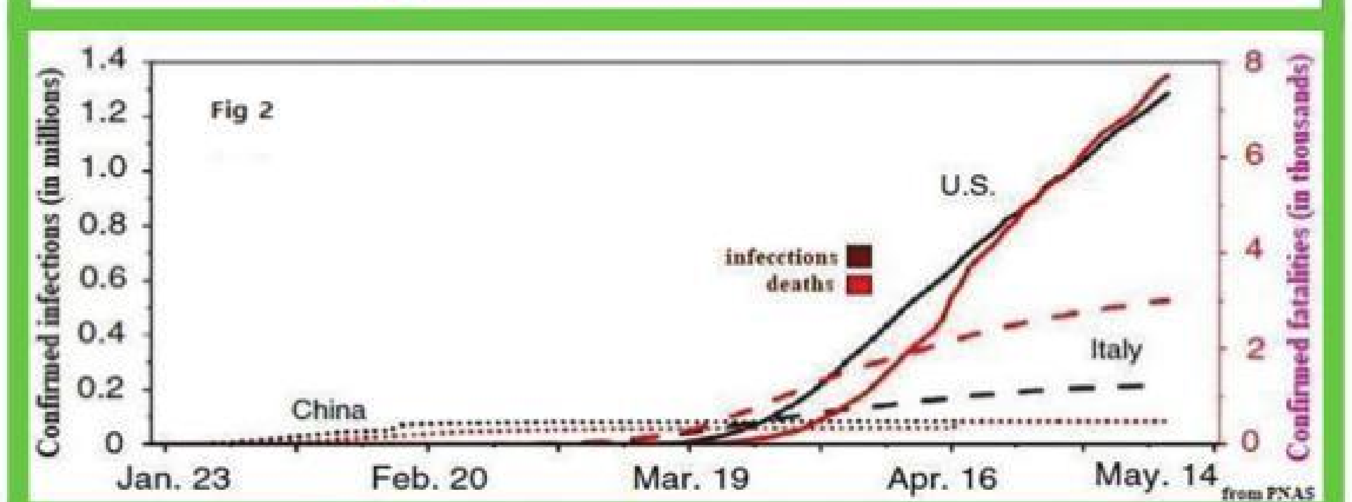
The recommendations are not new, both were specifically made, with grounds for their making, in June 2020. A team at the Scripps Institute of Oceanography and the School of Medicine, University of California at San Diego, and Sun Yat-sen University, Taiwan, in the journal, *Science*, detailed the findings about the airborne transmission of Sars-CoV-2. A team at the Texas A&M University, at Austin, Caltech, and University of California, San Diego, in the journal, *Proceedings of the National Academy of Sciences*, confirmed the finding and added data that shows the positive protection provided by the use of masks.

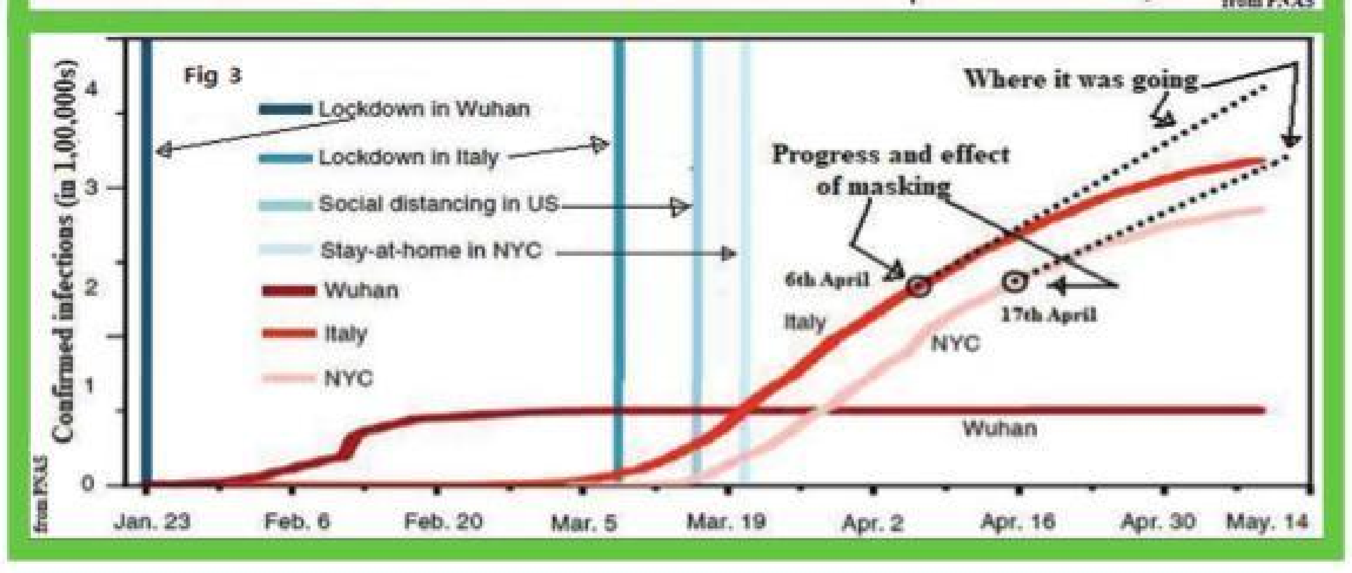
Respiratory infection, the first paper said, happens through virus-containing droplets, exhaled when infected persons cough or sneeze, or smaller droplets when they breathe or speak. Droplets larger than five microns fall to the ground or other surfaces before they evaporate, and deposit viruses that may remain for hours or days.

Droplets that are smaller than five microns evaporate before they fall, and the viruses they contain stay suspended in the air, as an aerosol, which can stay airborne for hours. The paper cites studies that say much of the transmission of Covid-19 has been through aerosols produced, perhaps, by asymptomatic individuals. Exercises of tracing those who came into "close contact" with infected persons are hence inconclusive. And it seems that many infections were acquired from longer distances, another of the cited studies said.

Transmission by aerosols consists of smaller respiratory droplets, and this affects the severity of the infection, the paper said. It is possible, the paper said, that the smallest aerosols reach the deepest parts of the lungs, even before the immune responses can start. The Covid-19 virus, which multiplies three times faster than the Sars virus, can then spread to the pharynx, from where it would enter the environment, when the patient breathes, speaks or laughs – all before symptoms begin to show. The paper cited a study which said undiagnosed cases of Covid-19 infection, with "mild, limited or no symptoms", were responsible for up to 79 per cent of viral infections in Wuhan.







The paper said World Health Organisation guidelines of six-feet distancing and hand washing were based on studies carried out in the 1930s. The technology available did not permit study of aerosols. Now we know that a large droplet settles in four to five seconds, but a one-micron particle stays airborne for over 12 hours. We also know that coughs and sneezes can deposit droplets 20 feet away and create thousands of aerosols that travel much further.

In enclosed spaces, hence, if there is an infected person, the viral load increases every minute. Ventilation is thus paramount and then, air-conditioning, which recycles the air, is a true step-in-aid to spreading infection.

Despite such findings in June 2020, the danger of airborne transmission has been questioned, as "not being established." The current study by *The Lancet*, however, says there is overwhelming evidence and details the grounds to show that it must be so. "...From 33 per cent to 59 per cent of all Covid-19 cases could be attributed to asymptomatic or pre-symptomatic transmission of Sars-CoV-2 from people who are not coughing or sneezing…which supports a predominantly airborne mode of transmission," the study says. That "super spreading events may be the pandemic's primary drivers, and other data, cannot be adequately explained by droplets or fomites," the study says.

Masking

The second paper, in *PNAS*, considered the then available data of Wuhan, Italy and New York City, to conclude that "that the difference with and without mandated face covering represents the determinant in shaping the pandemic trends in the three epicentres."

The graph in Figure 2 shows that the rise in infection flattened in China by end of January 2020, but rose sharply in Italy and NYC through March to May. In the case of China, there was extensive testing, quarantine, and contact tracing, and then aggressive measures of lockdown of all cities and rural areas in the whole country, isolation of those in close contact with infected people, and it was mandated to wear face masks in public. As all of those were put in place at the same time, we cannot identify how much each measure contributed.

In Italy also, measures of quarantine, isolation and city lockdown were implemented, right from 9 March 2020. In most of the U S too, social distancing, quarantine and isolation was started in March and April, on 22 March in NYC. But, as we can see from Figure 3, numbers kept increasing, and it was on 6 April (Italy) and 17 April (NYC) that the curve began to flatten.

It was on 6 April last year that WHO issued the guidelines for masking and it was ordered in northern Italy on the same day, and nation-wide on 4 May. NYC followed suit on 17 April. We can see from Figure 3 that on those very dates, the rate of infection began to drop (the dotted lines show where the trend was leading the curve).

India introduced a nation-wide lockdown from March 2020 and continued restrictions even after partial relaxations. Our infections, however, saw very high numbers through June and September. Our ratios appeared to be better than in other parts of the world, but it may be a result of our younger population, as well as much lower mobility. The surge of the last few days, however, has taken us to the very top of the list of affected countries.

Administrative measures, of restricting commercial activity, travel and gatherings are sure to follow. The simple step, however, of ensuring that everybody wears a well-fitting mask, even indoors, when in an enclosed, public space, would have dramatic effect. And so would steering clear of gatherings and crowded places. We should still wash our hands, however, as airborne transmission has not affected direct transmission through droplets.

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PLUS POINTS

Going to sleep

The National Aeronautics and Space Administration's InSight Mars lander is currently trying to endure the abrasive Martian environment, as it sits on the Red Planet conserving power as its solar panels get covered in dust.

InSight was designed to be powered by solar energy, gathered through dual two-metre panels. It was always expected that the panels would reduce their power output as time went on and dust landed on them, but would still have enough to last throughout the two-year mission.

Unfortunately, not all has gone to plan. Despite InSight landing in Elysium Planitia, a windswept area of Mars that gets lots of sunlight, none of the passing dust devils (funnel-like chimneys of hot air) have been close enough to clean the panels.

It means that InSight is only getting 27 per cent of the power that it otherwise would – shared between its scientific instruments, robotic arm, radio, and heaters.

To make matters worse, the windiest Martian season has just ended and it could be months before another cleaning event naturally occurs, and Mars is moving away from the Sun. Its already weak energy is getting weaker, and when InSight needs it most. Science operations have had to be put on hold until July 2021 when Mars is closer to the star.

"The amount of power available over the next few months will really be driven by the weather," said InSight's project manager, Chuck Scott of Nasa's Jet Propulsion Laboratory in Southern California, "As part of our extended-mission planning, we developed an operations strategy to keep InSight safe through the winter so that we can resume science operations as solar intensity increases."

Nasa scientists now find themselves in the unenviable position of having to choose which instruments need to be switched off each day to conserve necessary power for the heaters and radio communication.

The craft's weather monitoring will be off most days, meaning that Nasa will get less frequent updates about its environment, but it hopes that even if the craft did go offline due to a lack of power that it would be able to reboot when the sunlight returns.

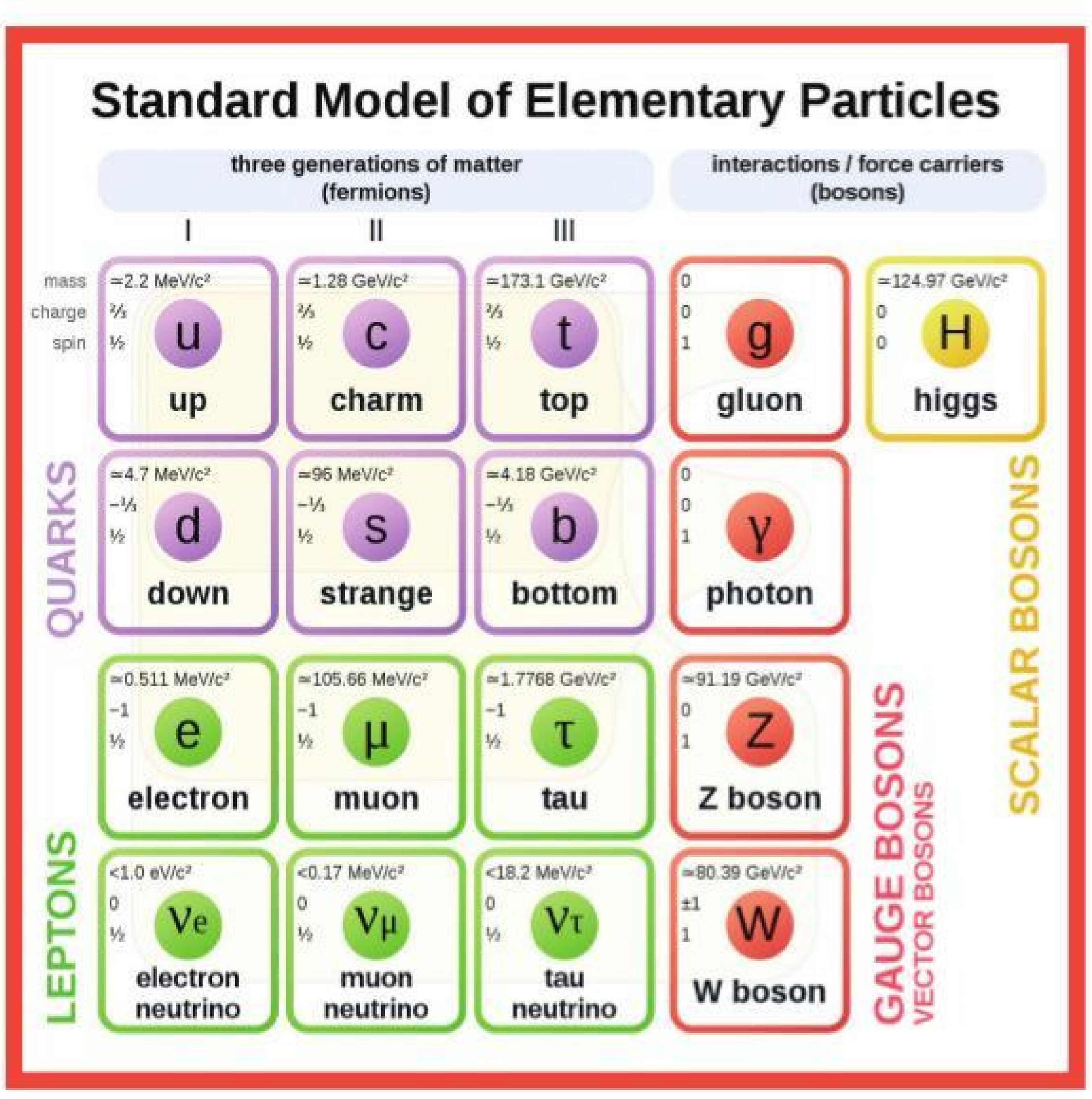
Before that, there is some recourse the agency can take to try and spark the lander into life. InSight will move its robotic arm, equipped with a camera, closer to the panels to better image the dust coating.

The team will then pulse the motors which unfurl each panel, in an attempt to disturb the dust. Nasa is not hopeful it will work, however, but feels it is worth the attempt to keep the craft powered.

The risk of damage to the craft is pretty likely, InSight's principal investigator commented to *Insider*. The cold weather on the Red Planet means that the delicate electronics could be damaged by the low temperatures – the lowest they will sink during the Martian year.

"Right now, our predictions, our projections are that we should be able to make it through the lowest-power point and come out the other side," Banerdt said, "We think we're pretty well off, but Mars is unpredictable. We never know exactly what's going to happen."

–THE INDEPENDENT



LONG-STANDING MYSTERY

Is there proof of new physics from the muon's magnetic moment? Maybe not, according to a new theoretical calculation

ZOLTAN FODOR

When the results of an experiment don't match predictions made by the best theory of the day, something is off.

Fifteen years ago, physicists at Brookhaven National Laboratory discovered something perplexing. Muons -- a type of subatomic particle -- were moving in unexpected ways that didn't match theoretical predictions. Was the theory wrong? Was the experiment off? Or, tantalisingly, was this evidence of new physics?

Physicists have been trying to solve this mystery ever since.

One group from Fermilab tackled the experimental side and on 7 April this year released results confirming the original measurement. But my colleagues and I took a different approach.

I am a theoretical physicist and the spokesperson and one of two coordinators of the Budapest-Marseille-Wuppertal collaboration. It is a large-scale collaboration of physicists who have been trying to see if the older theoretical prediction was incorrect. We used a new method to calculate how muons interact with magnetic fields.

My team's theoretical prediction is different from the original theory and matches both the old experimental evidence and the new Fermilab data. If our calculation is correct, it resolves the discrepancy between theory and experiment and would suggest that there is not an undiscovered force of nature.

Our result was published in the journal *Nature* on 7 April, the same day as the new experimental results.

The muon and the Standard Model

The muon is a heavier, unstable sister of the electron. Muons are all around us and are, for example, created when cosmic rays collide with particles in the Earth's atmosphere. They are able to pass through matter, and researchers have used them to probe the inaccessible interiors of structures from giant volcanoes to the Egyptian pyramids.

Muons, like electrons, have an electric charge and generate tiny magnetic fields. The strength and orientation of this magnetic field is called the magnetic moment.

Almost everything in the universe – from how atoms are built to how your cell phone works to how galaxies move – can be described by four interactions. You are probably familiar with the first two: gravity and electromagnetism. The third is the weak interaction, which is responsible for radioactive decay. Last is the strong interaction, the force that holds the protons and neutrons in an atom's nucleus together. Physicists call this framework – minus gravity – the Standard Model of particle physics.

All interactions of the Standard Model contribute to the muon's magnetic moment and each does so in multiple different ways. Physicists very precisely know how electromagnetism and the weak interaction do so but determining how the strong interaction contributes to the muon's magnetic field has proven to be incredibly hard.

A magnetic mystery

Of all of the effects that the strong interaction has on the muon's magnetic moment, the largest and also hardest to calculate with the necessary precision is called the "leading order hadronic vacuum polarisation".

In the past, to calculate this effect, physicists used a mixed theoretical-experimental approach. They would collect data from collisions between electrons and positrons – the opposite of electrons – and use it to calculate the strong interaction's contribution to the muon's magnetic moment. Physicists have been using this approach to further refine the estimate for decades. The latest results are from 2020 and produced a very precise estimate.

This calculation of the magnetic moment is what experimental physicists have been testing for decades. Until 7 April, the most precise experimental result was 15 years old. For this measurement, at Brookhaven National Laboratory, researchers created muons in a particle accelerator and then watched how they moved through a magnetic field using a giant, 50-foot-wide electromagnet. By measuring how muons moved and decayed, they were able to directly measure the muon's magnetic moment. It came as quite the surprise when Brookhaven's 2006 direct measurement of the muon's magnetic moment was larger than it should have been according to theory.

Faced with this discrepancy, there were three options: Either the theoretical prediction was incorrect, the experiment was incorrect or, as many physicists believed, this was a sign of an unknown force of nature. So, which was it?

New theories

My colleagues and I chose to pursue the first option: The theory might be off in some way. So, we decided to try to find a better way to calculate the prediction. Our team of physicists took the most basic underlying equations of the strong interaction, put the equations on a space-time grid and solved as many of them as possible at once.

The technique is kind of like making a weather forecast. As commercial aircrafts fly their routes, they measure pressure, temperature and the speed of wind at given points on Earth. Similarly, we placed the strong interaction equation on a space-time grid. The weather data at individual points are then put into a supercomputer that combines all the data to predict the evolution of the weather. Our team put the strong interaction forces on a grid and looked for the evolution of those fields. The more planes collecting data, the better the prediction. In this metaphor, we used billions of airplanes to calculate the most precise magnetic moment we could using millions of computer processing hours at multiple supercomputer centres in Europe.

Our new approach produces an estimate of the strength of the muon's magnetic field that closely matches the experimental value measured by the Brookhaven scientists. It essentially closes the gap between theory and experimental measurements and, if true, confirms the Standard Model that has guided particle physics for decades.

New experiments

But my colleagues and I have not been the only ones pursuing this mystery. Other scientists, like the ones at Fermilab, a particle accelerator close to Chicago, have chosen to test the second option: that the experiment was off.

At Fermilab, physicists have been continuing the experiment that was done at Brookhaven to get a more precise experimental measurement of the muon's magnetic moment. They used a more intense muon source that gave them a more precise result. It matched the old measurement almost perfectly.

The Fermilab results strongly suggest that the experimental measurements are correct. The new theoretical prediction made by my colleagues and me matches with those experimental results. While it may have been exciting to discover hints of new physics, our new theory seems to say that this time, the Standard Model is holding up.

One mystery remains though: the gap between the original prediction and our new theoretical result. My team and I believe that ours is correct, but our result is the very first of its sort. As always in science, other calculations need to be done to confirm or refute it.

The writer is professor of physics, Penn State University, United States. This article first appeared on www.theconversation.com