You Can't Feel Fifth Dimension

Forward

This is a transcript from a YouTube video.

Parenthetical and italicized text are mine.

I submit the following for your consideration in your modern understanding of the knowledge that Shakyamuni Buddha was trying to convey some almost 3000 years ago to a largely illiterate people as well as all caste up to the intellectual (*Brahman*) caste of India.

My constant goal is to make the history and scholarship of Buddhism and its founder's teachings as easy to understand as this modern era of Mappo can transmit. With the access to our great scholars in both Buddhist lineage as well as those academically trained, this wealth of information can be overwhelming. It is my task to reduce the noise or extraneous pursuits of politicized agendas to deliver a paired back but no simplified, straightforward teaching without distraction. The sciences today, from physics and cosmology to psychology and neurology, provide a glut of observable truths that apply directly to our Buddhist practices and rhetoric. I provide here a direct transcription of video talks from the Internet with interruptions of personal insight regarding Buddhist teachings and practice, as a guide to interrelate our practice with the provided text.

Sifu, Bodhisattva Sylvain Chamberlain

Love and respect,

NaMuMyoHoRenGeKyo

Transcript Annotated

You can't feel 11 dimensions. Here's why.

There are 11 dimensions woven into the fabric of this universe, and you are physically incapable of detecting 10 of them. Not because your brain isn't powerful enough, not because your instruments aren't sensitive enough, but because the very geometry of those dimensions makes them permanently mathematically inaccessible to anything built from the matter you're made of, including you, including every instrument humanity has ever built, including light itself. That claim isn't philosophy. It isn't speculation.

It comes directly from M theory, the mathematical framework that unifies all five versions of superstring theory. First consolidated by physicist Edward Witten at a

1995 conference that physicists now describe as the second superstring revolution. The equations of M theory require exactly 11 dimensions to be internally consistent. Remove even one and the mathematics collapses into contradictions. Infinities that cannot be re-normalized. Symmetries that break down, a universe that shouldn't exist.

> *(I remember writing about these dimensions derived in "M" theory, as related to the Buddhist consciousnesses, back in the 1990's.)*

The Stanford Encyclopedia of Philosophy describes M theory as the most mathematically complete framework for a unified theory of physics that currently exists. And every version of string theory that fed into it, type 1, type 2 IA, type Y, IB, heterero, heterodic, each independently required extra dimensions, not guessed, required. The way a bridge requires specific geometry to not fall down. These aren't optional additions physicists bolted on because they thought it sounded interesting. The extra dimensions are load-bearing structure. The theory only works if they're there. So, where are they?

By the time this video ends, you will understand three things that most physics textbooks don't teach in the same chapter, and that no one has quite connected the way I'm about to connect them for you now.

First, you'll understand exactly what a dimension is. Not the pop science version, not the science fiction version, but the rigorous mathematical definition that physicists actually use. And once you understand that, you'll immediately see why the existence of hidden dimensions isn't weird at all. It's almost obvious.

Second, you'll understand the Kaluza-Klein mechanism. One of the most beautiful and underappreciated ideas in the history of physics, which explains precisely how a dimension can be physically real, geometrically measurable, and yet totally invisible to anything that exists inside it. This idea was so ahead of its time that when Theodor Kaluza sent it to Einstein in 1919, Einstein sat on it for 2 years before publishing it because he couldn't believe it worked.

Third, and this is the part that will stay with you, you'll understand what the LHC at CERN has actually been searching for. why it hasn't found it yet and what it would mean for our entire conception of physical reality if it does. That last part doesn't just change physics. It changes what you think you are. Stay with me because the last part changes everything.

Hold up your hand in front of your face right now. Look at it. You are looking at something that exists in three spatial dimensions. You know this intuitively. It has height. It has width. It has depth. You can move it left and right. You can move it up and down. You can move it towards you and away from you. Three axis, three degrees of freedom, three dimensions. Now, here's a question that seems simple, but is actually one of the deepest questions in physics. How do you know there are only three? You might say, and because that's all I can measure. But measuring something and something existing are not the same thing. Your hand is also saturated with electromagnetic fields you can't see, gravitational curvature you can't feel, and quantum fields whose fluctuations you can't detect. The fact that you can't directly sense something has never been physics definition of it not existing. So, let me ask the question more carefully. How would you know if there were a fourth spatial dimension? A fifth, an 11th? Here's the brutal answer. You wouldn't, not directly, not with your biology, and possibly, depending on the geometry of those extra dimensions, not with any instrument you could ever build using matter from this universe.

To understand why, you need to think about a garden hose. Not the sophisticated version, just a hose lying across your lawn. From far away, from an airplane, for example. A garden hose looks like a line. It appears to have one dimension, one length. That's all you can see from that altitude. But walk up to the hose and look at it closely, and you suddenly see it has two dimensions. It has a length, yes, but it also has a circumference. It wraps around on itself. It's a tube. Now, imagine you're an ant. An ant walking along the surface of that hose experiences both dimensions directly. It can walk along the length of the hose, and it can also walk around the circumference of the hose. Two dimensions, fully accessible, fully real. But imagine instead you're a creature so small that you are literally smaller than the diameter of the hose. A creature the size of a proton. From that scale, the circumference of the hose is cosmologically large and you can travel around it in either direction forever.

It's a fully navigable dimension. Now reverse it. Imagine the circumference of the hose isn't larger than you. It's incomprehensibly smaller than you. So small that no experiment you could run, no probe you could build, no particle you could fire could ever detect that the curvature was there at all. The second dimension of the hose would still be real. It would still have measurable consequences. Consequences that showed up in the physics of how things moved along the hose, but you would never be able to directly perceive it. That is not a metaphor. That is the Kaluza-Klein mechanism. And it is the leading mathematical explanation for why we cannot feel the fifth dimension. Let's go deep because this is where it gets genuinely extraordinary.

In 1919, a mathematician and physicist named **Theodor Kaluza** was working in Kaliningrad (known as Königsberg until 1946) when he did something that in retrospect is almost absurdly bold. He took Einstein's field equations of general relativity, which describe how matter and energy curve four-dimensional spacetime, three spatial dimensions plus one of time, and he simply asked, "What happens in Klein's calculation: how small is the 5th dimension? If I add one more spatial dimension?" Not to reality, just to the equations. "What happens mathematically if I let spacetime be five-dimensional?" The result stunned him. When he expanded **Einstein's field equations** into **five dimensions**, something unexpected fell out of the mathematics. The extra terms generated by the fifth dimension didn't produce nonsense. They produced **Maxwell's equations**. The complete and exact mathematical description of *electromagnetism*. Read that again. He added one dimension to gravity's equations. And electromagnetism appeared spontaneously, necessarily without being inserted by hand. The fifth dimension treated mathematically as a compact extra spatial direction contained within its geometry the complete structure of electromagnetic theory. Kaluza sent his paper to Einstein in April 1919.

Einstein's response preserved in correspondence was unusually hesitant. He wrote back that the idea was so beautiful it seemed implausible. He delayed endorsing it for nearly 2 years, not because it was wrong, but because it seemed almost too elegant to be real. He eventually helped Kaluza publish it in 1921 in the proceedings of the Prussian Academy of Sciences. Then in 1926, the Swedish physicist Oskar Klein solved the one problem Kaluza's framework had left open. Kaluza had shown what happened when you added a fifth dimension, but he hadn't explained why we can't see it. Klein did. Klein proposed that the fifth dimension exists, but that it is compactified. Rolled up curled into a circle so small that it is physically undetectable by anything that exists at our energy scale. How small? Klein calculated it. The compactification radius, the size of the circular fifth dimension, is approximately the plank length. That's 1.716 * 10 ^ of -35 m. To give you a sense of scale, a proton is approximately 10 ^ of 15 m in diameter.

The plank length is 20 orders of magnitude smaller than a proton. It is so small that the concept of looking at it becomes meaningless because looking involves photons and photons with enough energy to probe the plank scale would have so much energy that they would collapse into a black hole before they could resolve anything. This is not a limitation of our technology. This is a fundamental constraint built into the structure of spacetime itself. So the fifth dimension in the Kaluza picture is real. It has geometry. It has a radius. Objects moving through it carry momentum in that direction. What physicists call the fifth component of **momentum**. And here's the critical thing. That fifth component of momentum isn't invisible. It shows up as electric charge. (***In Kaluza-Klein theory, electric charge is not a fundamental property of matter. It is momentum in the fifth dimension.)*** The reason an electron has charge and a neutron doesn't is that the electron is in the five-dimensional picture moving through the compact fifth dimension and the neutron is not. This is one of the most startling conceptual unifications in the history of physics.

Charge, mass, and gravity all from geometry. All from the shape and curvature of a five-dimensional spacetime. Now, the Kaluza mechanism is beautiful, but it runs into problems. The original 1921 version gives predictions that don't match what we observe. Specifically, it predicts that the mass of the first excitation mode of a Kaluza-Klein particle would be around the plank mass, which is about 10 to the^ of 19 gv. That's roughly 20 micrograms, not in the range of anything the LHC can probe and not matching any known particle in the standard model.

This led to decades of refinement. In that refinement we encounter the full framework of string theory and M-theory, and the picture becomes simultaneously more complex and more compelling. String theory doesn't just add one extra dimension — it requires six additional spatial dimensions for a total of ten. M-theory requires seven additional dimensions for a total of eleven. These extra dimensions don't have to be compactified at the Planck scale; different compactification schemes give different predictions.

In 1998, theorists Nima Arkani-Hamed, Savas Dimopoulos, and Gia Dvali — collectively known as ADD after their initials — proposed a radical alternative. What if the extra dimensions aren't compactified at the Planck scale but at a much larger scale, maybe as large as a fraction of a millimeter? This is the large extra dimensions hypothesis. It makes a specific, testable prediction: at the scale of those larger extra dimensions, gravity would appear stronger than the inverse-square law predicts in three dimensions because it would start leaking into the extra dimensions as well. In other words, if you could measure the gravitational force between two objects separated by distances smaller than the compactification radius, you would see gravity deviate from Newton's inverse-square law — getting stronger more quickly, as if additional spatial dimensions were opening up.

This is experimentally testable and has been tested. Washington group experiments at the University of Washington, first published in the early 2000s, measured gravitational attraction at sub-millimeter scales using torsion balances of extraordinary precision. The goal was to see whether gravity deviated from the inverse-square law at those distances. The setup, two parallel discs, one rotating, one stationary, separated by gaps as small as 55 micrometers, less than the width of a human hair.

The gravitational torque between them was measured to extraordinary precision. Any deviation from the inverse square law, any hint of extra dimensions opening up would appear as a measurable anomaly in that torque. What they found, no deviation. Gravity behaves exactly as Newton's inverse square law predicts down to scales of about 50 micrometers. If there are large extra dimensions, they must be compactified at a radius smaller than approximately 44 micrometers. The millimeter scale version of ADD is ruled out. But here's what's important. The AOT wash results don't rule out extra dimensions. They constrain the size of extra dimensions. Everything below 44 micrometers remains experimentally open and the plank scale compactification of the original Kaluza picture remains completely untested because we have no way to probe forces at the plank scale yet. Now let's talk about the LHC because this is where the search for extra dimensions becomes something genuinely dramatic.

The Large Hadron Collider at CERN, buried 100 meters beneath the Franco–Swiss border, collides protons at energies up to 13.6 teraelectronvolts (13.6 TeV) in its current Run-3 configuration. These are the highest-energy collisions ever achieved by humanity. Among the things physicists have been searching for in the debris of those collisions are signatures of extra dimensions — two signatures in particular.

The first is Kaluza–Klein graviton excitations. In theories with extra dimensions, the graviton, the hypothetical quantum of gravity, isn't a single particle but a tower of particles. The ground-state graviton has essentially zero mass and propagates through all dimensions. When a graviton acquires momentum in a compact extra dimension, it appears in our four-dimensional space as a series of heavier particles — the **Kaluza–Klein tower**.

> *(This "tower" of dimensions seems quite relatable to the cascade of interactions and dependencies described through the Nidana. The precipitous amalgams of actions and reactions precipitating the expression of forms from potential energies, tendencies, and conditions. I am often fascinated with the near rhetoric of scientific discovery and exploration into the language of near 3000 year old dialogues of the Buddhist thought on truth and the nature of life.)*

These particles would have specific predictable mass gaps between them determined by the compactification radius. If the LHC generated one of these particles, it would show up as an unexplained resonance, a spike in the invariant mass spectrum of its decay products. No such resonances have been observed as of the completion of run 2 in 2018. The CMS and ATLAS detectors have pushed the mass limit for spin-2 Kaluza–Klein gravitons in the Randall–Sundrum model — a specific extra-dimension framework — to above approximately 4 TeV. They simply aren't there at the energy scales we've reached.

The second signature is microscopic black holes. In theories with large extra dimensions, the true Planck scale — the energy at which gravity becomes as strong as the other forces — could be as low as 1 TeV rather than 10^19 GeV. If that's true, the LHC should be producing microscopic black holes in many high-energy collisions. These black holes would evaporate essentially instantly through Hawking radiation, producing a very specific signature: a democratic spread of high-multiplicity, high-transverse-momentum particles across all particle species. Again, no such signature has been observed — not one confirmed microscopic black hole candidate in the entire Run-1 and Run-2 data set.

Does this mean extra dimensions don't exist? Not at all. It means the specific parameter space of large extra dimensions with TeV-scale gravity is constrained. The Randall–Sundrum model proposed in 1999 by Lisa Randall and Raman Sundrum remains viable in significant portions of its parameter space. There are entire classes of compactification schemes and extra-dimension models that the LHC is not sensitive to because they predict signatures at energy scales we haven't yet reached or predict effects that manifest through precision measurements rather than direct production.

Here's the detail most physics explainers miss: the absence of a direct detection at the LHC doesn't threaten the mathematical necessity of extra dimensions in string theory and **M-theory**. Those dimensions are structural requirements of the mathematics. The equations of M-theory require exactly 11 dimensions or they are inconsistent. What the LHC non-detections do is constrain which particular version of compactification nature has chosen — they indicate that if extra dimensions exist as required by M-theory, they are either too small or too weakly coupled (or both) to produce detectable signatures at 13.6 TeV.

Now let's go even deeper because the Kaluza-Klein mechanism as beautiful as it is only one of two major frameworks for understanding extra dimensions. The other and in many ways the more conceptually radical one is the idea of Branes. In M theory the fundamental objects aren't just one-dimensional strings. They're extended objects of various dimensions. Strings are one Branes, membranes are two Branes and there are Branes all the way up to nine Branes.

> *(Wait,wait, wait, a (9) nine Branes? Hu Hu Humm, 9 consciousnesses? In Branes. Okay, I just had to point out this strangeness, or is it symmetry.)*

Our entire observable universe, everything you've ever seen, touched, measured, or imagined, might be a three-Brane, a three-dimensional hyper-surface embedded in an 11 dimensional bulk spacetime. And here's the key physics of Branes that makes extra dimensions invisible to us. The forces of the standard model, electromagnetism, the strong nuclear force, the weak nuclear force, are confined to the brain. They are stuck to our three-dimensional surface like paint on a wall. They cannot propagate into the bulk. Gravity, however, is different. Gravity in string theory is mediated by closed strings loops rather than open-ended filaments and closed strings are not confined to the brain. They propagate freely through the full 11 dimensional bulk. This is why gravity is so much weaker than the other forces.

The phenomenon physicists call the hierarchy problem: gravity seems absurdly weak compared to electromagnetism. An ordinary refrigerator magnet can overcome the entire gravitational attraction of planet Earth to hold itself against a vertical surface. That hierarchy — a deficit of roughly 10^36 between the electromagnetic and gravitational forces — has never been satisfactorily explained within a purely four-dimensional framework. The brane-world scenario offers an answer: gravity appears weak to us because most of it is leaking into the extra dimensions. The gravitons that should be pulling your coffee mug toward the table spread out into a bulk we can't access; we only catch a fraction of them. This is not metaphor — it is the Randall–Sundrum model's quantitative prediction. In their 1999 paper in Physical Review Letters, one of the most cited papers in theoretical physics of the last 30 years, Randall and Sundrum showed that a single additional warped dimension, with our universe as a three-brane at one end and another brane at the other, can naturally generate the observed hierarchy between gravity and the other forces without fine-tuning. The warped geometry of the extra dimension exponentially suppresses the graviton's wavefunction on our brane, making gravity appear weak — even though it is fundamentally the same strength as the other forces; the extra dimension produces the effect. The weakness of gravity in this picture is an illusion created by geometry we cannot observe.

There is one more mechanism to explain before the philosophical “gut punch”: supersymmetry (SUSY), which is deeply connected to why extra dimensions work mathematically. Every known matter particle (every quark, every electron, every neutrino) is a fermion with half-integer spin. Every force-carrying particle (photons, gluons, W and Z bosons) is a boson with integer spin. In the Standard Model these two classes are unrelated. String theory requires supersymmetry, a mathematical symmetry that pairs every fermion with a bosonic superpartner and every boson with a fermionic superpartner. The superpartner of the electron is the ‘s’-electron; the superpartner of the quark is the ‘s’-quark; the superpartner of the graviton is the gravitino. Why does this matter for extra dimensions? Without supersymmetry, quantum corrections to particle masses diverge — they run to very large values in a way that cannot be removed.

These infinities are called quadratic divergences, and they plague any quantum field theory that doesn't respect supersymmetry. String theory is only mathematically consistent, free of infinities, renormalizable, and internally coherent in a spacetime that has both extra dimensions and supersymmetry. They're not separate features — they're intertwined.

The geometry of the extra dimensions in string theory is called a Calabi–Yau manifold: a six-dimensional shape of extraordinary mathematical complexity with hundreds of different possible topologies. The choice of Calabi–Yau manifold determines the physics of our four-dimensional world — which particles exist, what masses they have, what forces they feel. The Standard Model in this picture is the shadow that the geometry of a Calabi–Yau manifold casts onto our three-dimensional brane. We cannot see it because it's compactified at extremely small scales; it is here right now, woven into the fabric of the space your hand occupies. Every point in the space around you contains, coiled within it, a six-dimensional Calabi–Yau manifold with a diameter roughly the Planck length. At every point, everywhere, your hand is moving through nine spatial dimensions — six of those dimensions are curled up so tightly that every measurement and experiment to date has detected only the three large ones. But they're there.

A Calabi–Yau manifold is a specific type of complex geometric shape. The name honors mathematicians Eugenio Calabi, who conjectured their existence in 1954, and Shing-Tung Yau, who proved the conjecture in 1977; that proof helped earn Yau the Fields Medal. The defining geometric property of a Calabi–Yau manifold is vanishing first Chern class combined with a Ricci-flat metric. For our purposes, that means the shape is, in a precise sense, perfectly balanced: its curvature integrates to zero over the whole manifold. It is the most symmetric six-dimensional shape consistent with the requirements of supersymmetry.

String theorists need Calabi–Yau manifolds because supersymmetry imposes constraints on the allowed shapes of the extra dimensions. If you curl the extra dimensions into an arbitrary shape, supersymmetry breaks. The moment supersymmetry breaks at the compactification scale, mathematical inconsistencies can arise. Calabi–Yau manifolds preserve exactly the right amount of supersymmetry to keep the theory consistent while producing a four-dimensional world with the kinds of particles and forces we observe. The topology of the chosen Calabi–Yau — its connective structure — determines the particle content of the resulting four-dimensional theory. The number of holes in the Calabi–Yau, characterized by what mathematicians call Hodge numbers (specifically h1,1 and h2,1), determines the number of generations of matter.

The Standard Model has three generations of fermions: three copies of the quark–lepton pattern at increasing masses (up/down, charm/strange, top/bottom, with associated charged leptons and neutrinos). We don't know why there are three generations within the Standard Model; in string theory, the number of generations is a topological property of the Calabi–Yau manifold. A Calabi–Yau with the right Hodge numbers gives exactly three generations. The particle generations are thus a topological property of six-dimensional geometry. This is the deepest version of Kaluza's original insight: it's not just that forces come from the geometry of extra dimensions — everything does. The number of matter species, the ratios of their masses, the strengths of the forces between them, and even the cosmological constant (the energy density of empty space driving the accelerating expansion of the universe) are parameters that, within the Standard Model, must be measured, but in string theory are determined, at least in principle, by the shape of a six-dimensional object coiled into the fabric of space at every point.

Now a further complication: flux compactification — the mechanism by which string theorists stabilize the extra dimensions. This explains why the extra dimensions are compactified at a particular scale instead of expanding to become large like our three spatial dimensions or collapsing to zero size. When you compactify string theory on a Calabi–Yau manifold, you get more than geometry: you also get field analogs of the electromagnetic field threading the holes in the manifold. These are called fluxes — quantized field strengths that wrap the topological cycles of the Calabi–Yau. The fluxes exert pressure on the manifold, resisting changes in its size and shape. The balance between flux pressure and curvature creates a stable equilibrium — a minimum in what string theorists call the moduli potential.

The critical paper here is by Shamit Kachru, Renata Kallosh, Andrei Linde, and Sandip Trivedi — collectively known as KKLT — published in 2003. The KKLT construction showed how, using a combination of fluxes and non-perturbative quantum corrections, it is possible to create stable vacuum states in string theory with a positive cosmological constant — precisely what we observe in our accelerating universe. The mechanism is baroque in its complexity, but the principle is clear: extra dimensions are held at their compactification size by physical forces (fluxes) derived from the theory. This is also the origin of the landscape problem. Different choices of flux configuration — different ways of threading fields through the holes of the Calabi–Yau — give different four-dimensional physics. There are an astronomical number of possible flux configurations; the oft-quoted number ~10^500 is the KKLT landscape. It is both the most impressive result and the most troubling feature of contemporary string theory.

Every experience you have ever had — every sensation, perception, thought, memory, moment of joy, grief, boredom, or wonder — has occurred inside a three-dimensional slice of an 11-dimensional spacetime. You have never perceived any of the other eight spatial dimensions: not once, not even slightly, not even at the most fundamental level of your neurology.

Your entire model of reality, the model your brain has constructed since the first moment you opened your eyes as an infant and refined through every second of experience since, is a model of three dimensions plus time. Everything your intuition tells you about space, about distance, about direction, about shape, all of it, every bit is a description of a shadow, not a metaphor. Physics is telling you this literally. The world you experience is the projection of a higher dimensional structure onto a three-dimensional surface. The way a shadow on a wall is the projection of a three-dimensional object onto a two-dimensional surface, except the object casting the shadow is 11 dimensional and you are inside the shadow.

> *(I don't think it is necessary for every Buddhist to understand the extreme elegance of this model of the universe in order to practice Buddhist method to fulfillment. However, I do feel that as an exercise of our minds, it is a profoundly important reminder of the amazing and awesome processes of the* ***Engine of Life*** *to remain always in awe of the immediate connection we make with Daimoku to this engine of energy.)*