DISRUPTIVE

REWRITING THE RULES OF PHYSICS

STEVEN B. BRYANT

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Dedication

For my daughter Sarah, her generation, and all those who dare to ask: "Why?"

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Preface

"Why can't we go faster than the speed of light?" That was the question I asked everyone I knew. The answer came back: "Because Einstein said so," which was an answer that did not sit well with me. In fact, that specific answer pressed a particularly personal and emotional button that was implanted many years earlier. When I was a child, my mom would offer that response: "Because I said so!" when she was exasperated with me and wanted to bring the conversation to an end. It didn't mean she had an answer, at least not one that I would find remotely acceptable. However, it meant she was done discussing it and if I didn't want to get into trouble I had better "*step into line*."

I share this background to provide some context for the issue I had with people who gave it – "Because Einstein said so" – as a response to my question about *why* we could not travel faster than the speed of light. While this answer ended the conversation, it did not answer the underlying question: *Why?* As was the case with my mom's answer, their answer didn't sit well with me because it pressed the exact same button. So I had to find the answer another way. I had to discover the answer for myself.

The good news is that I knew that the answer was in Einstein's work. If people were saying: "Because Einstein said so," then I just needed to find *where* he said it. I knew that once I found it, I would either *step into line* and believe what everyone else believed, or I would have a better understanding of his work and find a specific reason for objecting and believing something different. In either case, I would have an answer. Finding the answer to this fundamental question is how I started my journey into the exciting world of physics.

While my exploration of physics started with a focused, concerted effort to understand Einstein's relativity theory, it did not end there. What was interesting is that for each question I answered, two new questions arose. It was this never–ending question–and–answer cycle that led to my understanding of the works by many of the founding fathers of theoretical and experimental physics: Newton, Maxwell, Lorentz, Einstein, Michelson and Morley, De Broglie, Heisenberg, and Planck.

When I started exploring physics, I approached my research with no preconceptions that any theory, specifically relativity theory, was right or wrong. My goal was to develop an understanding of the material based on what the authors said. I sought out their original works instead of looking for some simplification of their ideas that might be presented in an introductory college textbook. I wanted to understand the material so well that I could derive their equations and communicate their key theoretical points. I wanted to see everything I read from the point of view of the authors – to understand their choice of words (sometimes in their native languages) and understand why they chose certain words over other words. As an author, I know that how you say something – your choice of words; what you choose to say, and what you choose not to say – are all equally important. I think this perspective enhanced my understanding of the various theories, increased my understanding of what the authors were trying to accomplish, and helped me develop an understanding of what they were not able to effectively explain in their work.

I'm writing this book at a time when many scientists believe that certain theories, such as Einstein's relativity theory, are sacrosanct. As a result, we must acknowledge an important fact: Many of these theories have been useful for more than a century, with each helping us advance our scientific thinking and knowledge. However, just because a theory is useful, that doesn't mean it is perfect or, in some cases, even correct.

By today's standards, the ancient Greek model for the motion of the planets is wrong because it placed the Earth at the center of the solar system. Today, we know that all of the planets orbit the Sun as the center of the solar system, not the Earth. So, no matter how useful their model was and how well it might have served them, the Greek model was wrong. We have advanced beyond their model because our knowledge and experience have advanced. As a result, we are now able to make additional predictions that could not have been made with the ancient model.

Having a useful theory does not mean that we should end our quest for something better, something that has more accuracy, something that is easier to understand, or simply something that aligns better with other theories or experiments. The late Dr. Richard Feynman, a well–known and respected physicist, recognized the importance of being open to alternative theories, even those that disagree with the consensus. While the truth is probably in the prevailing direction, in his 1965 Nobel speech, he said that we have to remain open to the possibility that the "*truth may lie in another direction.*"

As responsible scientists, we must study, use, extend, and defend those models that provide the *best answers* and help us explain observations of our world. Now, we can't just change from something that seems to work to an alternative theory on a whim. That's not smart or useful. But, we always have to remain open to the possibility that each of our theories might be limited, incomplete, flawed, or simply wrong. If we're not open to this possibility, then we are not responsible scientists, because we will have let our beliefs get ahead of our judgment, rigor, and disciplined scientific method. So, we must explore those theories and ideas that give us the best answers – the best conceptual, mathematical, and predictive answers – regardless of our beliefs in the validity of any existing model or theory. This is how science advances.

This brings us to a very important point: A new model does not need to align with an existing theory, certainly not one that it is intended to replace. A new model must explain existing observations in a way that makes sense and is consistent. While we have to be able to explain existing theories and how they are related to a new theory, that comparison needs to happen at the end, not as a prerequisite.

We are going to develop and build our model from the ground up. As you progress through this book, you should gain a deeper understanding of this new model, called Modern Mechanics. Building upon classical mechanics as a foundation, Modern Mechanics is a unified model that offers greater mathematical accuracy than relativity theory and is easier to understand than quantum mechanics. In addition, you'll develop new perspectives of existing theories and experiments that you may not have seen before. For example, you'll learn about time dilation and length contraction, what they mean, why relativity theory requires both characteristics, and why these concepts are *not* part of Modern Mechanics.

You'll also examine nuances associated with one of the foundational experiments in quantum mechanics: the double–slit experiment. In this case, you'll learn how Modern Mechanics explains a particle's movement to the left or right of center in the experiment, rather than continuing in a straight line, a nuance not explained by quantum mechanics today.

This introduction to Modern Mechanics is intended for anyone with an interest in science, an interest in how things move, and an interest in physics. While an understanding of college algebra will facilitate comprehension, the math will be kept as simple as possible, only relying on advanced math when necessary. When we develop several equations in chapters 4 through 7, their meanings will be explained textually, as well as mathematically.

Sometimes, mathematics involving functions and equations can appear more difficult than it actually is. This can occur when we use an expanded character set, subscripts, or superscripts to represent variables. For example, if we wanted to sum the weight of Tom and Harry, we could represent this as the equation $S = T + H$. Alternatively, we could use Greek letters to write the equation as $\zeta = \delta + \varpi$. We could also use subscripted variables, where the same equation could be represented as $w_S = w_T + w_H$. While this may look complex and intimidating, we sometimes need more letters than the 26 that are in our alphabet. Greek letters, subscripts, or superscripts enable us to use other "letters" that make sense in our work. These are simply different ways of representing variables. For example, T, H, and S might refer to Tom's weight, Harry's weight, and their sum, as measured on Earth, while δ, ϖ, and ζ might refer to their weights as measured on Mars. Lastly, it is important to recognize that some characters, while different, will look similar. For example, the Greek symbol τ, called Tau, is different from the letter r, although they look similar.

I am excited to finally be completing this book. However, I don't want to give the impression that my work or thought process occurred in a vacuum. In fact, that would be entirely incorrect, especially given the number of people who have helped and inspired me. There are several people I'd like to acknowledge. I have to start with my wife, Julie, and daughter, Sarah. It is through them that I have found a never–ending source of love, passion, and support. I thank Irene Cole who, early on, advised me to approach my work in a scholarly, scientific way. That meant being disciplined about how I approached my research and writing. I also thank Dr. Nettie LaBelle–Hamer, whose advice after reading my first paper still rings loud and clear. She essentially said: *It's a good paper, but it doesn't go far enough. Don't just imply something; say it! People don't want to read something that isn't definitive. Put your neck on the table. Say what you want to say and stand by your convictions.* She was coaching me to take a risk, metaphorically, by putting my neck on the table. She was also advising me to make sure I had done my homework so that it didn't get chopped off. Great advice! It is advice that you will see reflected in the pages that follow.

I also want to thank my reviewers: Dr. Glenn Borchardt, Don Briddell, and Anatoliy Neymark. Each reviewer asked insightful questions, the answers to which are contained herein. Not only did they provide valuable feedback on the content, tone, and flow, their excitement and desire for the next update was truly inspiring. You will see their feedback reflected throughout the book.

Finally, I want to thank my editor, Grant Dexter. While he focused on grammatical, typographical, and content corrections, he read the material with the same passion and curiosity that I hope is shared by many readers. His attention to detail, corrections, and recommendations have enhanced and improved the overall quality. Words cannot express my gratitude for his

contribution and I am fortunate to have partnered with such a skilled professional.

There are many others, who should be listed by name, but in more than 15 years of research it would take pages to list them all and I inevitably would leave someone out. At this point, I want to acknowledge everyone who has been part of my journey so far. Thank you!

I started writing this book in a café in Emeryville, California; with much of the material being written wherever I happened to be in the world: Berkeley, Charlotte, Point Reyes, London, San Francisco, or on an airplane flying at 36,000 feet. I hope that I'm able to provide you with an introduction to the new and exciting physics model called Modern Mechanics!

Steven Bryant, 2016
San Francisco Bay Area, California

Chapter 1 Introduction

Modern Mechanics is a unified model that represents the next generation in physics. It corrects mathematical mistakes and conceptual problems with existing theories, is intuitive and easy to understand, and has higher mathematical accuracy than its alternatives. To appreciate and understand what Modern Mechanics means to physics and why it's needed, we have to explain what physics is, understand the problems it tries to solve, and identify the problems with the established theories.

When people think of physics, what comes to mind for many is an extremely difficult subject that, if it wasn't part of a required science curriculum, might be actively avoided in high school and college. Others think of well–known theories like relativity or quantum mechanics, theories that some feel can only really be understood by a small subset of the scientific elite. These misperceptions about the level of difficulty of physics mask the simplicity and elegance that makes up its magnificent world.

Defining physics is surprisingly easy: *It is the study of why, how, and what happens when things move.* Consider several of the areas that make up physics and notice how each is simply a description of motion. Classical mechanics is about how things move around in the physical world. Thermodynamics, which is about heat, is in large part really about the movement of molecules, particles, or electrons to generate that heat. Optics is about how light behaves when it moves. Electrodynamics is essentially about how radio waves behave and move. Relativity is about the movement of large things and what happens when they move very fast. And quantum mechanics is about the movement of small things and what happens when they move very fast. If it moves, it is described with physics. This surprisingly simple explanation of what physics is helps us define a discipline that explains many aspects of our lives.

Since the beginning of time, mankind has tried to explain the world we live in, a large part of which involves describing how things move. Scientists play an important role by developing models and theories that explain what we are observing or provide us with a means to make predictions. Historically, these useful and valuable theories are grounded in religion and science. Sometimes explanations originate in religion and are later explained solely in scientific terms. Regardless of where an idea originates, as we expand our scientific knowledge and develop better models and theories, the number of things we are able to scientifically explain grows. Once a model or theory has demonstrated its value, it is difficult to change – even if it is not intuitive, has gaps in what it can explain, or has some inaccuracies or limitations. We would rather have a theory or model that is wrong or only works some of the time than nothing at all.

Replacing an existing theory or model is not an easy task, and acceptance of a new idea requires several elements; one of which is timing. It has to be developed at the right time and championed, meaning that it will be advocated by a person or group who will support and encourage its adoption over the reigning model. Generally, scientists are cautious about embracing a non–traditional, novel theory, especially if it negates an existing, well–established theory. This cautious approach minimizes the risk and harm to one's reputation that could result from challenging the accepted doctrine. Regardless of whether the new model is right, challenging the prevailing model is risky. Gaining the interest and support of the broad scientific community when they already support a position is a significant initial hurdle.

In addition, the new theory or model should be rational, intuitive, consistent, and offer something that the existing model does not. A model that does not offer better explanations, provide better answers, or make better predictions than the prevailing model is not going to make headway in advancing science or establishing itself as the leading model.

While successfully changing a widely accepted belief in an existing model or theory is difficult and does not occur often, it does happen. In fact, physics has already gone through two significant generational changes, or paradigm shifts. In the 15th century, the prevailing consensus was that the Earth was the center of the universe around which all heavenly bodies – the stars, planets, Sun, and Moon – orbited. Nicolaus Copernicus, someone whom today we would call an astronomer or a physicist, did not accept the reigning theory and had a different idea. He believed that the Sun was at the center of our solar system and that all of the planets orbited it instead of the Earth. In the 15th century, this was a radical idea, one that would take more than 200 years to change. In fact, it did not change until the 17th century, when Galileo Galelei conducted several experiments that supported Copernicus' theory. Like Copernicus, Galileo's conclusions were considered radical; so much so that he was arrested, put on trial, and served the remainder of his life under house arrest. Considered heresy in his day, we now accept this Sun–centered solar system view as scientific truth. While change did not occur easily, the views of Copernicus and Galileo are now widely accepted, and their work on motion forms the foundation of physics and astronomy.

Isaac Newton, widely regarded as one of the greatest scientists who ever lived, was born less than a year after Galileo's death. Like Galileo, he conducted experiments in motion and developed several theories to explain how things move. The works of scientists like Copernicus, Galileo, and Newton, who are among the founding fathers of physics, form the foundation of first–generation physics, called classical mechanics.

Classical mechanics helps us understand how physical things move. Many students are introduced to classical mechanics in elementary school when they learn about geometric transformations in math class. Classical mechanics helps us answer questions about how we move throughout our world; for example, *If you live 300 miles from Disneyland and leave your house at 6AM, driving at 60 miles per hour, when will you arrive at Disneyland?* Many people quickly arrive at the answer of 11AM because it takes 5 hours to travel 300 miles when driving at 60*mph*. After adding 5 hours to a start time of 6AM, we know you will arrive at 11AM. Questions like this are answered on a daily basis and most of us never realize that we're using classical mechanics, or first–generation physics.

Classical mechanics served mankind well for a long time. It was, and still is, very useful in helping us understand how physical things move and behave. As the reigning theory of its day, it was beyond reproach until the discovery of a new and mysterious force called the electromagnetic force (EMF). While classical mechanics was extremely useful, it did not explain everything that scientists were observing with EMF experiments at the end of the 19th century. In fact, a scientific crisis occurred when experiments with light (also called optics) and EMF could not be explained using classical mechanics.

Out of crisis comes opportunity, and the turn of the 20th century was a fabulous time for physics. Our understanding of the electromagnetic force, the building block of all modern electronics and communications, was just forming. Because classical mechanics did not make accurate predictions in this area, we needed a new model or theory to explain how things moved. Scientists like Hendrik Lorentz, Henri Poincaré, and Albert Einstein filled the void by developing equations and theories to explain the experiments that could not otherwise be explained using classical mechanics.

Einstein’s theory, called relativity, would reign for more than a century. Relativity theory is generally regarded as a replacement for classical mechanics and forms the foundation for modern theories in astronomy, motion, and gravitation. His theory, however, was not universally welcomed when it was first unveiled, probably because it was difficult to follow and because its conclusions marginalized the work of Newton, whose theories were still widely accepted. However, to Einstein's benefit, relativity theory provided an explanation for some of the experiments with light and EMF that classical mechanics was unable to explain. Because Einstein's theory offered an explanation, along with a mathematical model that offered far better accuracy than classical mechanics, it gained a solid foothold and became the foundational theory in what we now call modern physics.

Relativity theory was not the only theory that attempted to explain areas that fell through the gaps of what classical mechanics could explain. Led by scientists like Max Planck, Niels Bohr, and Werner Heisenberg, the field of quantum mechanics was born. While relativity explained the motion of large things, like planets, quantum mechanics explained the motion of very tiny things that are the building blocks of electrons and other small particles. Together, relativity and quantum mechanics are commonly referred to as modern physics, or second–generation physics.

While both theories do a good job of explaining their respective areas, neither serves as a unified theory, because they do not do a good job of explaining observations that the other explains well. First and second–generation theories and models were developed by different people at different times using different assumptions. As a result, these models and theories, and their accompanying mathematical equations, do not always work well with one another. A perfect example of this problem is the interplay between relativity theory and quantum mechanics, the latter of which relies heavily on statistics and probability. Einstein did not agree with quantum mechanics, saying it was "spooky" and that God does not roll dice. Because the two theories are based on different assumptions, their unification is challenging at best. While scientists today accept the merits of both theories (including their incompatibilities), we still love elegant solutions. *Why should we have two theories when one unified theory would be better?* Modern scientists have embarked down a path to find a theory that unifies relativity and quantum mechanics. This search for a unified theory is one of the most interesting and exciting scientific quests of the late 20th and early 21st centuries. Imagine the power, simplicity, and beauty of being able to explain with just one theory how things move and interact.

Previous attempts at a unified theory, like quantum electrodynamics and the standard model, retain and incorporate the existing theories. Any unified theory that tries to incorporate relativity as one of its foundational theories will be incorrect, since, as you will read later in this chapter, relativity is mathematically incorrect. This also applies to any derived theory, such as general relativity, which holds as one of its key assumptions that special relativity is correct. These are bold statements that can only be made because Modern Mechanics produces equal or better mathematical answers, in addition to overcoming mathematical and conceptual shortcomings found in earlier theories.

Modern Mechanics represents the third generation in physics and overcomes several problems with second–generation physics. First, quantum mechanics and relativity, while complementary, are at odds with one another in their fundamental assumptions. Modern Mechanics does not try to retain and reconcile the two. Instead it offers unified explanations of the key foundational experiments, independent of how other theories may have attempted to explain them in the past. Like Einstein's theory of relativity, it explains how large things move and behave. Like quantum mechanics, it explains how small things move and behave; it just does so differently. Second, some of the modern experiments with superluminal light (light traveling faster than 300,000km/s) are not easily explained by existing theories, or more worrisome, require experimenters to come up with novel reasons to explain why their results and the theory remain consistent. Such explanations are not required with Modern Mechanics, which does not have a *speed limit* like relativity theory. A third problem is that these modern–physics theories contain math or logical mistakes that invalidate them or, at a minimum, require their conceptual foundation to be revisited. These mistakes are extremely subtle, even by modern standards, and could not have easily been uncovered using the body of knowledge available to scientists at the end of the 19^{th} or start of the 20^{th} century.

Admittedly, this will be the most controversial aspect of this book, because many people will not easily accept that a theory that has been expertly reviewed and used for more than a century could contain an overlooked mistake. However, if we develop a new model that is more intuitive; has a unified explanation of the experiments addressed separately by classical mechanics, quantum mechanics, and relativity; and provides more accurate mathematical results than those models, then this would represent prima facie evidence of problems in those other theories.

Modern Mechanics has to satisfy three objectives to function as a unified theory. First, it must provide mathematical results that are equal to or better than the results provided by the reigning models. Any theory that fails to meet this objective cannot unseat the prevailing models. A significant benefit of producing equal or better math results is that scientists and engineers have a responsibility to research and understand those models and theories that offer the best mathematical answers. To do otherwise risks being mired in dogmatic belief, which is not scientific.

Second, it should be easy to understand. One of the challenges in modern physics is that relativity and quantum mechanics are hard for non–scientists to comprehend and understand. They are largely inaccessible to those who do not have a firm grounding in advanced math, including calculus and partial differential equations. While grounded in mathematics, Modern Mechanics is intuitive and can be largely described using geometric terms and algebra. Although any theory or model can be described using advanced math, and Modern Mechanics is no different, accessibility to the non–scientist is enhanced when we can communicate clearly and easily.

Third, it must be mathematically sound. This leads to two related questions: If modern physics has served us well for a century, what, if anything, could possibly be wrong with its foundational theories? Haven't they been "proven" by now? Surprisingly, wrong equations can often produce good results; up to a point. For example, as a crutch, some school children will learn that Pi equals 22 divided by 7. While incorrect, it is accurate to two decimal places, and if this is all the accuracy you need, this equation will work well. However, it is wrong because Pi, which begins as 3.14159265359, is defined as the circumference of a circle divided by its diameter. Pi, which is an extremely interesting irrational number, is not 22 divided by 7. Similarly, relativity contains mathematical mistakes that render it incorrect, but accurate up to a point. The small amount of error, when compared with other models of its day, explains why relativity theory has survived as a useful theory.

Relativity is one of the foundational theories in modern physics. It has produced good mathematical results and, in some cases, has been the only theory able to accurately predict the outcome of specific experiments. It has withstood the test of time by successfully repelling the previous onslaught of challenges and criticism. To understand why relativity has been so resilient and the mistake hasn't been previously discovered, we must examine how the theory has been challenged and defended.

As illustrated in Figure 1–1, relativity theory is actually the combination of two theories: special relativity, which Einstein defined in his famous 1905 paper, and general relativity, which Einstein published ten years later. General relativity is built upon the assertion that special relativity is correct, but incomplete. Both theories follow the same general approach, which is to 1) begin with a key set of *assumptions*, 2) develop the math for the theory – called the *derivation*, 3) check the work to ensure it makes sense and holds together – called the *proof*, and 4) discuss the key *implications* that result from the theory. Einstein's development of special and general relativity follow this four–step approach.

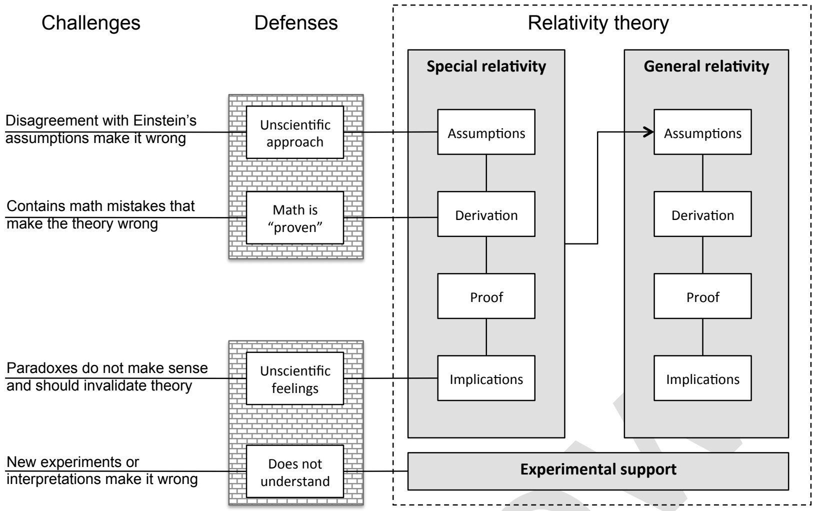


Figure 1–1 Framework for challenging and defending relativity theory.

Although Einstein's work follows this approach and is widely accepted, many have challenged his efforts. Most of the challenges have been made against special relativity, partly because it is the easier of the two theories to understand and partly because if special relativity were shown to be incorrect, then general relativity, because of its dependency on special relativity, would also be shown to be incorrect. Challengers have focused their attacks on special relativity's *assumptions*, *derivations*, *implications,* and *experiments*. Regardless of whether a challenge was on the right path or not, each of these attacks has been rejected.

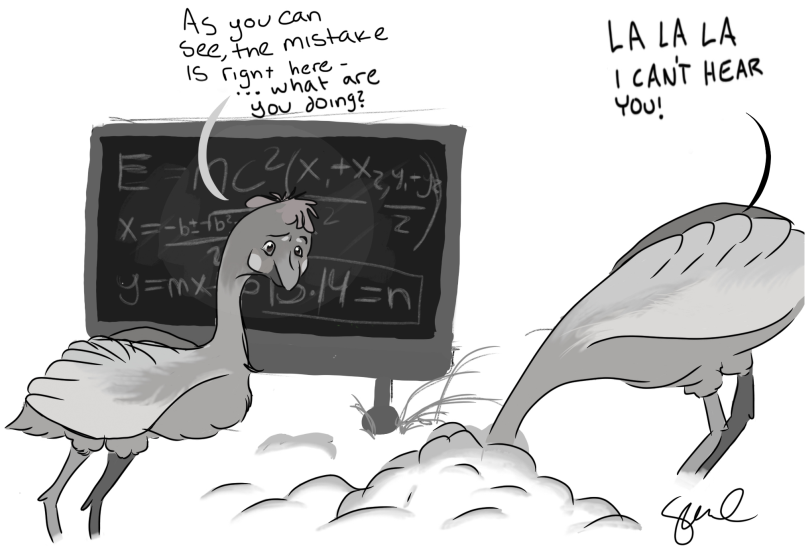
Assumptions are simply the foundational items of a theory that are presumed to be correct. Scientifically, and in Einstein's work, these assumptions are called postulates. As long as the derivation, proof, and implications do not violate the foundational assumptions, then the theory holds together. Challenging a theory solely based on a disagreement over the foundational assumptions will be insufficient to invalidate a theory. All a supporter has to say is "*you don't understand the theory*" or "*you're not following a scientific process,"* dismiss the rest of the challenge, and walk away. This defense has proven successful because the challenger, especially when the rest of the theory remains unchallenged, is not following a disciplined mathematical or scientific approach.

Some challengers have attacked Einstein's *derivation*. This type of attack suggests that relativity theory contains mathematical mistakes that render the theory incorrect. However, there are two problems with this type of attack. First, the mistakes are extremely subtle and often hinge on an understanding of some specific nuances that not all scientists, engineers, and mathematicians are familiar with. However, what is often the case is that the challenger has overlooked a key mathematical characteristic. Second, the defense against this attack is to simply ask: "*If Einstein's math is wrong, why does his proof work and why do his equations offer the best math predictions?*" Until the introduction of *The Model of Complete and Incomplete Coordinate Systems*, the precursor to Modern Mechanics, this second objection could not be countered and the defense would hold. As you will soon read, the proof actually failed and the equations associated with Modern Mechanics produce equal or better results than relativity theory.

Rather than challenge the assumptions or derivation directly, some have resorted to challenging the *experimental* support for relativity theory. Often these attacks challenge the predictive capabilities of a theory without offering an alternative theory that would produce equal or better results. They interpret the results in novel, non–mathematical ways, or conduct new experiments that fail to gain the recognition of the broader scientific community. With this type of attack, the challenger often disregards the fact that relativity theory has a proven experimental track record. While this does not make the challenge wrong, these challengers fail because they do not provide an alternative that produces improved results, nor do they show what specifically is wrong with Einstein's theory. With this challenge, the defender simply says that the challenger "*doesn't understand the experiment*" and dismisses the attack.

Many challengers attack the *implications*, such as time dilation and length contraction, because these concepts do not make intuitive sense. They argue that the entire theory should be invalidated because the concepts of the theory do not make sense. The defense is simply to say, if the approach was sound; the assumptions are consistent; the derivation is correct; the proof passes; and the experiments support the theory, then you must accept the implications regardless of what you might intuitively believe. Unless the challenger can offer evidence of a problem elsewhere in Einstein's work, this type of attack will be easily defended because it is viewed as an undisciplined attack based on non–scientific *feelings*.

For more than a century, the nature of the challenges has fallen into these four categories: assumptions, derivation, experimental support, and implications. Since historically the challenges have been unsuccessful in convincing the broad scientific community of a problem with Einstein's work, many modern challenges in these areas are met with deaf ears.



The only area that had not been challenged was the *proof*. In fact, a quick review of Einstein's spherical wave proof would leave any reader with the belief that his proof is correct. Prior to the author's work, *The Failure of Einstein's Spherical Wave Proof*, few (if any) scientists had challenged Einstein's proof. It is straightforward to show where Einstein's proof fails, but it is far harder to change the *belief* that his theory is right. Before we can begin to define Modern Mechanics, it is imperative that you understand why people believe Einstein's proof is sound, why it actually failed, and why finding the mistake has been so elusive.

Einstein's Spherical Wave Proof

When scientists develop new, nonobvious theories, they must also develop proofs that show their assumptions and mathematics are compatible. Einstein developed such a theory and an accompanying proof, which is referred to throughout this book as the spherical wave proof. This proof is the most critical component of Einstein's paper, because without it, he is unable to claim that his theory is mathematically and conceptually correct.

As illustrated in Figure 1–2, Einstein's spherical wave proof consists of six sentences. He begins with a spherical wave and considers the proof successful if he can show that the transformed points form a spherical wave when observed in a moving system.

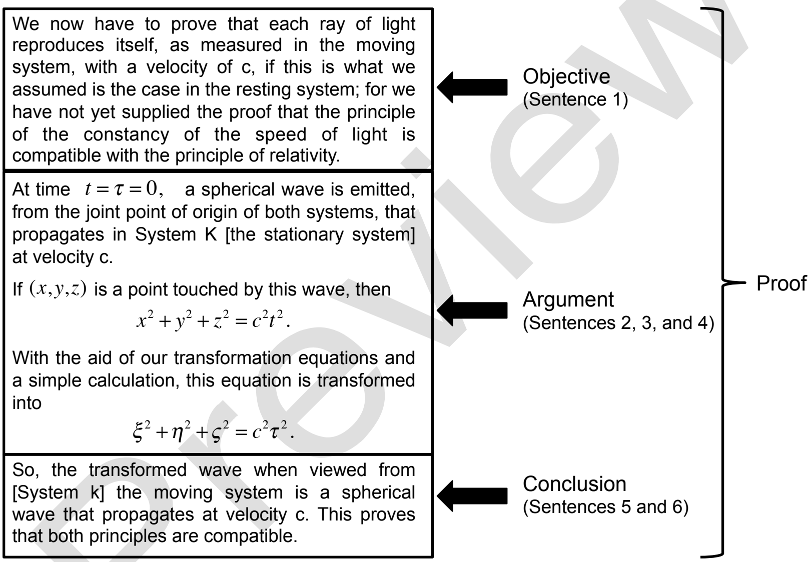


Figure 1–2 Spherical wave proof (English translation) from Einstein's 1905 paper establishing special relativity: *Zur Elektrodynamik bewegter Körper (On the Electrodynamics of Moving Bodies)*.

Einstein's proof requires that light propagate in all directions – up, down, left, right – at the same rate, regardless of whether the system, also called a *frame*, is in motion or stationary (Sentence 1). A spherical wave is a conceptualized spherical surface whose size expands in all directions at the same rate. A way to visualize a spherical wave is to imagine a large bubble that gets bigger as more air is blown into it. A spherical wave, which can be thought of as a "light bubble," expands in all directions at the same velocity, c. Regardless of how big the wave becomes, it remains spherical.

The remainder of the proof is straightforward:

1. Begin with a specific closed shape, a spherical wave, which is just an expanding wave (or bubble) whose radius from a common center is determined by the amount of time that has passed since the wave was first emitted (Sentence 2). Einstein chose a spherical wave because all of its light rays extend outward from the center at the same velocity. In addition, a spherical wave enables Einstein to show that his theory is valid for *every point in three–dimensional space*; a requirement for his proof to be valid.

2. Take all of the points that make up the surface of the spherical wave and confirm that they satisfy the mathematical equation for a sphere:

$$x^2 + y^2 + z^2 = c^2 t^2 \qquad \text{Eq. 1.1}$$

   where ct is the radius (Sentence 3). Einstein uses ct rather than R in his equation to represent the radius from a common center in the stationary frame because he is discussing a spherical wave, which has a specific size at time t. This is distinguished from a static sphere, whose size does not vary with time. Einstein uses the Latin characters x, y, and z, to represent a position, and t to represent time in the stationary frame.

3. Take all of the points that make up the first sphere and use his equations to produce “transformed” points (Sentence 4).

4. Take the “transformed” points and show that they satisfy the mathematical equation for a sphere:

$$\xi^2 + \eta^2 + \varsigma^2 = c^2\tau^2 \qquad \text{Eq. 1.2}$$

   where $c\tau$ is the radius (Sentence 4). Similar to what was described in Step 2, Einstein uses $c\tau$ rather than R' in his equation to represent the radius in the moving frame. This is distinguished from a static sphere whose size does not vary with time. Einstein uses the Greek characters ξ, η, and ς, to represent a position and τ to represent time in the moving frame.

5. Conclude that if steps 1 through 4 are successfully performed, a spherical wave is formed in the moving frame, successfully completing the proof (sentences 5 and 6). If a spherical wave is not formed in the moving frame, then the proof establishing relativity theory fails.

As illustrated in Figure 1–3, Einstein and other researchers over the past century have reviewed these five steps to reach the same conclusion; that a spherical wave was formed in the moving frame and the proof appears to pass.

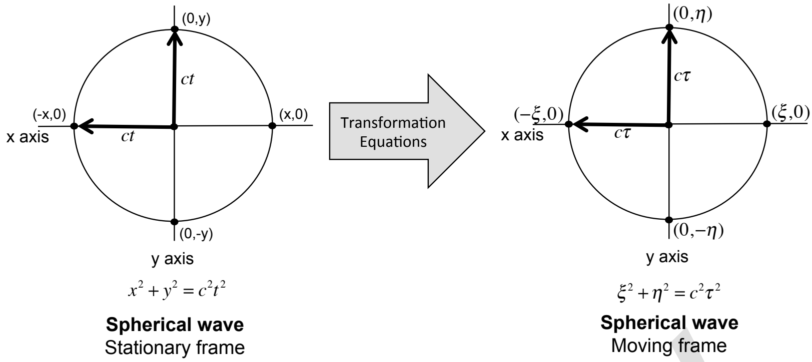


Figure 1–3 The purpose of Einstein's spherical wave proof is to show that if a spherical wave exists in the stationary frame, the converted points will all be part of a transformed spherical wave in the moving frame. (Note: A two–dimensional circle is shown for illustrative purposes.)

While not obvious, the proof actually failed, because a spherical wave is not formed in the moving frame. The problem is hard to detect, because if you follow steps 1 through 5, above, you will reach the same conclusion as Einstein. The problem with Einstein's proof is not that the steps are wrong; the problem is that the proof is incomplete. As you will soon see, satisfying the equations is alone insufficient to prove that a spherical wave exists in the moving frame. To understand why this proof failed, we have to examine the definition of a sphere.

> *A **sphere** is a three–dimensional surface, **all points of which** are equidistant from a fixed point.* *Def. 1.1*

It follows that:

> *A **spherical wave** is a conceptual three–dimensional surface, **all points of which** are equidistant from a fixed point, where the radius is determined by the velocity of the*

wave and the amount of time since the wave was first emitted. *Def. 1.2*

A sphere and a spherical wave share an important characteristic: that *all points are equidistant from a common fixed point.* The transformed shape must satisfy this definition for Einstein's objective and conclusion to be satisfied. If the second shape meets the definition, the proof passes; if it does not, the proof fails.

Before examining Einstein's proof further, we must look at the conditions required to determine whether a set of points satisfies Definition 1.1 and by extension Definition 1.2. In mathematics, the condition: "***all points of which*** *are equidistant from a fixed point*" is often implied or assumed. It is not explicitly checked. For example, a two–dimensional surface, called a circle, is defined as the set of all points equidistant from a common fixed point. It is mathematically written as:

$$x^2 + y^2 = R^2 \qquad \text{Eq. 1.3}$$

The points on the surface of the circle are written as members of a set in the form $\{(x, y)\}$. To simplify our analysis, we will only examine four specific points, which fall on the x or y axis:

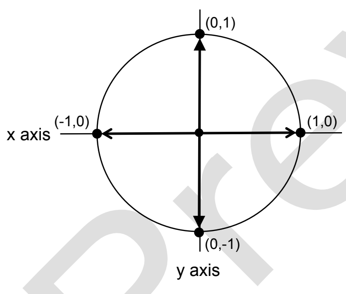
$$\left\{\begin{array}{l}(-1,0),\\(0,1),\\(1,0),\\(0,-1)\end{array}\right\}$$

Every point is assumed to be the same distance from the center (0,0). When given this set of points, we would use Equation 1.3 to correctly conclude that they are part of the same circle. Although not explicitly checked, the radius of 1 is assumed true for every point that lies on the circle.

Alternatively, the radius can be explicitly included as a member of the set, so that the points are written in the form $\{(x, y, R)\}$. Using the same example as given above, we would simply include the radius with each coordinate, so that the four points are now written as:

$$\left\{\begin{matrix}(-1,0,1), \\ (0,1,1), \\ (1,0,1), \\ (0,-1,1)\end{matrix}\right\}$$

As illustrated in Figure 1–4, when this set of x, y, and R values is validated using Equation 1.3, we once again correctly conclude that they are all part of the same circle.



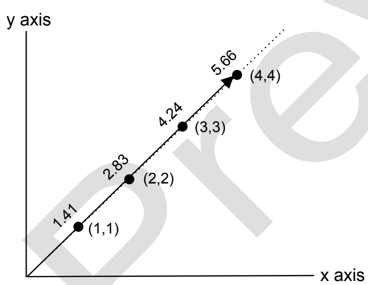
x	y	R	$x^2 + y^2 = R^2$
0	1	1	✓
1	0	1	✓
0	-1	1	✓
-1	0	1	✓

Figure 1–4 The set of values that all satisfy the equation of a circle (Equation 1.3) with all points having the same radius.

The inclusion of the radius as part of the set is subtle, but critically important to understanding the problem in Einstein's proof. To illustrate the effect of this change on the behavior of the equation, consider the following set of four points, also written in $\{(x, y, R)\}$ notation:

$$\begin{Bmatrix} (1,1,1.41), \\ (2,2,2.83), \\ (3,3,4.24), \\ (4,4,5.66) \end{Bmatrix}$$

Each point is expressed in terms of x, y, and the radius R (rounded to two significant figures). Since Equation 1.3 is satisfied for each point in the set, we could incorrectly conclude that these points are all part of the same circle. This is illustrated in Figure 1–5, where you can see that the points form a line, not a circle. What this means is that the use of the equation alone, without validating that all points share the same radius, will not prove that the points are part of any specific shape. *With the radius included with the coordinates for a point, we must show that the radius is the same for every point in the set.*



x	y	R	$x^2+y^2=R^2$
1	1	1.41	✓
2	2	2.83	✓
3	3	4.24	✓
4	4	5.66	✓

Figure 1–5 A set of values that individually satisfy the equation of a circle (Equation 1.3), leading to the incorrect conclusion that they are all points on the same circle. These points do not form a circle, since they do not all share the same radius.

Equation 1.3 will correctly tell us when the members of a set are part of a valid circle. Unfortunately, Equation 1.3 could also tell us that we have a valid circle when, in fact, we do not. This type of mistake is called a Type I error and occurs when correct results are returned (eg, a circle) along with results that should have been rejected (eg, a line).

Returning to Einstein's proof: To show that a spherical wave was formed in the second frame, definitions 1.1 and 1.2 must be satisfied. This means we must show that the set of values each satisfy the equation of a sphere *and that all of the values share the same radius*. This requires us to perform a second test to confirm that there is only one unique radius in the set of values.

Mathematically, because we define the set A to contain the distance from the origin for each point on the shape, the second check must show that $|A| = 1$. While the cardinality operator $|A|$ looks identical to the absolute value operator, it is used to count the number of unique values in a set. For example, consider the set $A = \{1,1,1,1\}$, which represents the radii for the points illustrated in Figure 1–4. Because there is only one unique distance in the set, its cardinality is $|A| = 1$. In other words, every point is the same distance from the origin. However, when the set is $A = \{1.41, 2.83, 4.24, 5.66\}$, which represents the distances from the origin for the points illustrated in Figure 1–5, then $|A| = 4$. Because the cardinality of this set is greater than 1, all points do not share the same radius. A circular or spherical surface requires that the distances from a common center to each point be the same, requiring $|A| = 1$. This cardinality check will confirm that every point is the same distance from the center.

We now examine the five steps of Einstein's spherical wave proof using a brute–force analysis, which uses specific values. Step 1 requires that we begin with a valid spherical wave in the stationary frame. This condition is met if we evaluate the spherical wave at $299{,}792{,}458^{-1}$ seconds following emission. At this time, the wave has a radius of 1 meter in all directions. This is called a unit sphere and we will examine four points on its conceptual surface:

$$\left\{\begin{matrix}(-1,0,0,\dfrac{1}{299{,}792{,}458}),\\ (0,1,0,\dfrac{1}{299{,}792{,}458}),\\ (1,0,0,\dfrac{1}{299{,}792{,}458}),\\ (0,-1,0,\dfrac{1}{299{,}792{,}458})\end{matrix}\right\}$$

The set of values includes time, t, and is written in the form $\{(x, y, z, t)\}$, with z required for calculation of a sphere as opposed to only x and y required for a circle in previous discussions. The radius is easily found by multiplying time, t, by the velocity of light, c, for each point in the set. Given that $c = 299{,}792{,}458 m/s$, it is easy to show that each point has the same radius, which is 1 meter.

Step 2 uses Equation 1.1 to successfully confirm that all of the points of the original unit sphere actually form a spherical surface. This condition is satisfied.

Step 3 converts the original points $\{(x, y, z, t)\}$ into a set of transformed points $\{(\xi, \eta, \varsigma, \tau)\}$. All of the points of the original spherical wave are converted using Einstein's equations:

$$\xi = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\eta = y$$

$$\varsigma = z$$

$$\tau = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

To visually perform the analysis, we select a large velocity, $v = 289{,}000{,}000 m/s$, so that the first point

$$(-1,0,0,\frac{1}{299{,}792{,}458})$$

is transformed into:

$$(-7.4,0,0,\frac{7.4}{299{,}792{,}458})$$

Each point is converted into a transformed point using Einstein's equations, the results of which are given in Table 1–1.

	Original Points				Transformed Points			
Row	**x**	**y**	**z**	**t**	**ξ**	**η**	**ς**	**τ**
1	1	0	0	3.3356E-09	0.1	0	0	4.5160E-10
2	-1	0	0	3.3356E-09	-7.4	0	0	2.4638E-08
3	0	1	0	3.3356E-09	-3.6	1	0	1.2545E-08
4	0	-1	0	3.3356E-09	-3.6	-1	0	1.2545E-08
5	0	0	1	3.3356E-09	-3.6	0	1	1.2545E-08
6	0	0	-1	3.3356E-09	-3.6	0	-1	1.2545E-08

c= 299,792,458
v= 289,000,000

Table 1–1 Conversion of the points on the unit sphere into transformed points using Einstein's equations. Position coordinates are written to one significant figure. Time values are in scientific notation. For example, $3.3356\text{E} - 09$ is written in fractional notation as $299{,}792{,}458^{-1}$ in the text. Time is measured in seconds and velocity is measured in meters per second. Points that fall on the z axis (rows 5 and 6) are shown for completeness, but not discussed in the text.

Once the original points are converted using Einstein's equations, the transformed points are:

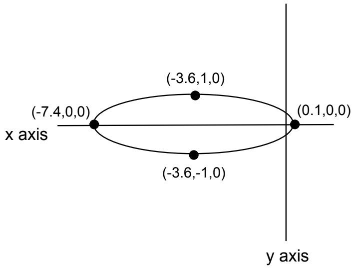
$$\begin{Bmatrix} (-7.4, 0, 0, \frac{7.4}{299{,}792{,}458}), \\ (-3.6, 1, 0, \frac{3.8}{299{,}792{,}458}), \\ (0.1, 0, 0, \frac{0.1}{299{,}792{,}458}), \\ (-3.6, -1, 0, \frac{3.8}{299{,}792{,}458}) \end{Bmatrix}$$

The radius for each transformed point is found by multiplying time, τ, by the velocity of light, c. Because relativity requires that $c = 299{,}792{,}458 m/s$ for each of the transformed points, it is easy to see that the length of each ray that begins at the origin of the new shape is found using $R' = c\tau$ for each of the converted points. To make the radius obvious, the points are given in the form $\{(\xi, \eta, \varsigma, R')\}$ as:

$$\begin{Bmatrix} (-7.4, 0, 0, 7.4), \\ (-3.6, 1, 0, 3.8), \\ (0.1, 0, 0, 0.1), \\ (-3.6, -1, 0, 3.8) \end{Bmatrix}$$

Step 4 confirms that all of the transformed points, to one significant figure, satisfy Equation 1.2. Since the equality of this statement is maintained for each point, this condition is satisfied.

Since the requirements of steps 1 through 4 of the proof were successfully met, we would conclude in Step 5 that a valid spherical wave was formed in the second frame. In other words, we have just shown that Einstein's proof appears to work. However, as illustrated in Figure 1–6, the transformed shape is not a spherical wave centered at the origin, but is instead an ellipsoidal wave with a center to the left of the origin at $(\frac{-vt}{\sqrt{1-\frac{v^2}{c^2}}}, 0, 0)$.



ξ	η	ς	R'	$\xi^2+\eta^2+\varsigma^2=R'^2$
-7.4	0	0	7.4	✓
-3.6	1	0	3.8	✓
0.1	0	0	.1	✓
-3.6	-1	0	3.8	✓

Figure 1–6 The set of transformed points individually satisfy the equation of a sphere, leading to the premature conclusion that they are all points on the same spherical wave. This is a Type I error. The transformed shape is not a spherical surface centered at the origin, but is instead an ellipsoidal surface with a center to the left of the origin. *Note: The transformed values are rounded, which does not change the diagram or conclusions.*

An ellipse is not a sphere. In an ellipse, the radii (the distances from the center to the points on the surface) are not the same for all points. Mathematically, an ellipsoidal surface is described in terms of its center point and the length of its semi–minor and semi–major axes. Positions on the surface of the ellipsoidal wave are determined by the position of its foci on the major axis and by the length of the cord connecting the foci. While the stretching effect of the ellipsoidal surface along the x axis and shift of the center to the left of the origin is most *visibly* pronounced at high velocities, it is mathematically true for all positive velocities regardless of magnitude.

Now we revisit definitions 1.1 and 1.2 to determine whether the transformed shape satisfies these definitions. The transformed shape does not satisfy these definitions because *all points are **not** equidistant from a common fixed point*. In other words, because $|A| = 1$ is not true, the transformed shape does not meet the definition for a sphere or spherical wave.

As illustrated in Figure 1–7, there are actually four reasons that the transformed shape does not satisfy the definition and the proof fails. First, the two shapes are not the same; one is spherical while the other is ellipsoidal. In the spherical wave, the semi–major and semi–minor axes are the same length. In the ellipsoidal wave, the semi–major and semi–minor axes have different lengths. Second, in the spherical wave, the origin is at the center, while in the ellipsoidal wave the origin is to the right of center. Third, in the spherical wave all points share the same length (or radius) from a fixed point. However, in the ellipsoidal wave, the distances to the points from a common fixed point are different. Fourth, in the spherical wave, the distances, ct, are radial values, where each represents a distance from the center of the shape to its surface, but in the ellipsoidal wave, the distances, $c\tau$, represent a type of generator line that represents the distance from the origin (not the center of the shape) to points on the surface of the ellipsoid.

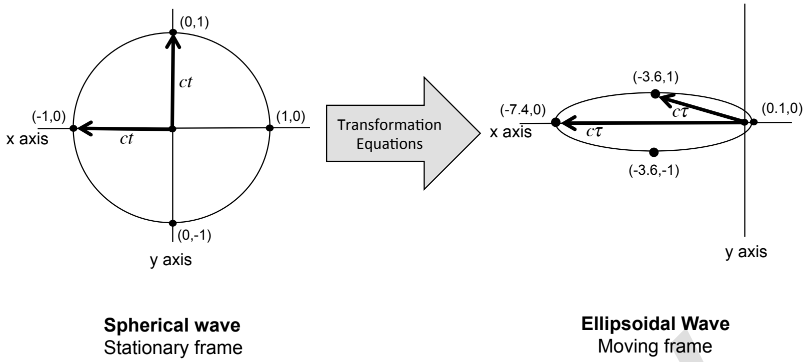


Figure 1–7 Einstein's equations transform a spherical wave into an ellipsoidal wave. In the original shape, illustrated by the left–hand image, the radius to reach each point is the same, originates from the center of the shape, and travels the same amount of time, t. Points on the transformed shape have different values for time, τ, and as a result have different lengths from the origin. In the transformed shape, illustrated in the right–hand image, the origin is not the center of the shape.

As noted earlier, this is a Type I error. It is very hard to detect because it requires the explicit examination of the radius for every point in the transformed shape. When all or part of the radius is included as part of a coordinate for a point, Equation 1.2 can only be used as a distance equation. However, since values are provided on both sides of the equals sign, the equation cannot distinguish between a collection of points belonging to a spherical wave, an ellipsoidal wave, a straight line, or a random collection of points. This is summarized in Figure 1–8.

	Original spherical wave	Transformed ellipsoidal wave	Collection of points on a line	Random collection of points
All points satisfy the equation when values from both sides of the equals sign are used	✔	✔	✔	✔
All points share the same radius	✔	✖	✖	✖
Origin is the center of the shape	✔	✖	N/A	N/A
Semi-major and semi-minor axes are the same length	✔	✖	N/A	N/A
Velocity multiplied by time represents the distance to a point from the center of the shape	✔	✖	N/A	N/A
Shape is spherical	✔	✖	✖	✖

Figure 1–8 When a constant radius is not common for all points, equations 1.1 and 1.2 cannot be used to confirm the existence of any specific shape. The additional check for a constant radius is necessary to confirm a spherical shape.

Einstein thought he had a spherical wave when, in actuality, he did not. A spherical wave requires a constant radius such that the same $R' = c\tau$ is true for all points. Said mathematically, $|A| = 1$ must be true for the transformed wave. Since τ has different values for the transformed points, the only way to maintain a constant radius, R', in the transformed frame is for the velocity of light, c, to change. Specifically, c would need to change with each different x coordinate in the transformed points. This would make Einstein's conclusion that "*the transformed wave when viewed from [System k] the moving system is a spherical wave that propagates at velocity c*" false, because c could not be constant: It must change in the moving frame to maintain a constant radius, R', for all points. If the velocity for each ray changes, then not only would this make Einstein's conclusion false, the equality of the mathematical equation would also be false. As a result, relativity theory is not validated, since Einstein's proof failed to associate the *principle of the constant velocity of light* with the *principle of relativity*.

The failure of the proof lends support to many of the historical challenges made against Einstein's work. A key strength of this analysis is that it does not require the introduction of new or novel mathematical concepts. Rather, the reader is simply reminded of the definition of a sphere (Definition 1.1) and is asked to verify whether that condition was satisfied. Another strength of this analysis is that, had a valid spherical wave been formed, the additional check for a constant radius would not change the proof's result. The fact that a check for a constant radius alters the proof's conclusion, changing it from pass to fail, supports the finding of a Type I error.

Common Objections

Even in the face of this evidence, some of Einstein's defenders will assert that the proof works because Equation 1.2 is satisfied and that the points do not need to form a spherical wave. This defense fails because it requires you to ignore half of the proof: the objective and the conclusion. Einstein is unambiguous in both his objective and his conclusion, where his intent was to show that if you begin with a spherical wave, you must end with a spherical wave.

Other defenders will argue that Einstein is only talking about one specific point on the sphere because, in some English–language translations, the first sentence reads "*any* ray of light," not "*each* ray of light." First, the use of "each" or "every" is a more accurate reflection of the original German paper. Second, once again, this defense fails because it also ignores half of Einstein's proof. In fact, this second defense is simply a variation of the first. Both defenses show a lack of understanding of Einstein's work, since satisfying the equations alone, or just considering a single point, would not prove the relationship between Einstein's two postulates.

A third defense asserts that a spherical shape has been formed if you *assume* simultaneity, length contraction, time dilation, or some combination of those terms. This defense fails because it does not recognize that the transformed points found using the transformation equations belong to the moving frame. The defender doesn't care what the math says and suggests that the proof should just be taken as valid because of a term Einstein invented. As a result, this defense requires you to disregard the proof's mathematical argument, specifically sentences 4 through 6. It also fails because, in a logical argument, a conclusion resulting from a proof – or the use of the term simultaneity, time dilation, or length contraction – cannot be used in defense of that proof *prior to the proof's completion*. While we will examine these relativistic terms in Chapter 6, what is important to know is that one cannot use any of Einstein's relativistic terms as a defense until after the proof establishing relativity has been successfully completed.

Each defense ignores the purpose of the spherical wave proof and, at a minimum, requires you to ignore half of Einstein's proof: the objective and the conclusion. Additionally, the terminology defense requires you to ignore the proof's mathematical argument as well. Said simply, the terminology defense ignores the entire proof.

The failure of Einstein's spherical wave proof does not indicate exactly what is wrong with Einstein's work. It just shows that there is a problem that results in the proof's failure. To determine why the proof's failure will ultimately invalidate relativity theory, we must first identify what is wrong in Einstein's subsequent work. This will be examined in Chapter 6 when we re–examine Einstein's 1905 derivation, equations, and terms.

The Michelson–Morley Experiment

The failure of the spherical wave proof will not be sufficient for some to accept a problem in Einstein's work. They will continue to believe that "*Einstein's work is experimentally proven*." To dispel this belief, we have to revisit a foundational experiment long thought to support relativity theory: the 1887 Michelson–Morley interferometer experiment. Albert Michelson and Edward Morley, two early researchers in electromagnetic force and optics, performed an experiment to validate a classical mechanics–based theory proposed by French engineer and physicist Augustin–Jean Fresnel. They hypothesized that if light were traveling as a wave, experiments would detect its motion, which they could use to determine the Earth's velocity as it orbited the Sun. They built an ingenious device called an interferometer, which they expected would detect the wave motion of light, allowing them to calculate the Earth's orbital velocity, which they knew was about 30km/s. Said simply, they built a speedometer and used it to measure how fast the Earth was traveling around the Sun.

As illustrated in Figure 1–9, after collecting and analyzing their data, Michelson and Morley were only able to **compute** an Earth orbital velocity of about 8km/s. This was a far cry from the 30km/s they expected to detect. It didn't work. Their experiment did not support the wave–based theory of light suggested by Fresnel. Einstein's supporters have taken this failure and turned it into a success for relativity theory. Supporters say that the Michelson and Morley measurements are anomalies, or errors, inherent with the interferometer. Their argument is that the device detected a velocity of 0km/s, which supports relativity theory, and that the observed measurement is simply "experimental error." This experiment and their revised conclusion of 0km/s is one of the reasons people believe that relativity theory has been experimentally "*proven*."

Fortunately, scientists and mathematicians have a disciplined way of explaining "experimental error" called *statistics*. Because Michelson and Morley included their data in their paper, we are able to perform a statistical analysis of their results. In statistics, a confidence interval defines the range in which we would expect to find the actual result, assuming a specific probability. For the Michelson–Morley experiment, this range is represented by the "normal curve" in Figure 1–9. What this diagram says is that we are 99.9% sure that the Michelson–Morley experimental data, *when evaluated using their equations*, found the Earth orbital velocity to be between 6km/s and 10km/s. By expressing the answer in statistical terms, we account for any errors that might exist with the experimental device or measurements. Clearly, 30km/s does not fall within the range, prompting Michelson and Morley to conclude that their results did not support Fresnel's theory. This led to a crisis, because classical mechanics was unable to predict these results, providing the opening for relativity to provide a better answer and establish itself as a leading theory.

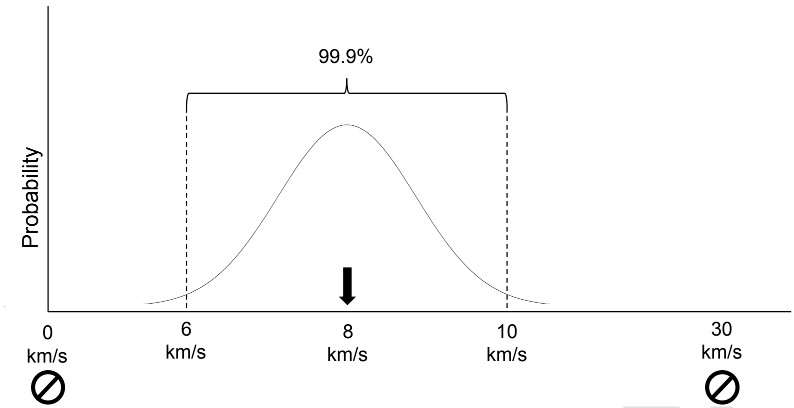


Figure 1–9 Results of the original Michelson–Morley interferometer experiment illustrated as a 99.9% confidence interval for the experiment. The amount of error between the actual result of 8km/s and the expected result of 30km/s is 22km/s. The amount of error between the actual result of 8km/s and the relativistic expected result of 0km/s is 8km/s. Neither 0km/s nor 30km/s fall within the 99.9% confidence level, suggesting that the Michelson–Morley analysis and data do not support Fresnel's theory or relativity theory. Illustration is not to scale.

However, 0km/s, which is required by relativity theory, does not fall within this range either! Mathematically, we are less than 0.1% confident that 0km/s is the Earth orbital velocity. The Michelson–Morley experiment does not support relativity theory when viewed through a statistical lens. Any theory based on the Michelson–Morley experiment returning 0km/s as the answer has less than a 0.1% chance of being right. In other words, the only way the Michelson–Morley experiment supports 0km/s, as required by relativity theory, is if we completely ignore the experiment's actual result!

Furthermore, if we do not ignore the actual data and do the calculations properly, we obtain a value supporting Fresnel's original hypothesis. As illustrated in Figure 1–10, and in contrast to the relativistic interpretation, the amount of error (the difference between the actual result and the expected result) when their data is evaluated using Modern Mechanics is less than 3km/s for the Michelson–Morley experiment. In fact, the error is less than 0.3km/s with Dayton Miller's repeat experiment performed in 1933. In both experiments, the error is significantly less when the Modern Mechanics equations are used to analyze the data. More importantly, the expected result of 30km/s is extremely close to the properly computed result of 32km/s. The expected result falls within the 99% confidence interval, showing that their experiment worked!

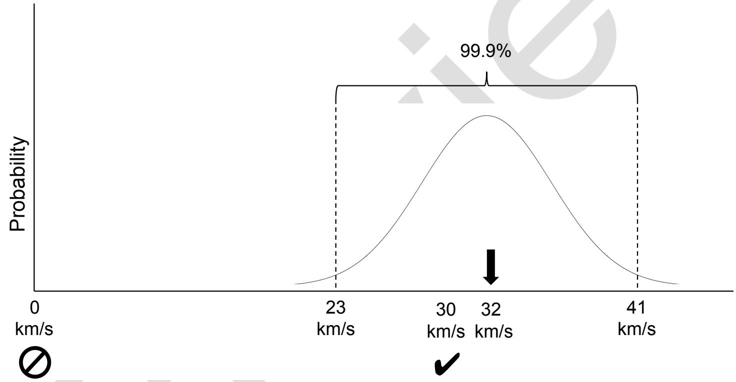


Figure 1–10 Results of the Michelson–Morley interferometer experiment evaluated using Modern Mechanics' equations. The amount of error between the actual result of 32km/s and the expected result of 30km/s is 2km/s. In addition, the expected result of 30km/s falls within the 99.9% confidence interval, suggesting that the Michelson–Morley data when analyzed using Modern Mechanics' equations, supports the result. Illustration is not to scale.

The Michelson–Morley experiment did not fail due to the accuracy of the device or because of the data that was collected. The Michelson–Morley experiment failed because they used the wrong equation (or algorithm) to convert the data from raw measurements into Earth orbital velocities. We will examine the corrected algorithm in Chapter 7.

As you can see, a continued belief in relativity requires you to ignore Michelson and Morley's actual data and statistics.

Summary

By now, you should have an understanding of two of the most significant shifts in the history of physics: the first move was to establish classical mechanics, or first–generation physics. The second was the shift to modern physics, or second–generation physics, which encompasses relativity theory and quantum mechanics. You should also understand that a nonobvious theory requires four elements: assumptions, derivation, proof, and implications. Einstein's theory of relativity followed these steps and was believed to be free of any fatal mistakes. While it has withstood an onslaught of historical challenges, relativity theory suffers from a critical mistake. A key component, its spherical wave proof, failed, but did so in such a way that people believed it had actually passed. Said simply, Einstein thought he had a spherical wave when in actuality, he didn't. This is a Type I error, one that has proven to be extremely elusive. In addition to revealing a mistake in Einstein's theoretical foundation, we have mentioned that Modern Mechanics' equations provide better results than the relativity equations for the Michelson–Morley experiment.

A failure of the spherical wave proof along with new equations that provide better results, while indicative of a problem in Einstein's work, does not identify what that problem is. These findings raise several interesting and important questions:

1. *How can Einstein's work be wrong while still producing really good results in many classes of experiments?*

2. *If there is a mistake in Einstein's work, why hasn't it been previously discovered?*

3. *Why must Einstein's spherical wave proof work on all points of a sphere and not just specific, individual points?*

4. *Why do Einstein's equations perform worse than Modern Mechanics' equations?*

5. *Can Einstein's equations be fixed, and if not, what are the implication for physics and science?*

The answer to these questions will be revealed in the pages that follow. Before we continue examining Einstein's work, we must first develop the Modern Mechanics model. Chapters 2 through 4 develop the conceptual and mathematical framework for Modern Mechanics. We then use Modern Mechanics, along with an explanation of functions developed in Chapter 5, as a springboard to understand Einstein's work. Chapter 6 examines Einstein's relativity derivation, reviewing its key concepts – which make it unique – and critical mistakes, which make it wrong. Built upon the material developed in chapters 2 through 5, Chapter 6 answers many of the questions we have just raised. We then use Chapter 7 to review several experiments to examine why Einstein's equations perform better than their classical mechanics counterparts and why Einstein's equations do not perform as well as the Modern Mechanics' equations. Chapter 8 examines the implications of Modern Mechanics and identifies interesting research areas.

A key implication of these findings is that relativity theory is incorrect, cannot be corrected, and cannot continue to exist. The removal of relativity theory from modern physics would create a crisis if there were no alternative that would produce equal or better results. Fortunately, Modern Mechanics is a mathematically and conceptually sound alternative. Modern Mechanics begins with a new set of assumptions and rules, distinguishing it from first and second–generation models. The result is a different theory and set of equations that yield equal or better results than relativity theory. Modern Mechanics has an ambitious goal: to be a unified model that explains things in an intuitive way.

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