Repairing Special Relativity
Quantum Relativity (for Speed)

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Abstract

Einstein's theory of Special Relativity is repaired for two errors based on two unproven assumptions. The first error is the *assumed general applicability* of the Lorentz transformation. The authors will show that the Lorentz transformation fails as coordinate transformation between two *inertial frames*. The Lorentz transformation will be shown to be applicable to a mass-point and an inertial frame only. The authors will replace the Lorentz transformation of coordinates by a transformation of *basic units* (MKSC).

The second error is the *assumed equality of reference frames*. The authors will show that reference frames are unequal; the universal frame is dominant over the frame of the earth, while the frame of the earth is dominant over a proper frame. The dominance of the universal frame results in the fastest clocks, nothing else. The authors redefine inertial frames to fulfill the requirements of *Noether's conservation laws* of energy-momentum.

The authors will prove the errors and repair Special Relativity. The repaired theory is called "Quantum Relativity for Speed" and unites Einstein's Special Relativity with Noether's conservation laws. Quantum Relativity for Speed *solves the paradoxes* of Special Relativity. Quantum Relativity for Speed is supported by the Michelson-Morley, Kündig, Ives-Stilwell, and Hafele-Keating experiments and by the survival of muons created by the solar wind. Quantum Relativity for Speed adds a new member to the relativistic Doppler family, uniting the Doppler Effect for sound and light. This addition to the Doppler family called "*uniform Doppler*" can also prove our theory experimentally.

Quantum Relativity for Speed will be extended to "Quantum Relativity for Gravitation" and "Quantum Relativity for Space-time" in the following two books. Our complete theory "Quantum Relativity" merges Einstein's Special Relativity with solutions to his theory of General Relativity and with Noether's conservation laws of energy-momentum. Quantum Relativity is mainly a repair of Einstein's Relativity, but *adds quanta of space and time* to Bohr's Quantum Theory and defines the properties of the universe; "from small to all". Quantum Relativity is a no-nonsense theory: no paradoxes, no (black hole) singularities, no dark energy, and less dark matter.

Loop – Doctor

Preface

Who we are and what we want

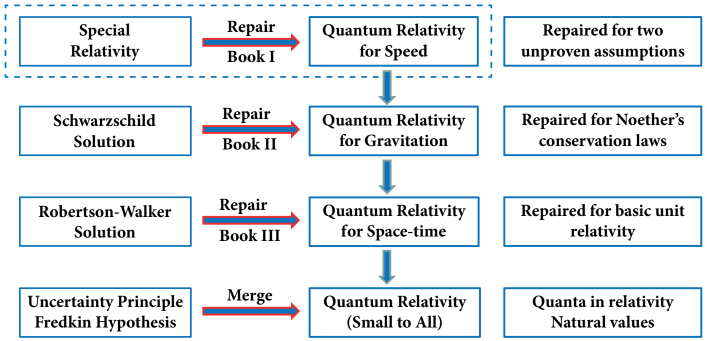
We are three Dutch academic engineers coming from different industries, without a professional link to a university. All three of us want to repair things, as engineers do. The academics in us want to use and check formulas in order to predict the correct and measurable outcomes. We are practical users of the formulas of physics; we want to use Einstein's theories of Special Relativity and General Relativity as well as Bohr's Quantum Theory to understand the universe from its very small building blocks to its overall size and energy.

Our Quest: No-nonsense Physics

We are engineers, not philosophers; we simply want to make sense out of our observations. We base ourselves on *measured* quantities and formulas that have proven to be correct in experiments. Experimental outcome is the key to our quest. Our quest is to check formulas against experimental outcomes, and repair the formulas based on fundamental physics where needed. Einstein's Relativity is a great, but *unfinished* theory. This book is about accepting the formulas of Special Relativity that work, and repairing the formulas that do not. We base ourselves on existing and experimentally proven physics: no-nonsense physics.

Our Theory: Quantum Relativity

This book is the first in a sequence of three (see below) about our theory: "Quantum Relativity". Quantum Relativity *unites* Einstein's repaired Special Relativity with the repaired solutions to his theory of General Relativity. Our theory has no paradoxes or singularities. Quantum Relativity is based on digital physics; the Fredkin hypothesis. Quantum Relativity *adds* finite quanta of space and time to the quantum theory. Our theory has a simple(r) explanation of all relativistic experiments.



Our theory offers a simple explanation of cosmic inflation (redshift plus one). Our theory describes our expanding universe without the need for a cosmological constant ("dark energy"). Black holes are nothing but massive and fast rotating objects without singularity; no science fiction. Our theory explains the orbital behavior of far stars in galaxies without the need for "dark matter". In summary: no-nonsense physics.

Errors in Special Relativity: Just a matter of Time

Time is measured with a clock. In the theory of Special Relativity, the clock paradox describes two sets of synchronized clocks that travel at a high speed away from each other. According to Special Relativity, the clocks of the *other* set tick slower, caused by the high speed relative to each other. This is the clock paradox, *which* set of clocks tick slower? To us, as engineers, it is simply impossible that the observers of both sets of clocks measure that the *other* set has slower clocks. This clock paradox clearly demonstrates that something is wrong in the theory of Special Relativity. The authors have identified two errors in the theory of Special Relativity, based on *two unproven assumptions*. To repair this theory, we need to stand on the shoulders of giants in the world of fundamental physics.

On the Shoulders of Giants

Down to earth engineers as we are, we base ourselves on the proven fundamentals of physics. To us, Noether's conservation laws of energy and momentum are the key to the repair of Einstein's relativity theories. Noether was a pupil of Hilbert; both of them were convinced that Einstein's theory of General Relativity *did not fulfill the requirements to prove energy conservation*[1]. In Noether and Hilbert, we find two (deceased) allies in our quest. We also base ourselves on the Quantum Theory, with the emphasis on Heisenberg's uncertainty principle and the Fredkin finite nature hypothesis. In other words, we stand on the shoulders of giants of fundamental physics like Einstein (relativity), Noether (energy-momentum conservation), Bohr (quantum physics) and Fredkin (digital physics). We also base our theory on the work of Schwarzschild (solving Einstein's field equations for a static sphere) and Robertson-Walker (solving Einstein's field equations for the universe based on "comoving coordinates").

Experiments and Observations

We accept the outcomes of *all* relativistic experiments. We have tested our theory against the following experiments: Michelson-Morley, Ives-Stilwell, Kündig, Pound-Rebka, Shapiro and Hafele-Keating. We accept *all* of the following observations: Eddington's bending of starlight around the sun, Mercury's perihelion precession, the gravitational redshift of the sun, the redshift of the Cosmic Microwave Background Radiation (CMBR), the distribution of galaxies over its redshift, the behavior of clocks in (GPS) satellites, the gravitational waves as measured by Hulse and Taylor, and the change in gyroscope orientation of gravity probe-B. In summary, our theory is not in conflict with the outcome of *any* relativistic experiment.

Three Predictions that make the Difference

The most important prediction of Quantum Relativity comes from the Hubble telescope observations. The Hubble telescope will confirm that events at galaxies are observed *redshift plus one* (z + 1) *faster* than at galaxies close by (see book III). The second prediction comes from our second book, the high temperature in the core of the earth (more than 5,380 Kelvin) and the sun (more than 15,500,000 Kelvin) are mostly caused by *energy conservation and not by nuclear fission or fusion alone*. The third prediction is less spectacular, but can verify our theory on earth. The prediction comes from a new addition to the Doppler family, the Doppler Effect in which both the source and the receiver move at high speed in the reference frame of the earth, similar to sound waves in air. We predict that the clocks of *both* the source *and* the receiver will slow down, irrespective of the direction of movement relative to each other (see chapter 7). These three predictions are contrary to current thinking. Quantum Relativity also explains the distribution of galaxies within our universe, and explains why the Pioneer 10 & 11 decelerate (the "Pioneer 10 & 11 anomaly") with the speed of light times the Hubble constant (c.H).

[1] Noether, E. (1918). "Invariante Variationsprobleme". Translated by Tavel, M. "Invariant Variation Problems". Transport Theory and Statistical Physics, 1971. 1(3) p. 186-207.

Written for you?

If you do not have a background in physics, you may find these books difficult to read. This first book will require you to have studied (but not entirely understood!) the theory of Special Relativity[2]. *If* you can understand this book, then you can understand the next two books. The second and third book *will not* include the complicated mathematics of the theory of General Relativity or of the Quantum Theory. If you are an academic engineer, a physicist, or an astronomer, you may be able to understand us. It will require you to think deeply and to be open to a revolutionary different vision of Relativity. I (Rob) confess that I am not a good author, but together with my co-authors Frans and Oscar, we have done our best to make these books understandable. However, the rewards of reading and understanding these three books will be great.

The 2017 update

The following subjects have been updated since August, 2013:

- The outcome of new and more accurate Michelson-Morley experiments prove that *proper space is not deformed*,
- The prediction of the core temperature of the earth and sun instead of LIGO detection (LIGO is replaced by *Advanced* LIGO), see book II.

These updates are included in this PDF version of the book. This PDF version is thus more up-to-date than the printed version.

The understanding you will gain

You will gain a full understanding of the effects of high-speed in this book. You will be freed from those nagging paradoxes of Special Relativity. You can safely compute the outcome of experiments without ambiguity. We have united the Doppler Effect for sound and light and have added an extra member to the relativistic Doppler family. This book will also prepare you for the astronomical things to come, understanding the Schwarzschild and Robertson-Walker solutions to Einstein's theory of General Relativity, black holes, the Pioneer 10 & 11 anomaly, cosmic inflation, the shape, size, and expansion of our universe, and the smallest quanta of nature up to the total mass-energy of the universe. We hope you will get as many "aha" experiences as we did.

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Schiedam,
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[2] Einstein, A. (1905). "On the electrodynamics of moving bodies", translated from the Annalen der Physik "Zur Elektrodynamik bewegter Körper". 17 (10) p. 891-921.

Contents

0 Extended Summary of Repairing Special Relativity

According to the authors, the theory of Special Relativity contains two unproven assumptions leading to errors and paradoxes. This extended summary describes the repair of Special Relativity and the resulting theory of "Quantum Relativity for Speed".

0.01 Two errors in Special Relativity based on two unproven assumptions

The authors will prove that reference frames are not equal (as Special Relativity assumes) and that the Lorentz transformation has limited applicability only (Special Relativity assumes full applicability), see chapter 1. The errors will be diagnosed and proven both theoretically and experimentally in chapter 2, 3, and 4. The theoretical evidence of the errors will be based on the relativistic Doppler Effect, Noether's conservation laws, Mach's principle, and the SI unit meter definition. The experimental evidence will be based on the survival time of muons created by the solar wind, the Michelson-Morley experiment, the Kündig experiment, the Hafele-Keating experiment (and its modern successors), and GPS clocks.

0.02 Paradoxes of Special Relativity vanish in Quantum Relativity for Speed

The essence of repair of Special Relativity is described in chapter 5. The result of the repair of Special Relativity is the theory of "Quantum Relativity for Speed", assigning a "*clock-factor*" to every reference frame and replacing the Lorentz *coordinate transformation* by an S-MKC (second, meter, kilogram, and Coulomb) *unit transformation*, solving the twin, clock, and Ehrenfest paradoxes. Quantum Relativity for Speed and the solutions to the paradoxes of Special Relativity are described in chapter 6. In the extended summary of the paragraphs to come, you get a first insight into our theory.

0.03 Reference frames in Quantum Relativity for Speed

In Quantum Relativity for Speed, three different kinds of reference frames are defined: the universal frame, a Noether frame, and a proper frame, see chapter 5 for details. In figure 0.1, the satellite has a proper frame S_0, and the earth has a Noether frame S_N based on the Schwarzschild solution to the theory of General Relativity.

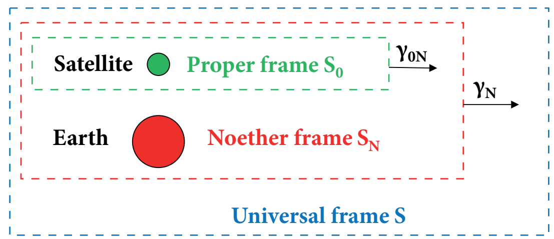

Figure 0.1: Proper, Noether, and universal frame in Quantum Relativity for Speed

In figure 0.1, "γ_{0N}" is the boost-factor of a proper frame S_0 within a Noether frame S_N, and "γ_N" is the boost-factor of S_N within the universal frame S. The universal frame S is the reference frame of the universe (the homogenous and isotropic *model* of the universe). A Noether frame S_N is defined as a reference frame within which Noether's conservation laws apply. The universal frame S is also a Noether frame, except that the universal space cannot move or rotate. A proper frame S_0 is a limited reference frame around a mass-point. In Quantum Relativity for Speed, the Noether frame coordinates are the inputs to the Schwarzschild solution to Einstein's field equations, while the proper frame coordinates are based on its resulting proper time. These frame definitions are in harmony with Einstein's theory of General Relativity. The "inertial frame" that Einstein defined, is a free-falling reference frame within which the laws of physics apply, see chapter 3.

0.04 Dominance of gravitational field

This book is about the relationship between the Noether frame (coordinates and units) and the proper frame (coordinates and units), while the gravitational influence is negligible, such that a comparison can be made between Quantum Relativity for Speed and Special Relativity. We will look at the reference frame of the exact Schwarzschild solution[3] of the earth; the Noether frame of the earth has its origin in the center-of-mass of the earth. Any laboratory, plane, or satellite has a small proper frame (based on the proper time of the Schwarzschild solution) around its own proper center-of-mass. Even though the gravitational influence of many experiments (Michelson-Morley, Ives-Stilwell, and the Doppler experiments of the Planck institute) is negligible, the dominance of the Noether frame of the earth over the proper frame of a plane or satellite is apparent from the Hafele-Keating experiment and GPS clocks. In other words, the *assumed* equality of reference frames of Special Relativity is contradicted by the Schwarzschild solution to the field equations, see chapter 2. Intuitively, we all understand that the reference frame of the earth is "stronger" than the reference frame of a satellite. The reference frame of the earth is dominant over the reference frame of the satellite.

0.05 Limiting and replacing Lorentz transformation

The Lorentz transformation that stands at the cradle of Special Relativity will be demonstrated to be limited in its applicability to physics. The Lorentz transformation will be limited (in its application to physics) to a dominant Noether frame (the Noether frame of the earth for example) and a mass-point with a small proper frame (a lab, satellite, or mass-particle). The Lorentz transformation of *coordinates* will be replaced by a *unit* transformation, transforming Noether units into proper units within a single reference frame, see chapter 5. The Lorentz transformation will maintain its validity for a dominant reference frame S and the *origin* of S' only, while a mass-point is located in the origin of the moving reference frame S'.

0.06 Paradigm shift from two-frame thinking to single-frame thinking

In Quantum Relativity, the laws of physics are applicable within a *single* reference frame only. This single reference frame can be the universal frame, a Noether frame or a proper frame. The proper frame has limited applicability. The proper frame is not Euclidean outside of its origin. Einstein limited the proper frame such that no internal gravitation is measurable, the "inertial frame". The validity of the laws of physics in a proper frame has to be checked per experiment. The authors will also demonstrate that the laws of physics cannot be applied in two receding inertial frames *simultaneously* (as the Lorentz transformation in Special Relativity assumes), see chapter 5.

[3] Schwarzschild, K. (1916). "Über das Gravitationsfeld einer Kugel aus inkompressibler Flüssigkeit nach der EINSTEINchen Theorie" from http://de.wikisource.org.

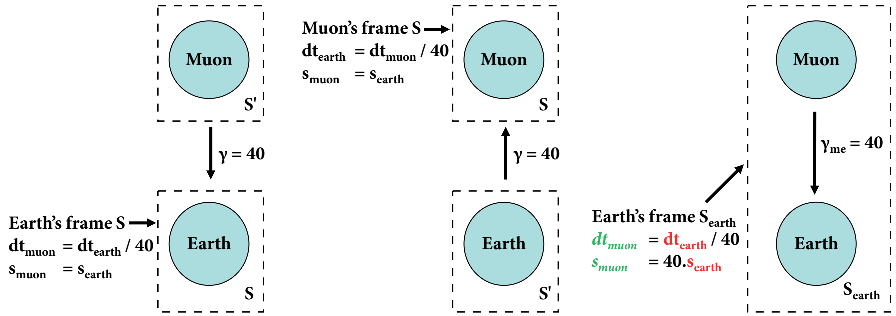

Figure 0.2: Coordinate relativity (left 2), and coordinate and *unit* relativity (on the right)

Figure 0.2 demonstrates Special Relativity from the point of view of the earth (on the left) and from the point of view of the muon (in the middle). Note the *presumed* equality of the units second (s_{muon} and s_{earth}) and the conflicting time dilation ($dt_{muon} = dt_{earth} / 40$ and $dt_{earth} = dt_{muon} / 40$). This is in essence the clock paradox and the twin paradox. Quantum Relativity for Speed demonstrates the Noether frame of the Earth only (on the right) and demonstrates the relativity of both the time *coordinates* ($dt_{muon} = dt_{earth} / 40$) and the *units* second ($s_{muon} = 40.s_{earth}$). According to the authors, the laws of physics can only be applied in a *single* reference frame. The authors reject the idea of Special Relativity that the laws of physics are simultaneously applicable in two receding inertial frames. Single-frame physics is a paradigm shift away from the current interpretation of the Lorentz transformation of two-frame physics. *This is a paradigm shift away from two reference frames with one set of basic units, to one inertial frame with two sets of basic units.*

0.07 Units of Relativity replacing the Lorentz transformation

Quantum Relativity for Speed redefines the units of relativity based on the cesium clock and its unit second, see chapter 5. The basic units meter, kilogram, and Coulomb depend on the unit second by the *predefined* constants of nature "c" (the speed of light), "G" (the Newton constant), and "K" (the newly defined electron constant). This new system of basic units is called the "S-MKC" system of units; the hyphen demonstrates the primary role of the unit second. Three sets of *basic units* are defined in S-MKC: proper, Noether, and universal (standard) units, see figure 0.3.

Noether to proper units within proper or Noether frame

Proper units $\begin{bmatrix} s_0 \\ m_0 \\ kg_0 \\ C_0 \end{bmatrix} = \gamma_{0N} \begin{bmatrix} s_N \\ m_N \\ kg_N \\ C_N \end{bmatrix}$ Noether units

Standard to Noether units within Noether or universal frame

$\begin{bmatrix} s_N \\ m_N \\ kg_N \\ C_N \end{bmatrix} = \gamma_N \begin{bmatrix} s \\ m \\ kg \\ C \end{bmatrix}$ Standard units

Figure 0.3: Unit transformations replacing the Lorentz transformation

In figure 0.3, "γ_{0N}" is the boost-factor of the proper frame S_0 within the dominant Noether frame S_N. The proper *unit dilation* ($unit_0 = \gamma_{0N}.unit_N$) demonstrates the relativity of the proper units (s_0, m_0, kg_0, and C_0) relative to the Noether units (s_N, m_N, kg_N, and C_N). The proper units dilate relative to the Noether units with the boost-factor "γ_{0N}". Relative (variant) units are printed in italic, contrary to invariant units. Figure 0.3 also demonstrates the transformation of the standard and universal units (s, m, kg, and C) into Noether S-MKC units either within a Noether frame or within the universal frame, this is the subject of the next books. The *unit* transformation of Quantum Relativity for Speed replaces the Lorentz *coordinate* transformation of Special Relativity.

0.08 Einstein's Relativity and unit transformations

Unit transformation is not unique to Quantum Relativity for Speed. Einstein did not define "length contraction", but defined "measuring rod contraction"[4]. A longer measuring rod (larger unit) results in shorter length measurements (smaller coordinates). Einstein took the first step into *unit* relativity; he thought about the *unit of length* change at high speed. Robertson and Walker found a solution to Einstein's field equations for the universe. Robertson and Walker defined "comoving coordinates"; space coordinates of the universe remaining the same while the *unit of space* expands. Robertson and Walker effectively expanded the *unit* meter of the universe, instead of a *coordinate* expansion. *The difference between a unit change and a coordinate change is significant*. For example, when the unit meter changes, all (coordinate) lengths, widths, and heights change. However, when the coordinate length changes and the width and height remain the same (Lorentz transformation), the unit meter depends on the direction. In other words, there is a conflict between the Lorentz transformation and the Robertson-Walker solution; a conflict between unit change and coordinate change. *The authors accept Robertson-Walker's "comoving coordinates"* at the cost of the Lorentz transformation in the y and z direction (y' = y and z' = z). The authors base their theory on *unit relativity*.

0.09 Principle of uniform measurements and Einstein's relativity principle

While the Lorentz transformation is a *coordinate* transformation between two receding reference frames, the *unit* transformation of Quantum Relativity for Speed is defined within a *single* reference frame (proper, Noether, or universal frame). This is a paradigm shift away from current thinking. The authors present the "principle of uniform measurements", which states that observers measure the same *product* of coordinate and unit, irrespective of the unit chosen, within a *single* frame. For example, my length is both 1.82 times one meter and 6.0 times one foot; my length is *uniform*, independent of the unit of length chosen. The principle of uniform measurements will translate the unit relativity into coordinate relativity within a single Noether frame.

> *Principle of uniform measurements:* The product of coordinate and unit of physical quantities of a mass-point or space-time, irrespective of the units chosen, is measured the same by any observer. Physics apply in uniform measurements within a Noether frame.

[4] Einstein, A. (1916). "Über die spezielle und allgemeine Relativitätstheorie". Springer Verlag 2009, 24. Auflage

The principle of uniform measurements *extends* Einstein's relativity principle[5]:

> *Extended relativity principle*: Within a Noether frame, the laws of physics and the constants of nature are invariant to the coordinate system, and to the system of basic units, chosen.

Note the additions: "Within a Noether frame" and "and to the system of basic units," to Einstein's original relativity principle. The universal frame is also a Noether frame; both principles apply to the universal frame.

0.10 Principle of uniform measurements solves Ehrenfest paradox

Figure 0.4 demonstrates the consequences of the unit transformation (between proper and Noether units) and the principle of uniform measurements to the coordinates of space-time and mass-points *within a Noether frame* in both proper and Noether units.
The units of the proper observer and its measurements in proper units are printed in green.

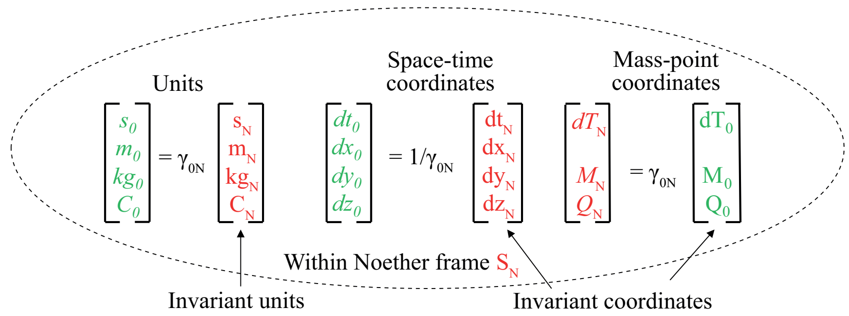

Figure 0.4: Basic units and coordinates within a Noether frame

The units of the Noether observers and their measurements in Noether units are printed in red. Note that within a Noether frame, all the laws of physics apply, irrespective of the units chosen, see chapter 5. The Noether mass-point coordinates lifetime "dT_N", mass "M_N", and charge "Q_N" are relative to the boost-factor, while the coordinates travel-time "dt_N" and space coordinate differences "dx_N", "dy_N", and "dz_N" are invariant to the boost-factor of the proper observer within the Noether frame. The proper mass-point coordinates: lifetime, mass, and charge (dT_0, M_0, and Q_0) are invariant to a change in boost-factor "γ_{0N}". Also, note that the *lifetime* of a mass-particle "dT_0" is invariant to the boost-factor "γ_{0N}", but the *travel-time* "dt_0" is not. The invariance of lifetime, mass, and charge is experimentally established. The invariance of quantities is the subject of appendix D. The mass-point coordinates are printed in capital letters (dT_0, M_0, and Q_0). Do not confuse dT_0 and M_0 with resp. the travel-time "dt_0" and the proper unit meter "m_0". To be consistent, we have also printed charge in a capital letter. The threefold coordinate contraction of proper space coordinates results in a uniform length, width, and height of all objects within Noether frame S_N, solving the Ehrenfest paradox, see chapter 6.

[5] Einstein, A. (1916). "Über die spezielle und allgemeine Relativitätstheorie". Springer Verlag 2009, 24. Auflage

0.11 Clock-factor solves twin paradox and clock paradox
The "clock-factor" of a proper frame determines the frequency of the proper clocks within that proper frame relative to the Noether clocks in the Noether frame (proper clock-factor "δ_0"). The Noether clock frequency is the clock frequency within a gravitational field as dictated by the solutions to Einstein's field equations. The Noether master clock of the earth is far away from the earth, where the Schwarzschild observer resides. The clock-factor "δ_0" of a proper frame within the Noether frame of the earth is uniquely proven by the Kündig experiment, see chapter 7. The introduction of the proper clock-factor solves the twin and clock paradox, see the chapters 5 and 6.

0.12 Uniform Doppler Effect for light and sound
The newly introduced "uniform Doppler Effect" will unite the Doppler Effect for light and sound. In chapter 7, we will demonstrate how the Doppler Effect for sound in air is principally the same as for light in a Noether frame. The authors will demonstrate how the relativistic Doppler Effect is a combined effect of the difference in clock speed between source and receiver, the "clock effect", and the delay caused by the moving source and/or moving observer, the "Doppler delay" (the *actual* Doppler Effect). This distinction between the clock effect and the Doppler delay will unite the current relativistic Doppler Effect with the Doppler Effect for sound. This distinction will put a small clock effect in the measurement of sound. This distinction will also create the relativistic Doppler Effect for *both* a moving source *and* a moving observer within a single Noether frame, within the Noether frame of the earth for example. In uniform Doppler, the "transversal Doppler Effect" has no "Doppler delay", but has a "clock effect" only.

0.13 Minkowski's space-time prepares for repair of Schwarzschild solution
In chapter 8, the authors will demonstrate how Minkowski's space-time can be deduced from Quantum Relativity for Speed. The difference between the Lorentz transformation and the Minkowski formula will be highlighted. The authors fully support the Minkowski formula, which is the essential form of solutions to the field equations of Einstein's theory of General Relativity. We will also demonstrate how the repaired Schwarzschild solution can be described both in the form of the Minkowski formula and in the original form of Special Relativity, uniting the repaired Schwarzschild solution with the repaired theory of Special Relativity.

0.14 Experimental proof of Quantum Relativity for Speed
The experimental proof of Quantum Relativity for Speed will be based on existing experiments (Michelson-Morley, Hafele-Keating, Kündig, the muons created by the solar wind, and GPS clocks). The newly introduced Doppler Effect for *both* a moving source *and* a moving observer can be experimentally tested and confirmed.

1 Errors in Special Relativity based on Two Unproven Assumptions

Two *unproven assumptions* translate directly into two errors in Special Relativity. The *assumed* equality of reference frames[6] is the root cause of the twin paradox and the clock paradox. The *assumed general applicability* to physics of the Lorentz transformation results in the inapplicability of physics in moving frame S' if frame S is an inertial frame. This is the root cause of the Ehrenfest paradox.

1.01 First error in Special Relativity: reference frames are not equal
The relativistic Doppler Effect is the result of the Lorentz transformation applied to reference frame S and the *origin* of the moving reference frame S'. The relativistic Doppler Effect is proven daily by the GPS system. The relativistic Doppler Effect is not in doubt. However, the relativistic Doppler Effect will be used to *challenge* one of Einstein's *unproven assumptions*: the assumed equality of reference frames. The authors will use the relativistic Doppler Effect to prove that reference frames are not equal. The inequality of reference frames is defined as a difference in the speed of progress of the physical processes between reference frames. A thought experiment with clocks will further support the inequality of reference frames. Mach's principle will give yet further support to the inequality of reference frames. In chapter 4, the theoretical proof of the inequality of reference frames based on the proven relativistic Doppler Effect will be experimentally supported by the muons created by the solar wind. In chapter 5, Special Relativity will be repaired for the inequality of reference frames by introducing a "clock-factor" to reference frames determining the speed of progress of the physical processes. The unit transformations, within a single reference frame, will also be described.

1.02 Second error in Special Relativity: Lorentz transformation has limited applicability only
Einstein *assumed* the Lorentz transformation to be generally applicable. The authors will show that the Lorentz transformation is applicable to all space-time locations ("events") in a dominant Noether frame S and a *single mass-point* in the moving reference frame S' *only*. The relativistic Doppler Effect is such an effect. Einstein assumed that physics apply to both reference frames S and S'; he assumed S and S' to be both inertial frames; reference frames within which the laws of physics apply. In chapter 3, the authors will demonstrate that the Lorentz transformation of all events of an inertial frame S within which physics apply, results in another reference frame S' within which physics no longer apply outside of its origin. In other words, the authors will demonstrate that the Lorentz transformation is valid for a Noether frame S and a single mass-point in the origin of S' only.

1.03 Twin paradox of Special Relativity
Two twins, Albert and Beatrice, decide to put Einstein's Special Relativity to the test. According to Special Relativity, reference frames are equal and time dilates within the *other* reference frame. In other words, the clock of the other twin slows down. Beatrice goes on a high-speed journey through space and returns to Albert, who remains on earth. When Beatrice has returned, who is the younger of the two? According to Special Relativity, both twins should be younger than the other one is, that is the paradox. This paradox is debated for more than a century. Most "solutions" to the twin paradox in literature leave both unproven assumptions (equality of reference frames and general applicability of the Lorentz transformation) intact. "Solutions" are generally based on acceleration of the travelling twin, turn around

[6] Einstein, A. (1916). "Die Grundlage der allgemeine Relativitätstheorie". Annalen der Physik. 4 (49) p. 769-822.

effects, or drawing "world lines" of space-time events. The authors will solve the twin paradox by disproving the two above-mentioned assumptions.

1.04 Ehrenfest paradox of Special Relativity

From Wikipedia: "The Ehrenfest paradox concerns the rotation of a 'rigid' disc in the theory of relativity. In its original formulation as presented by Paul Ehrenfest (1909) in the Physikalische Zeitschrift[7], it discusses an ideally rigid cylinder that is made to rotate about its axis of symmetry. The radius R as seen in the laboratory frame is always perpendicular to its motion and should therefore be equal to its value R_0 when stationary. However, the circumference ($2\pi R$) should appear Lorentz-contracted to a smaller value than at rest, by the usual factor γ. This leads to the contradiction that $R = R_0$ and $R < R_0$."

In other words, in the current explanation of Special Relativity, because of the difference between length contraction on one side and the *absence* of width and height contraction on the other side, the laws of geometry fail in the Lorentz transformed reference frame. The authors will solve the Ehrenfest paradox by the unit transformation within a single Noether frame.

1.05 Clock paradox of Special Relativity

The clock paradox is similar to the twin paradox, except that no acceleration or turn-around is involved. Therefore, the clock paradox is more damaging to the general applicability of the Lorentz transformation than the twin paradox is. The clock paradox describes two reference frames with at least two synchronized clocks each, see figure 1.1.

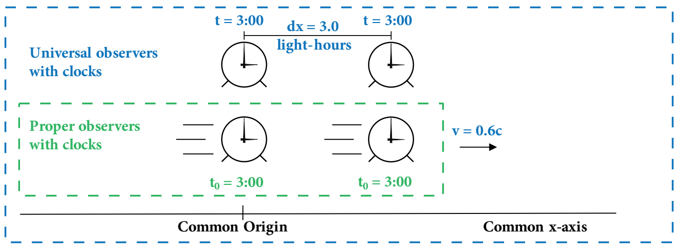

Figure 1.1: Clocks with observers passing each other at 3 o'clock

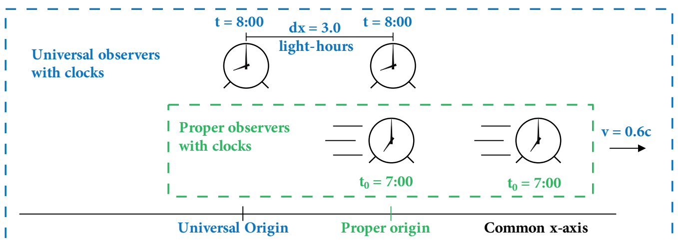

Figure 1.2: Same clocks after five universal hours at 8 o'clock

The left proper clock reaches the right universal clock at 8:00 (3.0 light-hours divided by 0.6 light-hours per hour or 5 hours later), see figure 1.2. The two reference frames with clocks pass

[7] Ehrenfest, P. (1909). "Gleichförmige Rotation starrer Körper und Relativitätstheorie". Physikalische Zeitschrift, 10 p. 918.

each other at constant speed (60% of the speed of light: v = 0.6c) at time zero (3:00 o'clock on all clocks), while the space origin of both reference frames is located at the left clocks. We have chosen a proper and the universal frame with synchronized clocks. When the clocks pass each other, the observers at the clocks note the time on their own clock and the indication on the passing clock (all observing 3:00).

At 8:00 universal time, the universal observer on the right and the proper observer on the left also write down the time when passing. The universal observer on the right notes down 8:00 on its own clock and 7:00 on the proper clock, "time dilation". This time dilation agrees with Einstein's time dilation formula ($t' = t / \gamma$ or $t' = 5 / 1.25 = 4$ hours, see chapter 3). In other words, there is no conflict with the theory of Special Relativity this far.

1.06 Situation from proper observer's point of view

However, when we look at the situation from the proper observer's point of view (equality of reference frames according to Special Relativity, see figure 1.3), the universal observers move to the left (also with 60% of the speed of light: v = –0.6c).

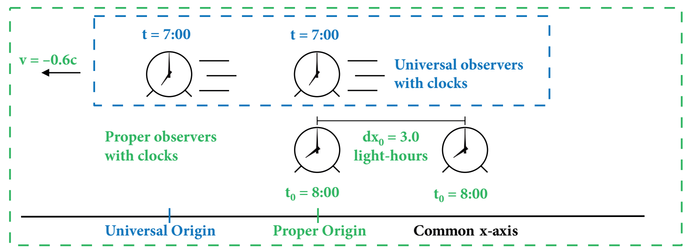

Figure 1.3: Same clocks after five proper hours at 8 o'clock

The proper observers regard themselves as standing still, while the universal observers are travelling. The universal observer on the right notes down to meet at 7:00 with the proper observer on the left, while the proper clock indicates 8:00; exactly reverse to the outcome as shown in figure 1.2! Clocks cannot indicate both 7:00 and 8:00. This thought experiment shows the paradox of equality of reference frames to clocks: the clock paradox.

1.07 Summary of consequences of the two unproven assumptions

Both *unproven assumptions* translate directly into two errors. The *assumed* equality of reference frames is the root cause of the twin and clock paradox. The *assumed* general applicability to physics of the Lorentz transformation results in the inapplicability of physics in moving frame S' if frame S is an inertial frame. This is the root cause of the Ehrenfest paradox. Lastly, and most damaging of all, the two errors result into the non-compliance to Noether's conservation laws in the theory of *General Relativity*. This non-compliance to Noether's conservation laws was signaled by Noether and Hilbert: "Hilbert enunciates his assertion to the effect that the failure of proper laws of conservation of energy is a characteristic feature of the "general theory of relativity"[8]. In book II, the authors will reunite the field equations solutions with Noether's conservation laws. Firstly, we need to repair Special Relativity to facilitate that.

[8] Noether, E. (1918). "Invariante Variationsprobleme". Translated by Tavel, M. "Invariant Variation Problems". Transport Theory and Statistical Physics, 1971. 1(3) p. 186-207.

2 Proving Inequality of Reference Frames with Relativistic Doppler Effect

The inequality of reference frames will be theoretically proven by the relativistic Doppler Effect, experimentally supported by the muons created by the solar wind (chapter 4), supported by Mach's principle, and supported by a clock (thought) experiment. The *inequality* of reference frames will solve the twin paradox and clock paradox.

2.01 Introduction

Einstein was a pioneer of relativity. He had to work with a single experiment (Michelson-Morley) and a single transformation (Lorentz transformation). He brilliantly combined the two into his theory of Special Relativity in 1905. Special Relativity explains the energy in mass ($E = M.c^2$). Special Relativity demonstrates that space is *not* a substance (the "ether"), but a relationship (formula) between observers. Special Relativity demonstrates that the time of one observer is unequal to the time of another observer. Space and time are relative to the observer. Two events that happen at the same time to one observer may not happen at the same time to another observer (no "synchronicity" between observers). The authors will not question any of these accomplishments of Special Relativity. In this chapter, we will look at Special Relativity in a different order, an order to demonstrate the errors.

2.02 Relativistic Doppler Effect

It may seem strange to start with the relativistic Doppler Effect; most authors start with the Lorentz transformation. However, the Doppler Effect is proven daily by our GPS satellites, while the general applicability Lorentz transformation *has no experimental backing* outside of the origin of the moving (reference) frame S'. In the Michelson-Morley experiment, the laws of physics cannot be valid in both S (solar frame) and in S' (the earthly frame). We will use the relativistic Doppler Effect to prove the inequality of the universal frame S and a moving proper frame S_0. The full relativistic Doppler Effect is presented in appendix A.

2.03 Confusing definitions in Doppler formulas

Before we start, we need to warn you of the many and sometimes conflicting formulas that are presented as the (relativistic) Doppler Effect. We, as authors, have spent a lot of time getting the definitions sorted out. The main confusion exists because of the *mathematical use* of a speed within a reference frame versus *approaching* and *receding* speeds. We mainly use the mathematical use of speed (v_0) within a reference frame. This speed is constant, but could be perceived as approaching or receding. However, in chapter 7 we had to use the approaching and receding speed, for reasons that become clear in chapter 7. To understand the difference, the formulas A.03 and A.04 in appendix A provide you with the definition. The angles used can also be confusing; we use the mathematical definition of angles. For clarity in angle definitions, see appendix A.

2.04 Relativistic Doppler Effect on the positive x-axis

In this chapter, we will only concern ourselves with the relativistic Doppler effects on the positive x-axis of the universal frame S. The universal frame is "inertial", see chapter 3. When a proper source moves over the positive x-axis in universal frame S, the following relativistic Doppler formulas apply:

$dt_{obs} = \gamma_0.(1 + \beta_0).dt_0$	Doppler time difference "dt_{obs}"	(2.01)
$\nu_{obs} = \nu_0 / (\gamma_0.(1 + \beta_0))$	Doppler frequency "ν_{obs}"	(2.02)
$\beta_0 = v_0 / c$	natural speed of the proper source "β_0"	(2.03)
$\gamma_0 = (1 - \beta_0^2)^{-½}$	boost-factor of the proper source "γ_0"	(2.04)

In these formulas, "dt_0" is the time difference as measured by a proper observer at the source and in the origin of reference frame S_0, "dt_{obs}" is the time difference as measured by the receiving observer *in the origin* of universal frame S, "v_0" is the speed of the proper source in universal frame S, and "c" is the speed of light. We will use a thought experiment to illustrate the inequality of reference frames S and S_0. Both the proper observer at the source ("0") and the receiving universal observer ("obs") are located in the origin of their reference frames. We will put the observer Albert in the following thought experiment in the origin of universal frame S, while Beatrice travels within the universal frame as moving source in the origin of her moving proper frame S_0.

2.05 Universal frame S

The universal frame S is the homogenous (everywhere the same) and isotropic (the same in all directions) universal *model*. The universal frame is a hypothetical set of lines parallel to the x-, y- and z-axis. The universal space is curved, but on the smaller scale, the universal frame and universal space is Euclidean ("straight"). This hypothetical frame is occupied by hypothetical universal observers, all standing still relative to the universal frame (relative to the distant stars, sidereal speed of zero). All universal observers have synchronized clocks indicating universal time. The origin of the universal frame is arbitrary. The universal frame is an inertial frame (see chapter 3) within which the laws of physics apply.

2.06 Beatrice travels in Albert's universal frame

In the following thought experiment, we will assign Beatrice to be the proper traveller within, and Albert to stand still within, universal frame S. In other words, Beatrice (in the origin of her proper frame S_0) travels in Albert's reference frame S, while Albert is observing the moving source. In appendix A, the situation for Beatrice as proper *receiving* observer is also worked out; this comes to the same end conclusion, the inequality of reference frames. Beatrice's travel is confirmed by the g-forces when getting up to speed and turning around. Both Albert and Beatrice acknowledge that Beatrice is travelling in Albert's universal frame S. Although the earth and the sun move within the universal frame, these speeds are very small compared to Beatrice's speed, the error made by considering Albert a universal observer is small. This thought experiment demonstrates the inequality of the universal frame and the proper frame.

Albert observes a lower frequency when Beatrice broadcasts electro-magnetic waves and moves away from him over the positive x-axis of S (top of figure 2.1). Albert observes a higher frequency after Beatrice has turned around.

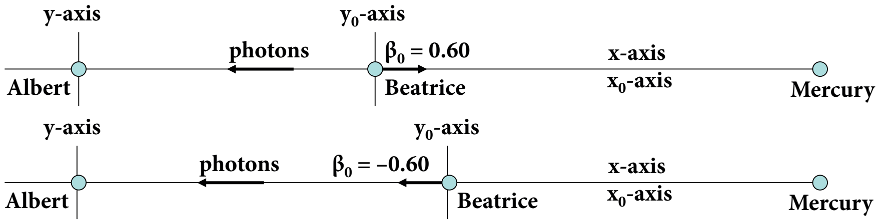

Figure 2.1: Beatrice's journey back and forth

The time difference between two peaks of the transmitted frequency gets longer when Beatrice moves away ($dt_A = \gamma_0.(1 + \beta_0).dt_0$) and shorter on her way back. We will use the subscript "A" for Albert's measurements as single universal observer and subscript "0" for Beatrice as single proper observer.

2.07 Thought experiment

A moving source accompanied by proper observer Beatrice, moves away from planet Earth towards planet Mercury. During her journey, Beatrice broadcasts a one-microsecond flash of green light of 600 [THz_0] every second: $dt_0 = 1.0$ [s_0]. Note that we use square brackets to indicate in which units the coordinates are expressed. When we multiply the coordinate by the unit, as we will do in chapter 6, we use the symbol ".". Albert remains on earth and follows Beatrice's journey by receiving these flashes of light. Beatrice moves at a speed of 60% of the speed of light towards Mercury ($\beta_0 = 0.60$), which results in a boost-factor "γ_0" of 1.25. Beatrice travels 800 seconds on her own clock, reaches planet Mercury and then turns around moving back to Earth. Beatrice returns with the same speed ($\beta_0 = -0.60$) towards Albert. After another 800 seconds on her clock, Beatrice arrives back on Earth. When applying the values of the thought experiment ($dt_0 = 1.0$ [s_0]) to the Doppler formula (2.01) for a moving source, we obtain:

$dt_A = 2.0$ [s]	Doppler for time difference to Albert when $\beta_0 = 0.60$
$dt_A = 0.5$ [s]	Doppler for time difference to Albert when $\beta_0 = -0.60$

Note that Albert's unit second "s" may not be equal to Beatrice's unit second "s_0". Every time Beatrice broadcasts a green flash of light of 600 [THz_0], Albert measures:

$\nu_A = 300$ [THz]	Doppler for frequency to Albert, $\beta_0 = 0.60$
$\nu_A = 1{,}200$ [THz]	Doppler for frequency to Albert, $\beta_0 = -0.60$

Albert receives an infrared flash of light of 300 [THz] every 2.0 seconds when Beatrice is receding, and an ultraviolet flash of light of 1,200 [THz] every 0.5 seconds when approaching. We will both observe and compute the time on both Albert's and Beatrice's clocks at arrival for comparison.

2.08 Albert counts flashes

Beatrice has sent 1,600 flashes of light on her journey (including a flash at arrival). Albert receives all these flashes of light (light flashes do not get lost). Albert *computes* that the clock of Beatrice has progressed 1,600 seconds ($t_0 = 1{,}600$ [s_0]), by counting flashes. Albert *looks* at his clock and sees that 2,000 seconds have passed by ($t_A = 2{,}000$ [s]). To check this result, Albert also adds up the time differences between all flashes (800 every 2.0 seconds and 800 every 0.5 seconds):

$t_0 = 1{,}600$ [s_0]	travel time t_0 *measured* by Beatrice on her clock
$t_0 = 1{,}600$ [s_0]	travel time t_0 *computed* by Albert (counting flashes)
$t_A = 2{,}000$ [s]	travel time t_A *measured* by Albert on his clock
$t_A = 800 \times 2.0 + 800 \times 0.5 = 2{,}000$ [s]	travel time t_A *computed* by Albert (Doppler for time)

The clock of Albert confirms the relativistic Doppler Effect for time differences.

2.09 Relativistic Doppler Effect proves inequality of reference frames

Both Beatrice and Albert conclude that 1,600 [s_0] have passed by on Beatrice's clock and 2,000 [s] have passed by on Albert's clock. The "time dilation" formula in the origin of S', as deduced by Einstein, is our next subject (chapter 3) and equals:

$t' = t / \gamma$	time dilation in the origin of S'

For now, we will just apply the formula ($t_0 = t'$ in the origin of S', $t_A = t$ in S and $\gamma_0 = \gamma$, the boost-factor of the proper observer Beatrice in S):

$t_0 = t_A / \gamma_0 = 2{,}000 / 1.25 = 1{,}600$ [s_0]	time dilation

Einstein's time dilation formula corresponds to the outcome of the thought experiment. However, perfect as this result may seem, one problem remains. Albert concludes that the clock of Beatrice has slowed down (time dilation), but Beatrice *must* also conclude that Albert's clock has ticked faster (*time contraction*). This is contrary to Einstein's *assumed* equality of reference frames. Equality of reference frames would mean time dilation for both Albert and Beatrice; this is in essence the twin paradox. This thought experiment contradicts Einstein's *unproven assumption* of equality of reference frames. This thought experiment proves inequality of reference frames based on relativistic Doppler of a moving source. For the full proof, see appendix A.

2.10 Mach's principle supports dominance of universal frame

Mach's principle[9] can be described as "The inertia of mass is caused by all other masses in the universe". This principle has two parts:

1) *relativity* of the inertia of mass,
2) *relationship* to "all other masses in the universe".

Einstein used the first part in the design of his theory only. The authors have added the second part of Mach's principle. The authors will argue that the universal frame (the homogenous and isotropic universal *model*) is more dominant than any other reference frame. The authors will argue that the dominance of any reference frame is determined by its clock-factor, see chapter 5. The universal frame is dominant over the earthly frame, which in turn is dominant over a proper frame. The second part of Mach's principle will be realized by making S the dominant frame and assigning clock-factors to proper frames.

2.11 Thought experiment proves dominance of universal frame

To further disprove Einstein's first assumption, the equality of reference frames, we could look again at the indication of two synchronized proper clocks, some distance apart, that pass two universal synchronized clocks at high speed, see figure 2.2. This experiment was described in chapter 1 in the paragraph "clock paradox".

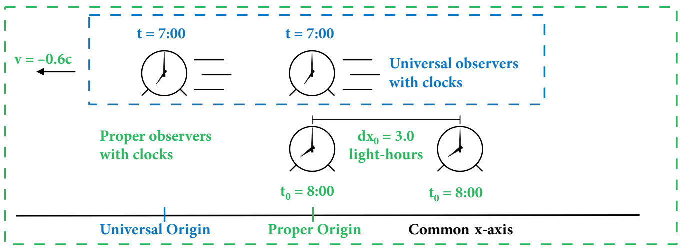

Figure 2.2: Dominance of the universal frame

Reference frames must be unequal; proper reference frames must have a lower "clock-factor" than the universal frame has. The authors will argue that the clock frequency depends on the speed of the proper frame within the universal frame.

2.12 Summary

The inequality of reference frames (inertial frames) is theoretically proven by the relativistic Doppler Effect, experimentally supported by the muons created by the solar wind (see chapter 4), supported by Mach's principle and supported by a clock (thought) experiment. The *inequality* of inertial frames will solve the twin and clock paradox, see chapter 6.

[9] Barbour, J. and Pfister, H. (1995). "Mach's principle: from Newton's bucket to quantum gravitation". ISBN 978-0-8176-3823-8. (Einstein studies, vol. 6).

3 Proving Limited Applicability of Lorentz transformation

The limited applicability of the Lorentz transformation is theoretically proven by its application to an inertial frame S at *any* given time. The resulting S' is not an inertial frame. In other words, physics do not apply outside of the origin of S', if S is an inertial frame.

3.01 Lorentz transformation

To understand Special Relativity and its errors, we need to understand the Lorentz transformation. The Lorentz transformation transforms space-time events within a reference frame S(t,x,y,z) into space-time events within another reference frame S'(t',x',y',z'). A condition to the Lorentz transformation is that at t = 0 and t' = 0 the frame origins of S and S' are at the same location. At any space-time event in S, the space-time coordinates of S' are found by the Lorentz transformation:

$t' = \gamma.(t - v.x / c^2)$	coordinate t' in S' is function of coordinates t and x in S	(3.01)
$x' = \gamma.(x - v.t)$	coordinate x' in S' is function of coordinates t and x in S	(3.02)
$y' = y$	coordinate y' in S' equals coordinate y in S	(3.03)
$z' = z$	coordinate z' in S' equals coordinate z in S	(3.04)
$\gamma = (1 - v^2 / c^2)^{-½}$	boost-factor	(3.05)

The reference frame S' moves with constant speed "v" in the positive x-direction of reference frame S. The Lorentz transformation ensures the constancy of the speed of light "c" in both frames S and S'. However, we will demonstrate that when S is an *inertial frame*, S' is *not* an inertial frame. In other words, the laws of physics in general are *not applicable* in S', if these are applicable in S.

3.02 Inertial frames and current definition

From Wikipedia: "In physics, an inertial frame of reference (also inertial reference frame or inertial frame or Galilean reference frame) is a frame of reference that describes *time homogeneously* and *space homogeneously, isotropically, and in a time-independent manner*[10]. All inertial frames are in a state of constant, rectilinear motion with respect to one another; they are not accelerating (in the sense of proper acceleration that would be detected by an accelerometer). *Measurements in one inertial frame can be converted to measurements in another by a simple transformation* (the Galilean transformation in Newtonian physics and *the Lorentz transformation in special relativity*). In the theory of General Relativity, an inertial reference frame is only an approximation that applies in a region that is small enough for the curvature of space to be negligible. Physical laws take the same form in all inertial frames."

This definition requires space to be independent of time within any inertial frame. However, the authors will argue that when all space locations of an inertial frame (at any arbitrary time t in S) are Lorentz transformed, the time t' within the resulting frame depends on the x'-coordinate in S' ($t' = t / \gamma - v.x' / c^2$). This dependence of time t' on location x' contradicts the definition of an inertial frame ("describes *time homogeneously* and *space homogeneously, isotropically, and in a time-independent manner*"). The authors will also argue that the Lorentz transformed frame S' is not isotropic (the same in all directions) in space, if S is an inertial frame.

[10] Landau, L. and Lifshitz, E. (1960). "Mechanics". Pergamon Press p. 4–6.

3.03 Lorentz transformed inertial frame is not an inertial frame

When all the space coordinates of an *inertial* frame S at time 0 of S(0,x,y,z) are Lorentz transformed (all events at time zero in S), the resulting S' frame coordinates (t',x',y',z') do not represent an inertial frame, see figure 3.1.

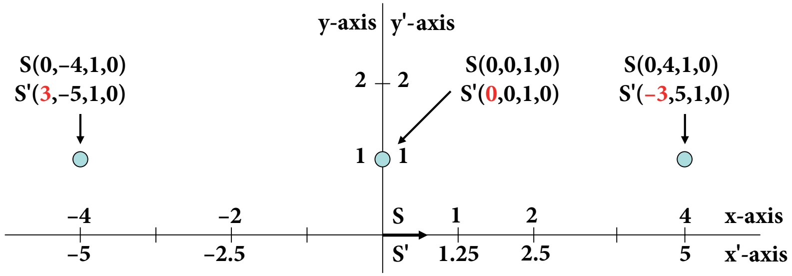

Fig 3.1: Inertial frame S and Lorentz transformed S' at t = 0

The interdependence of t' and x' (t' = −v.x' / c²) in S' at t = 0 of S conflicts with the *homogeneity of time* (the same time throughout the frame) in S' and with "*space homogeneously, isotropically, and in a time-independent manner*" in S', see the current definition of an inertial frame. This is demonstrated for distances in light-seconds (c = 1.0 light-second / second) and time in seconds for a speed of reference frame separation v of 0.60 light-seconds / second (60% of the speed of light). The time t' in S' at three locations of S at time t = 0 is shown in red (t' = −0.60.x'). S' cannot be an inertial frame if S is, S' conflicts with the above-mentioned definition of an inertial frame.

3.04 Failure of isotropy of S'

You may also note that the space in S' is not isotropic, the x'-axis coordinates are larger than the x-axis coordinates in S, while the y'-axis coordinates and y-axis coordinates are the same. In figure 3.1 is demonstrated how the unit meter in inertial reference frame S is the same in the x and y direction (0,1,0,0) and (0,0,1,0), while the Lorentz transformed coordinates in S' are unequal (0,1.25,0,0) and (0,0,1,0). The failure of isotropy of space puts the SI standard for the unit meter in S' in question (the unit meter is the distance light travels in 1 / c seconds in vacuum). Looking at figure 3.1, can we draw the unit meter on both the x'- and y'-axis? Of course not. The Lorentz transformed S' is in conflict with our isotropic SI unit meter definition. S' cannot be an inertial frame if S is; S' conflicts with our unit meter definition.

3.05 Failure of synchronization in S'

The Lorentz transformed space locations of S at time zero (t = 0), result in events in S' with different times t'. Speed is measured within an inertial frame with *synchronized clocks*. To apply all physics, including speed measurements, the clocks must be synchronized, just as the speed measurements of neutrinos between CERN and Gran Sasso is based on synchronized clocks. In other words, when the clocks in S' are not synchronized, physics do not apply and therefore S' cannot be an inertial frame. The Lorentz transformation fails if the space-time events are not located in the origin of S'. When S is an inertial frame, S' cannot be an inertial frame since the clocks in S' are not synchronized. In S', speed cannot be measured accurately. Accepting that

the Lorentz transformation has limited applicability to physics (in the *origin* of S' only), and accepting that inertial frames are *unequal*, solves the paradoxes of Special Relativity.

3.06 Synchronicity within a frame and synchronicity between observers

Einstein proved that synchronicity of two events to one observer does not mean synchronicity to another observer. However, *within* an inertial frame, synchronicity is a necessity to apply physics. Space-time has no meaning when all the clocks *within* an inertial frame indicate a different time. When looking at figure 3.1, do not confuse synchronicity *within* an inertial frame with synchronicity between observers in different reference frames.

3.07 Another thought experiment with clocks

To disprove Einstein's second assumption, the general applicability of the Lorentz transformation to physics, we could also apply the Lorentz transformation to the clock experiment of Chapter 1 and 2, while accepting the inequality of reference frames. Figure 3.2 demonstrates how the Lorentz transformation of universal frame S works out at the start at 3:00. The origins are located at the left clocks (x = 0 and t = 0 for the Lorentz transformation).

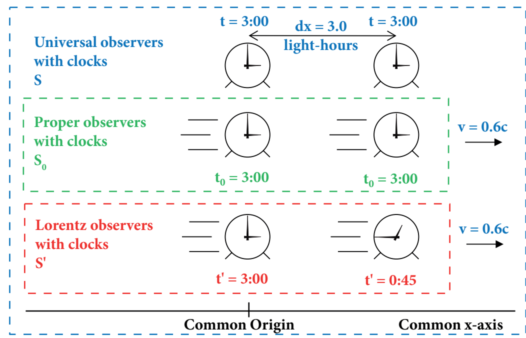

Figure 3.2: Snapshot of all clocks at 3:00 universal time

Notice how the Lorentz transformed clock in the origin (the left clock) agrees with the universal and proper clock, but the Lorentz transformed clock on the right does not agree with the universal and proper clock (not in the origin). In figure 3.2, the right universal clock within S is 3.0 light-hours away from the left clock in the origin of S (x = 3.0 for the Lorentz transformation). The time of the universal clocks within S in Lorentz terms equals zero (t = 0). The speed "v" equals 0.6c, resulting in a boost-factor of 1.25. Applying the Lorentz transformation for this space-time event (the right universal clock) in S(0,3,0,0), results in a Lorentz transformed S'(−2.25,3.75,0,0). The time is 2¼ hours behind the clock in the origin of S', the time on the actual clock is 0:45. The Lorentz transformed clocks within S' are not synchronized. S' is not an inertial frame if S is; physics do not apply within S', except for the origin of S'.

3.09 Summary

The limited applicability of the Lorentz transformation is theoretically proven by its application to an inertial frame S at *any* given time. The resulting S' is not an inertial frame; in other words, physics do not apply outside of the origin of S'.

4 Muons Support Inequality of Reference Frames

The 80% survival rate of muons, created high in our atmosphere by the solar wind, proves the inequality of the reference frame of the earth and the reference frame of the muon. The authors will show that the presumption of distance contraction as seen from the reference frame of the muon is correct, but reinforces the *inequality* of the reference frames.

4.01 Muons prove inequality of reference frames experimentally

The inequality of reference frames is supported by the survival of muons that originate from the solar wind. This experimental proof of inequality of reference frames is fully described in appendix B. In short, muons are created by the collision of the protons of the solar wind with our atmosphere. Most muons originate above 10 km, for the example we have chosen a muon that is created at 12 km height. The boost-factor of these muons in the frame of the earth is high; for this example we have chosen a boost-factor of 40.

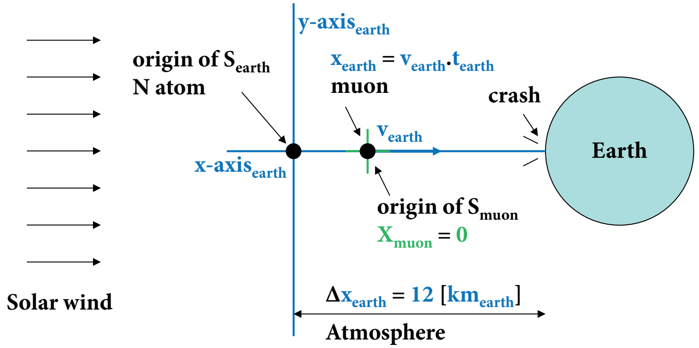

Figure 4.1: Muon moving in reference frame of the earth S_{earth} ($x_{earth} = v_{earth} . t_{earth}$)

In figure 4.1, a nitrogen molecule is hit by a proton from the solar wind. One of the two nitrogen atoms is destroyed and a muon is created that moves towards the earth's surface with a boost-factor of 40. This muon has its own reference frame S_{muon}. The other nitrogen atom remains in the atmosphere and becomes the origin of the reference frame of the earth S_{earth}. In essence, the application of the Lorentz transformation in the origin of S_{muon} within the reference frame of the earth S_{earth} describes a trajectory of 12 km (see figure 4.2). The computations can be found in appendix B. This trajectory requires the muons to survive 1.001 microseconds (at a height of 12 [km$_{earth}$] at a boost-factor of 40) to reach the surface of the earth. Within S_{earth}, we measure 40.040 microseconds survival time of the muon. Both the measured time "Δt_{earth}" of 40.040 [μs$_{earth}$] and the *measured trajectory* "Δx_{earth}" of 12 [km$_{earth}$] are the *only measured data*.

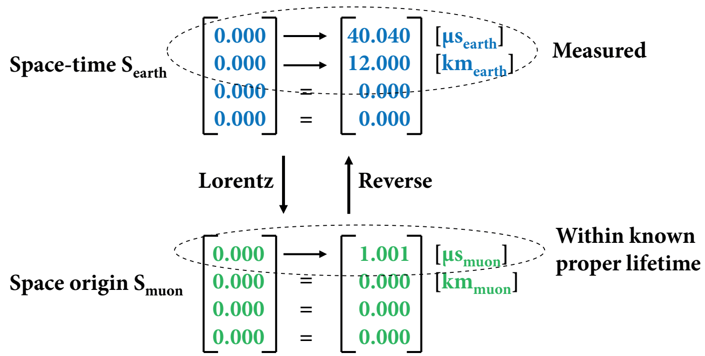

Figure 4.2: Lorentz transformation and reverse Lorentz transformation

Figure 4.2 demonstrates the trajectory within space-time S_{earth} only, note the x-coordinate of S_{earth} (x_{earth}) going from 0 to 12 [km$_{earth}$], while the space coordinates of S_{muon} remain 0.000 (origin of S_{muon}). This change is indicated by a black arrow; the unchanging space-time events are indicated by "=". Also note that the Lorentz transformation of the Lorentz transformation ("Lorentz" and "Reverse") results in the original space-time events.

4.02 Average lifetime of muons

The average lifetime of muons at rest (proper lifetime), as measured in laboratories on earth, amounts to about 2.2 microseconds. Within S_{muon}, the muon is at rest. In other words, most muons survive the fall towards the earth's surface if the travel time is less than 2.2 *proper* microseconds. We measure that more than 80% of the muons reach the earth's surface. The above example of a muon that is created at a height of 12 kilometers, with a boost-factor of 40, has a very good chance of reaching the earth's surface. The people on earth *measure* different space and time; they measure a *trajectory* of 12 kilometers and a travel time of 40.040 microseconds. Note that the muon does not travel within its own reference frame; x_{muon} remains zero.

4.03 Travelling earth within the reference frame of the muon

To test the equality of reference frames, we are going to let the earth travel in the reference frame of the muon S_{muon}. We will then observe the trajectory of the *origin* of the reference frame of the earth in the reference frame of the muon. In other words, in the next paragraph we will see x_{earth} remain zero and x_{muon} to change from zero to a non-zero value.

4.04 We may not presume the distance to be 300 meter within S_{muon}

We will have to compute the non-zero value of x_{muon} such that it corresponds to the known distance, which the origin of S_{earth} travels within S_{earth} ($x_{earth} = 0$), and the measured travel time within S_{earth}: $\Delta t_{earth} = 40.040$ [μs$_{earth}$]. We then get to an x_{muon} of –480 [km$_{muon}$] and a t_{muon} of 1,601.608 [μs$_{muon}$], see figure 4.4 and appendix B. *We may not presume that the origin of the earth travels only 300 meters* (12 km / 40) within S_{muon}. This would imply the dominance of the universal frame, see appendix B. If you *do* think that earth's origin only travels 300 meter within muon's frame, then *you are right*, but then you also *acknowledge* the *inequality* of reference frames, see appendix B.

4.05 The trajectory of earth's *origin* as seen in muon's space-time

When we look at the reference frame of the muon, the earth is moving and the muon is standing still. When the earth's surface collides with the muon, the origin of the earth, the N-atom, has moved to the left and is at –480 [km_{muon}] in S_{muon} (S_{muon} in green). The origin of the earth in S_{earth} remains zero (x_{earth} = 0), and the trajectory of the origin of the earth, within the reference frame of the muon, results in a changing x_{muon} (in green: $x_{muon} = v_{muon}.t_{muon}$). The application of the Lorentz transformation to the origin of S_{earth}, within the reference frame of the muon S_{muon}, describes a 480 km trajectory (see figure 4.3 and 4.4).

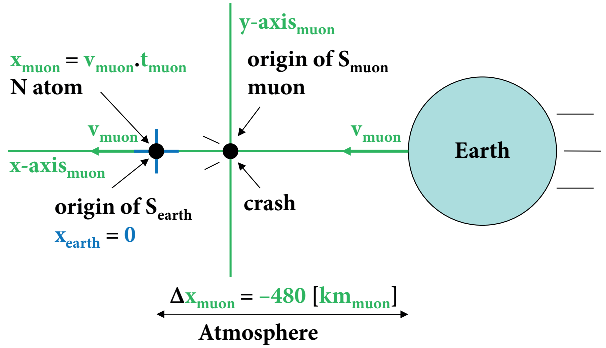

Figure 4.3: Trajectory of the origin of earth in S_{muon} ($x_{muon} = v_{muon}.t_{muon}$)

The Lorentz transformed trajectory of the origin of the earth within the reference frame of the muon is shown in figure 4.4 (in green).

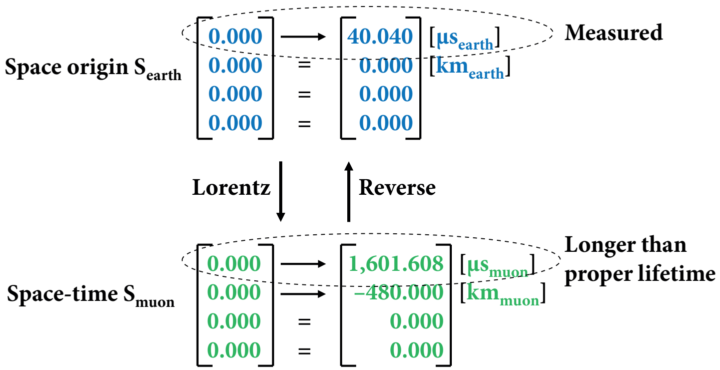

Figure 4.4: Lorentz transformation of the origin of the earth in S_{muon}

Note that the space coordinates of S_{earth} remain zero (origin of S_{earth}), while a trajectory of 480 km is travelled by the origin of S_{earth} in space-time S_{muon}. In other words, the trajectory is exactly reversed from the trajectory in figure 4.1. In figure 4.1, the origin of S_{muon} is travelling within the reference frame of the earth, while in figure 4.3, the origin of the earth is travelling within the reference frame of the muon. Also, note that the only quantity measured is the time on the clocks on earth of 40.040 [$µs_{earth}$]. This trajectory within S_{muon} would require the muon to survive much longer to reach the surface of the earth (more than 1,601 [$µs_{muon}$]) than we know from experiments on earth that it does (2.2 [$µs_{muon}$] on average in its own reference frame). We measure that more than 80% of the muons reach the surface of the earth. *We must conclude that the reference frame of the muon is not applicable.*

4.06 What the experiment proves

In other words, the muons reaching the surface of the earth prove the *dominance* of the reference frame of the earth S_{earth} over the reference frame of the muon S_{muon}. For the full description, including the presumption of the 300-meter trajectory, we refer to appendix B.