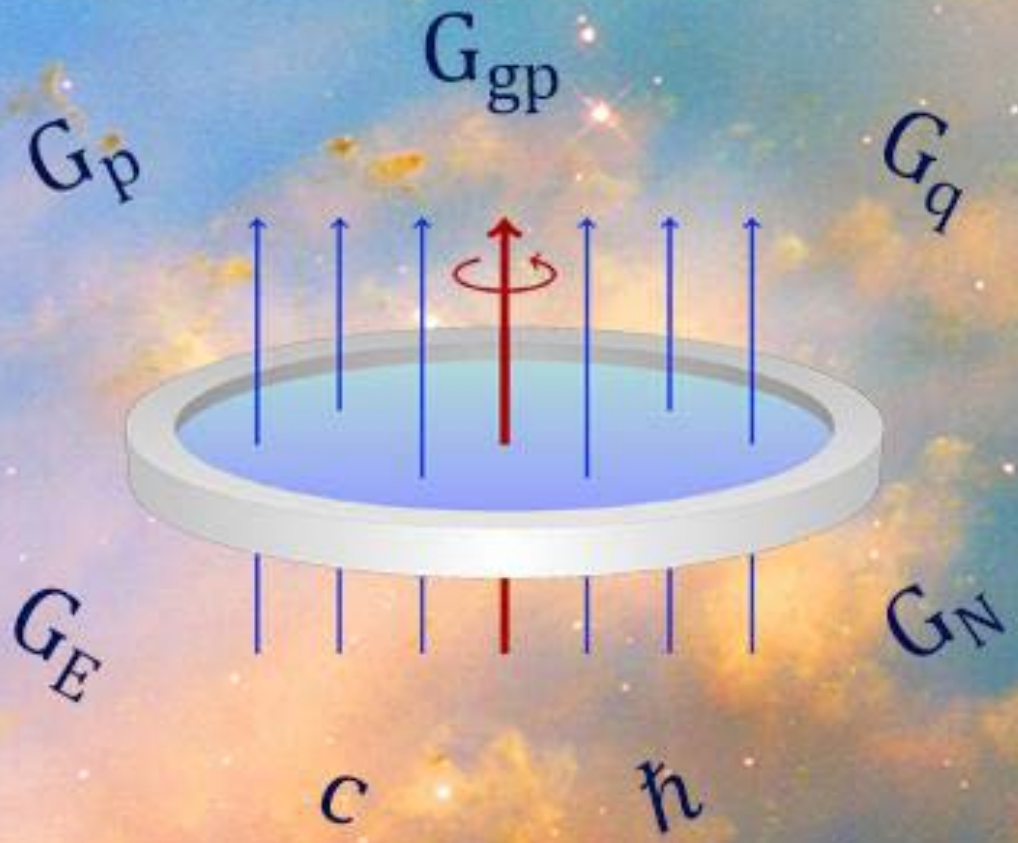
Introduction to Physics Astrophysics and Cosmology of

Gravity-Like Fields



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HPCC-Space GmbH
Hamburg

Introduction to

Physics
Astrophysics and Cosmology
of
Gravity-Like Fields

"... behind all the discernible laws and connections,

there remains something subtle, intangible and inexplicable."

Albert Einstein

An Elementary PRIMER for

Physics, Astrophysics, and Cosmology of Gravity-Like Fields

Breakthrough Physics for Propulsion and Energy Generation Technologies

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Physics, **A**strophysics, and **C**osmology of **G**ravity-Like **F**ields

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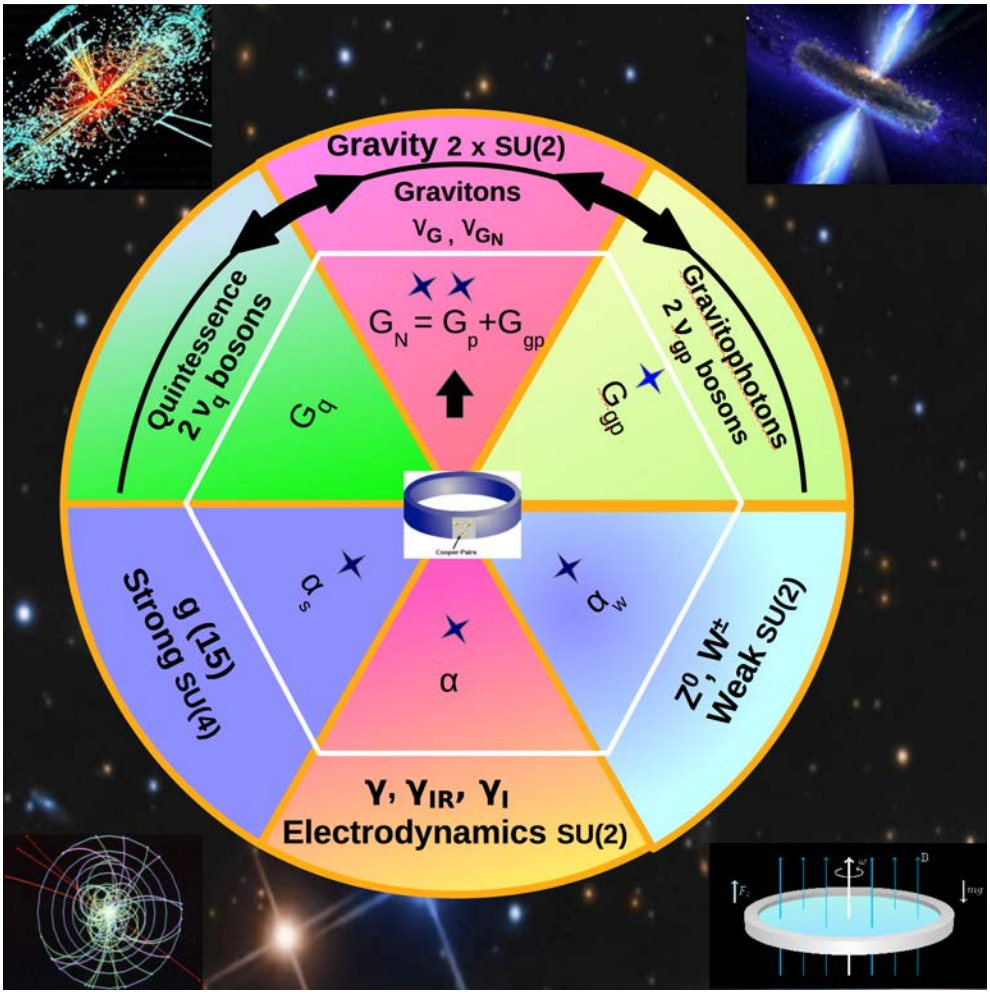
Gravity 2 x SU(2)
Gravitons
v_G , v_{G_N}
$G_N = G_p + G_{gp}$
Quintessence
2 v_q bosons
G_q
G_{gp}
Gravitophotons
2 v_{gp} bosons
α_s
α
α_w
g (15) Strong SU(4)
Z^0, $W^{\pm}$ Weak SU(2)
Y, Y_{IR}, Y_I
Electrodynamics SU(2)

Mandala Picture

THE MANDALA OF PHYSICAL INTERACTIONS

The mandala of the physical forces shows ***six fundamental interactions***.
Three of them are assumed to be of ***gravitational nature*** (upper half).

Gravitation, identified with the Newtonian force formulated in 1687 and reformulated by A. Einstein in 1915 as the general theory of relativity (*GR*), is still a mysterious force. According to modern quantum field theory, gravitation is mediated by the graviton, ν_{G_N}, a spin-2 tensor particle (indicated in the illustration by two star symbols). The force acting between two masses ($m_1, m_2 > 0$) is characterized by the single gravitational coupling constant G_N (the index N stands for Newton), which is the same in both Newtonian and Einsteinian gravitation. Recent measurements of G_N (there is no theory to calculate its value) have shown strange deviations in the results in spite of the accuracy of the measurement techniques. So far, this problem has not been resolved (see text).

Recent calculations by the authors, and possibly also experiments, suggest that gravity might have a more subtle structure. It might exhibit a multi-faceted nature comprising three gravitational constants: G_p for hadrons, G_{gp} for leptons, and G_q for the interaction with dark energy (the vacuum field of spacetime) and the spacetime lattice (or continuum, depending on spatial resolution).

This means, the Newtonian gravitational constant should be a combination $G_N = G_p + G_{gp}$. Moreover, to account for the interaction with the vacuum field (dark energy) characterized by Einstein's cosmological constant Λ, a second gravitational constant needs to be introduced, termed Einsten's gravitational constant, since it plays a role only in *GR*, given by $G_E = G_N + G_q$. Now Newtonian and Einsteinian gravitation exhibit slightly different gravitational constants, since in Newton's theory space and time have absolute character (static), while in Einstein's *GR* spacetime is a dynamical field.

Furthermore, the physical model, presented in this primer, termed *Extended Heim Theory* (*EHT*), predicts the existence of *six* gravitational bosons (see figure), replacing the singular graviton of *GR*. *EHT* predicts the existence of two types of gravitational fields. The first type are the cosmological fields that include the graviton of *GR*. The second type of fields are the so-called conversion (or cold) fields that are assumed to be generated by a phase transition at cryogenic temperature. They would be many orders of magnitude larger than comparable cosmological fields. This theoretical view may be supported by reports of the production of extreme gravitomagnetic and gravity-like (acceleration) fields in the laboratory by using a small rotating Nb ring (center of illustration), which according to *GR* is totally impossible.

The three bosons of the (three) cosmological gravitational fields are the graviton ν_{G_N} for static masses, the gravitophoton ν_{gp} for moving masses, and the quintessence particle ν_q mediating the interaction between dark energy and the spacetime lattice (expansion or contraction).

As published since 2002, conversion fields should exist due to the existence of three additional gravitational bosons, namely $\tilde{\nu}_G$, $\tilde{\nu}_{gp}$, $\tilde{\nu}_q$. Two of these novel particles should be spin-1 bosons: the so called cold graviton $\tilde{\nu}_G$ and the cold gravitophoton particle $\tilde{\nu}_{gp}$. The third, $\tilde{\nu}_q$, denoted as cold quintessence particle, must be a spin-0 particle and is assumed to be the mediator boson between dark energy and spacetime by acting as a very weak repulsive gravitational force since it causes spacetime to expand. In contrast to cosmological fields, these particles are ephemeral particles since they depend on the presence of cryogenic conditions.

These particles are suggested to result from the conversion of **electromagnetic** into extreme **gravitomagnetic** or **gravity-like** (acceleration) fields, triggered by a kind of phase transition at cryogenic temperatures. The postulated interaction between electromagnetism and gravity — surmised and intensely sought by A. Einstein since 1915 upon the publication of his theory of general relativity — seems to be occurring at cryogenic temperatures and caused by the phenomenon of symmetry breaking in a process analogous to superconductivity.

The strong variations in the measured values of G_N might be caused by neutrino fluctuations affecting the values of the gravitational constants G_E and G_N by $\pm G_{gp}$, depending on the *Sun's* activity (11-12 years period) and/or the location of the laboratory (daily/nightly variation due to the rotation of the *Earth* with respect to the *Sun*). Gravitation also might possess a non-local feature.

According to this novel approach, apart from leading to a change in the *Weltbild* of physics by extending the general theory of relativity, **gravitational engineering** may eventually become a technological reality and lead to a novel era of spaceflight, i.e., **propellantless propulsion**. As a further consequence for physics, this theoretical view would force major extensions of both the standard model of cosmology and particle physics by providing a mechanism for the existence of dark matter and dark energy as well as novel fundamental particles.

This book is dedicated to the venerable
Hozumi Gensho Roshi
Professor of Applied Sciences, Hanazono University, Kyoto, Japan
whose illuminating teisho on the reality of physical phenomena as well as the incomprehensible nature of the comprehensible Cosmos have been a source of profound inspiration over the years and

to the eminent
Andreas Resch, P Dr. Dr., C.Ss.R.
Professor and Director at the Institute für Grenzgebiete der Wissenschaft
Innsbruck, Austria
to acknowledge his scientific work, Imago Mundi, whose prime subject was and is the creation of a consistent Weltbild, to unify both science and humanities, bridging the gap that still seems to divide these two disciplines.

The text of the calligraphy means *COSMOS*, comprising the two symbols for ***space*** and ***time***. Calligraphy by *Hozumi Gensho Roshi*. The two red squares depict the seals of *Hozumi Gensho Roshi*.

To the Reader

The twentieth century has seen substantial progress in physics, but **gravity is still a mysterious force**. The last fifty years were dominated by particle physics, where space and time are not playing a major role. The twenty-first century therefore needs to *re-establish the dominant role of spacetime* [1] , if the true nature of the gravitational force and its implication on technology are to be revealed.

During the last decade not only new ideas on physical interactions, but also (so far non-conclusive) experiments hinting at the existence of laboratory produced gravity-like fields have been reported. The reader is advised that this is a ***highly speculative*** topic and eventually may turn out to be *wrong*.

This book provides the **introduction** to novel physics, in particular regarding the fundamental nature of gravity and spacetime, based on (as yet nonconclusive) experimental data and theoretical ideas of the authors, proposing novel elementary particles and groups as well as postulating a connection between *electromagnetism (electroweak interaction) and gravitation*, based on the concept of the geometrization of physics.

The most striking technology effect would be the possibility of propellantless space propulsion, that is, space propulsion without fuel. In this regard, a breakthrough in propulsion physics might be achieved, actively pursued in NASA's breakthrough propulsion physics program (1996-2001). In addition, this physics might not only lead to a different *Weltbild* [2], but also may lead to entirely novel means of general transportation as well as energy generation technologies.

The novel physics described is based on both theory and experiment. A set of eleven recent experiments is discussed that seem to require a drastic extension of both the current *standard model of particle physics* as well as the *SM of cosmology*.

The **reader** of this book is required to be willing to make an *intellectual effort* to grasp the new material and think it over. This book is therefore for the *curious* and *pervasive* mind. No hidden secrets of *Nature* will be revealed that, once understood, would be leading to miraculous effects. The presentation is scientific and technical, but basic. Moreover, the reader should be aware that the concepts presented here, might just be the beginning, resulting in numerous open questions. Also, as with every revolution, there is the possibility that it does *not* succeed. If correct, a genuine breakthrough in the *Weltbild* of physics and technology might evolve. Thus, the reader not only needs to be willing to invest his time, but needs to have a *daring* and *adventurous* mind as well.

We will not follow the trodden path. So, one should be aware of the ***danger*** in deviating from the orthodox way of thinking. On the other hand, science might be *more* wondrous than science fiction.

Subtle is the Lord ... Albert Einstein.

[1] *Note.* It is important to note that in *EHT* the physical meaning of spacetime comprises both atoms of space and time as well as the dark energy field. Dark energy is considered to be a pre-cursor of ordinary matter, see the discussion in Sec. 9.6.

[2] View of the world.

Executive Summary

How can gravity-like fields be generated?
How does propellantless propulsion work?
How can gravity-like fields generate energy?

Any breakthrough in propulsion or energy generation, in order to become a real game changer, needs to be functioning ***without fuel***. This insight is not new, and was already discussed in the book on space propulsion by Corliss, 1960,[2] termed *field propulsion*, and was actively researched in industry and academia at that time.

At present NASA no longer has a manned spaceflight program (at the moment Orion is a space capsule only), but there is a group of adventurous space entrepreneurs who have a keen vision of technology, and, having founded their own companies, are determined to bring man into space at relatively low cost.

The only technology currently available results from the physics of classical momentum conservation, applied to a physical system comprising the *rocket and its fuel*. This concept has **fundamental limits** as expressed by Tsiolkovsky's rocket equation of 1904, and no technical refinement can overcome it. This will soon become apparent to all of the new space companies, after initial successes. Rocket science as it is used today, is **not** suitable for manned spaceflight. In order to succeed, these space entrepreneurs need to complement their vision of technology together with the appropriate **vision of science** [3]. For instance, US entrepreneurs *did* succeeded in building the Panama canal by focusing on the issue of malaria that affected the workforce, not on the technical construction of the canal, as was done by the French, who failed.

What are the **lessons learned** from these recent failures? First, rocket propulsion *cannot be abandoned* at present, since it is currently the only technology available that is providing sufficient thrust to deliver material to low earth orbit (LEO) or communication satellites to geostationary orbit. Second, if we are serious about spaceflight, a *crash research program* should be started forming a task force dedicated to the aim of studying whether there exists *novel gravitational physics* that could lead to the development of propellantless propulsion.

[3] These lines were written in 2012. Unfortunately, as from late 2014, they proved to be true, since major incidents happened within half a year. When a Russian Proton rocket exploded in a massive fireball on 16 May 2014 in Kazakhstan, carrying an advanced communications satellite, no one in the West took notice. Next, on 22 August, a Space X rocket exploded during a test launch at its facility in Texas, but this did not excite much public attention. On 28 October 2014, the Antares rocket, owned by Orbital Sciences, scheduled to carry about 2,200 kilograms of supplies to the space station, fell back to *Earth* fifteen seconds after liftoff and exploded in a spectacular fireball, the public was (once more) unmistakeably reminded about the *inherent danger* of spaceflight. Then, three days later, in a tragic accident, the Spaceship Two of Virgin Galactic crashed, killing one pilot and leaving the second pilot seriously injured. Now the public has become critically aware that both manned and unmanned spaceflight is a high risk venture. Owing to its propulsion technology this risk can never be avoided or substantially reduced, it is built in by the physics. The latest incident happened on 28 June 2015 - the third major failure for the U.S. commercial space industry in eight months - when a SpaceX Falcon 9 rocket failed to launch cargo to the ISS, another setback for both NASA and SpaceX, which intends to send astronauts to the ISS. Comments like *space is hard* are correct but are also a sign of helplessness.

The physical principle was already envisioned by W. Corliss and other physicists half a century ago. A ***novel physical principle*** for spaceflight as well as energy generation is needed *first*, then everything else will fall into place, i.e., the proper technology will follow from this principle. The technology must be feasible, which means that no unrealistic concepts like antimatter, negative energy (wormholes), or spacetime warping etc. should be involved, but it should be accepted that, at least in the beginning, the science of any novel propulsion, necessarily, will have to be speculative, since it cannot be based on current physics.

What could this new physical principle be? Obviously, it has to do with both *gravitation and spacetime*. Planetary gravitation needs to be overcome during launch, and once in space, a vehicle is moving through a medium called spacetime. Spacetime is considered a dynamical physical field, since it is inseparably associated with all pervading field of dark energy, and thus assumed to carry both energy and momentum. Momentum exchange between the space vehicle and spacetime needs to take place, which is assumed to result in additional *spacetime dynamics*, that is, contraction or expansion. Instead of interacting with its fuel, the spacecraft (aircraft) is communicating with the surrounding spacetime. How? Through the generation of gravity-like (acceleration) fields outside *GR* by the mechanism of (delayed) symmetry breaking. The consequences are straightforward, namely, both air and space propulsion would have to be able to produce their own gravity-like field, strong enough to overcome planetary gravitation. So far for the speculative aspects of the ideas presented in this primer. However, if gravity were completely described by Newton's law, as current physics proposes, then there is no possibility in achieving this goal. Any breakthrough in propulsion or energy generation does require a breakthrough in gravitational physics. This primer therefore discusses the possible reality for the existence of novel gravity-like fields, not produced by large static or moving masses. Both experimental and theoretical concepts are presented. A set of recent *eleven experiments* was identified that, in some way or another, contradict established physical theories. Our theoretical approach, admittedly speculative, termed *Extended Heim Theory* (*EHT*) predicts *six fundamental forces*, three of them of gravitational origin, including the existence of an interaction between electromagnetism and gravitation. In particular, *EHT* is employed to discuss and analyze those recent experiments that might have generated extreme gravitomagnetic fields by small rotating masses at cryogenic temperatures.

The existence of novel gravitational laws might further be supported by the *Modified Newtonian Dynamics* (*MOND*) hypothesis, which alters Newtonian gravity for small accelerations. It implies that the relation between the Newtonian gravitational force and acceleration differs from Newton's second law for very weak accelerations, which is typical for large scale structures like galaxies. So far MOND has not been motivated by any underlying physical model or theory. Therefore an attempt is made to explain the physics of MOND by employing the physical concepts of *EHT*. Recently S. S. McGaugh has demonstrated the validity of MOND for 47 gas rich galaxies. Thus a modified gravitational force law seems to exist. The experimental situation seems to be contradictory, since Ciufolini in 2006 and the NASA-Stanford Gravity Probe-B experiment (from 2004-2008, final data released on 4 May 2011) confirmed the Lense-Thirring effect as predicted by *GR* (gravitomagnetic fields generated by a rotating massive body, i.e., *Earth*) within some 10% and 19%, respectively.

In numerous experiments, first published in 2006, Tajmar et al.[56, 248, 253, 255–257] reported on the measurements of *extreme gravitomagnetic fields* produced by small rotating Nb rings at cryogenic temperatures that are up to 18 orders of magnitude larger than predicted by *GR*.

However, recently M. Tajmar [4] published a *re-interpretation* of his earlier results[258] . There is a major difference between recantation and re-interpretation. The measured results of Tajmar et al. are *correct* as published. Results had to be recanted (or retracted), for instance, in the recent CERN neutrino velocity measurements, because faulty equipment produced wrong data. Therefore, these data *cannot be used* as reference to be checked against a physical hypothesis, because the values are incorrect. However, Tajmar has re-interpreted his earlier experimental results, and now considers it *more likely* that the strong signals, measured with his experimental configurations termed Setup A and B, were caused by *acoustic noise*. The major reason behind his re-interpretation is based on the lack of finding a physical explanation for the drastic reduction of signal strength in the new experimental Setup E. On the other hand, he states that alternative interpretations are *not* excluded, provided convincing physical arguments can be found to explain the observed phenomena.

Such an approach would make no sense if experimental results had been recanted or retracted by Tajmar (no comparison of theoretical results against present CERN neutrino measurements would make any sense). The claims of E. Davies thus are **not** substantiated and most likely result from a misinterpretation of the latest paper of M. Tajmar (November 2011)[258] . The conclusions given by Tajmar in this paper, however, are unmistakable.

Corresponding to standard scientific practice these experiments (at least not until final clarification is reached) [5] *cannot be cited as proof* for the existence of extreme gravitomagnetic fields, or be used as experimental support for the novel physical ideas of *EHT*. Further experiments are needed, as suggested in Sec. 8.9, to unequivocally decide on the generation of extreme gravitomagnetic fields in the laboratory.

The physical analysis by *EHT* also addresses those phenomena that cannot be explained by the assumption of acoustic noise. It is shown that consistent physical explanations for the reported staggering phenomena can be provided, not only observed by Tajmar et al., but also seen in the experiments by Graham et. al as well as in the Gravity-Probe B (NASA-Stanford University-Lockheed Martin) experiment. It is argued that the anomalous phenomena observed in these experiments can be consistently explained by the existence of extreme gravitomagnetic fields; in particular, concerning the so called *parity violation* effect, which has found no explanation so far. Based on these results it is concluded that the assumption of the existence of extreme gravitomagnetic fields provides a more probable and

[4] In an e-mail to the second author on 30 January 2013, *Dr. Eric Davies*, Institute for Advanced Studies at Austin, TX, U.S.A. claimed that M. Tajmar had *recanted* his experimental results. *Prof. M. Tajmar*, TU-Dresden, Germany rejected this view by writing to the second author on 3 March 2013: *Ich habe doch meine Messergebnisse nicht zurückgenommen - die Interpretation ist eine andere.* Tajmar also laid out the motives for the re-evaluation of his experimental results (Sec. 8.3.1). Tajmar will resume his gravitomagnetic experiments in the second half of 2015.

[5] In his e-mail from 10 November 2014 M. Tajmar informed the second author that he will repeat his gravitomagnetic experiments with improved equipment in 2015 in his laboratory at the Institut für Luft- und Raumfahrttechnik, TU Dresden.

conclusive hypothesis than any other current explanation.

Even if acoustic vibrations were present, the experiments of Tajmar et al. would be no proof for the non-existence of extreme gravitomagnetic fields, but could indicate that this kind of experimental configuration may not be suited for the detection of these fields. In other words, acoustic vibrations could have masked the presence of gravitomagnetic fields. In a similar way, both an electrostatic patch effect and extreme gravitomagnetic fields might have been present in the Gravity Probe-B experiment.

The case, therefore, is not closed, and we are *not dealing* with another set of gravitational experiments that eventually turned out to be wrong. If extreme gravitomagnetic fields are accepted as cause for the anomalous experimental effects, they are obviously **outside** both *GR* and the SM of particle physics.

In order to explain the presence of extreme gravitomagnetic fields, *EHT* requires the conversion from electromagnetic into gravity-like fields, triggered by the phenomenon of (delayed) symmetry breaking as well as the existence of novel elementary particles. Admittedly, these are strong requirements, but they follow directly from the assumption of an internal gauge space of eight dimensions. This 8D internal space is deemed to be sufficient to produce a *classification scheme* for all types of elementary particles (fields) and their interactions.

The other two gravitomagnetic experiments, namely the measurements by Graham et al. were not subject to acoustic noise, since the laser interferometer used by Graham et al. has a footprint of about 20 m $\times$ 40 m. Furthermore, there are additional anomalous effects in the Gravity Probe-B experiment, i.e., the spin-drift and the tangential accelerations of the four gyroscopes (which are Nb coated quartz spheres). However, none of the two experiments can be considered conclusive. Results from Graham et al. are *not* in the five σ range and thus, according to experimental standard, are not conclusive. The peculiar behavior seen in the GP-B experiment could also be explained by an *electrostatic patch effect* as was done by the Stanford team, but there remain open questions that might leave room for the existence of extreme gravitomagnetic fields (see Secs. 8.3.3 and 8.6).

Therefore, there is as yet no firm experimental basis for the predictions of *EHT*, which therefore needs to be classified as a **speculative** (pointed out by E. Davies) physical model. On the other hand, the experimental situation for *EHT* appears to be *better* than for the so called advanced physical theories that either cannot be falsified (string theory), and/or are predicting particles not found by the *LHC*[259] . Even worse, quantum gravity and supersymmetry, which are extensions of the SM of particle physics, seem to contradict latest experimental findings, in particular the ACME experiment (Sec. 2) [6]. Moreover, current observations from space science missions are demanding huge amounts of dark matter to be present inside galaxies, in order to avoid the MOND (Modified Newtonian Dynamics) hypothesis. However, recent observations suggest that dark matter is only present in the halo of a galaxy but not within. Hence, gravity might have a multi-faceted nature, and Newtonian gravitation seems to represent just one feature.

As it turns out, entirely novel technologies would be possible in form of ***gravitational engineering*** (*if EHT* is correct). Laboratory generated gravity-like (acceleration) fields might become a reality, similar to the generation of electromag-

[6] As R. P. Feynman stated in one of his 1964 lectures at Caltech: Guidelines of how to find a new physical theory: *Guess* $\rightarrow$ *Compute physical consequences* $\rightarrow$ *Compare with experiment*. If you cannot do these three steps, it is not a physical theory. If it disagrees with experiment, it is wrong, regardless how beautiful it is. This should be kept in mind.

netic fields, which would cause not only a *revolution* in propulsion but as well as energy generation. It would bring a new level to almost all kinds of technology, lowering the cost of transportation and energy production by orders of magnitude, providing a simple but safe and highly efficient technology, initially requiring the handling of liquid helium, but also high-temperature extreme gravitomagnetic fields are conceivable (by special composition of materials), and thus resembling a technology from MacGyver land [7].

[7] Pronouns *his* or *him* are used throughout the book, though this might not be considered politically correct by some gender ideologists. Gender studies, which are presently carried out at many Western universities, for instance, in Germany at Humboldt University, Berlin or University of Leipzig and many others, are considered to fall in the category of *pseudoscience*, and according to W. Pauli are *That's not right, it's not even wrong*, see the report by G. Buchholz, University of Applied Sciences and Arts, Hannover, Germany.[1] They are just an expression of the folly of our *Zeitgeist*. Those married to the *Zeitgeist*, will be divorced swiftly.

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Needless to say, all remaining errors are due to the authors.

The second author is grateful to Dr. Jean Muylaert, director of the Von Karman Institute, Brussels, Belgium, with whom he started working together at ESA more than twenty years ago. Dr. Muylaert always shared his enthusiasm for spaceflight and has a keen vision on both novel technology and fundamental science.

The authors are most grateful to Prof. P. Dr. Dr. A. Resch, director of IGW, Innsbruck for his support since 2002. Prof. Resch has not only published the theories of the late Burkhard Heim (2001), but was also instrumental in editing the complete scientific work of Heim. This proved to be an enormously difficult and time-consuming task, since Heim was not able to proofread complex manuscripts, and thus could not help with the typesetting of the complex formulas. The authors also wish to acknowledge the voluminous scientific work of Dr. Resch, *Imago Mundi*, whose prime subject was and is the creation of a consistent *Weltbild*, acceptable both in science and humanities to bridge the gap that currently divides these two disciplines.

We wish to express our gratitude to Prof. M. Tajmar, Institut für Luft- und Raumfahrttechnik, TU Dresden, Germany for explaining the physical reason of the recent re-interpretation of his gravitomagnetic and gravity-like experiments as well as for numerous helpful comments about the details of his measurements.

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Figure 1. The moon our nearest cosmic neighbor. The scarred surface of the moon is an eloquent testimony about the violent history of our solar system. What about its future?
Picture courtesy of my (former student and) colleague Dr. phil. Thorsten Ludewig, Ostfalia University, Campus Wolfenbüttel, Germany.

That I might see what secret force,
hides in the world and rules it course,
envisage the creative blazes,
instead of rummaging in phrases.

Faust I:
The first part of the tragedy, translated by Walter Kaufman, 1961[3]

Prologue

If humanity wants to progress, there must be *progress in physics*. Advanced physics will not only liberate humankind from their most basic needs, but also will lead to a *change of consciousness*, at least in some of the more advanced human minds. This established fact has been demonstrated by the research of Copernicus, Kepler, Galileo, Newton, Einstein, and of course more recently the advent of quantum theory, which each time lead to a different and more comprehensive *Weltbild*.

The secret force hidden in the world, [8] but ruling its course is the topic of this book. If we can unravel it, perhaps a higher level in our understanding of *Nature* is at our doorsteps. What could it be?

Comprehending the fundamental nature of gravity and spacetime!

For this very reason this first primer for the *Physics of Gravity-Like Fields: Breakthrough Propulsion and Energy Generation* is delivered, with the goal of presenting to the general public as well as the engineering and scientific community an introduction to the latest state of theoretical and experimental research in the emerging field of *physics for novel gravity-like fields* that might represent a new paradigm shift regarding the very nature of gravitation. The aim of this primer is to present the basic ideas and concepts for a more comprehensive understanding of physical reality, that is, for an approach in determining the number and properties of all physical interactions in a qualitative way, based on Einstein's original idea on the geometrization of physics. To this end, a *supermetric* needs to be constructed, or expressed more technically, a poly-metric tensor has to be found, from which the particles (fields) and interactions of physics can be derived. Einstein only used a single metric, which is synonymous with Newtonian gravity. An extended understanding of the nature of gravitation might lead to a breakthrough in two technology fields that did not see much progress since the last hundred years, namely transportation (governed by the reaction principle) and energy gen-

[8] *Daß ich erkenne, was die Welt im Innersten zusammenhält, schau alle Wirkenskraft und Samen und tu nicht mehr in Worten kramen*. There are several excellent translations of Goethe's Faust I, but none arguably gets as close to the original as the translation by Walter Kaufman.

eration. Thermodynamic and electromagnetic engines employ the same principles since the times of James Watt and James Clerk Maxwell, whereas energy generation is based on the release of chemical energy (for instance, the use of fire by ancient man) or on fission and fusion (which always seems to be the energy of the future), the latter already known for about eight decades.

In order to overcome the enormous technical challenges posed on conventional propulsion systems by the drag of gravity, it becomes obvious that only *propulsion without propellant* can solve this problem. Surprisingly, *field propulsion*, aptly named by W. R. Corliss in his book *Propulsion Systems for Space Flight Space*, Academic Press, 1960, was then an active topic of academic and industrial research, however, without delivering any practical results. Space propulsion is still dealing with the technologies (and hazards) developed in the 50s and 60s of the last century, and the vision portrayed by *Wernher von Braun* in his famous article in Collier's magazine in 1952, entitled *Man on the Moon*, did not become a reality. A manned *Mars* mission, despite all the claims made by the various *Mars* projects - as the second author, while working at the European Space Agency, knows from first hand experience - will not take place any time soon, unless a breakthrough in propulsion physics can be achieved.

First, however, a breakthrough in physics must be achieved, which means that the true nature of gravity needs to be revealed. So called advanced propulsion systems have been conceptualized since the 1930s, for instance, the usage of antimatter propulsion or interstellar travel by wormholes. Though physically not infeasible, the efficient and effective technical realization of antimatter propulsion is in the realm of science fiction. Wormholes, which are mathematical solutions of Einstein's field equations, are rendered non-physical by quantum effects, as was demonstrated by recent causal dynamical triangulation simulations.

The shuttle era has come to an end, and now NASA is without a transportation system that can carry humans into space. The next generation space vehicle, *Ares I-X*, a two stage rocket, has been replaced by *Orion* and its associated heavy launcher (to be developed). The problem is not with the engineering, which even goes beyond the present state of the art. It is *linked to the underlying propulsion physics* that remains unchanged since the days of ancient Chinese rockets. It is the *physical principle of classical momentum conservation* which stands in the way of producing an efficient and effective propulsion system.

The same holds true in the field of *energy generation*, though no energy shortage is to be expected, but cost and environmental impact of future energy production (**global warming is *not* an issue**) will be high, as described by Richard A. Muller in *Energy for Future Presidents*, 2012. In particular, fusion may be out of reach as was discussed in *Fusion's False Dawn* by M. Moyer in Scientific American, March 2010. As it seems now, only *novel physics* can overcome this barrier.

There is, of course, always the zero-point energy of the quantum mechanical vacuum, introduced by the field quantization process itself, i.e., by a mathematical procedure[9], but the ratio of the vacuum energies calculated from the two fundamental theories of physics, namely quantum theory and general relativity, is about 10^{122} that is, a *major contradiction* exists and the error is in the exponent.

The Casimir force[226] [10] is of interest on the nanometer scale, and, although

[10]There is a lot of technobabble about this effect and other concepts like spacetime warping or traveling through wormholes (Hollywood's great *Interstellar* movie) etc. The

known since 1948, no practical energy production scheme has come out of it. The difficulties, which are due to the experimentally observed stability of the vacuum, are discussed in more detail in Sec. 3.4. There is the probability that this situation will remain unchanged for the foreseeable future. However, as was pointed out by Dr. H. Deasy, ESA-ESOC, to the second author, there are ideas that might have the potential to lead to technical applications, but research is in an initial stage and the outcome is uncertain (see also Sec. 8.4).

Therefore, the motivation to further explore the mysterious nature of gravitation is justified, and the aim is to go beyond Newtonian (Einsteinian) gravity. Gravitation has maintained the interest of researchers at every stage in the history of physics, and it became Einstein's quest to unify gravitation with the other forces since 1916, the year he published his general relativity theory. The still unfinished manuscript on his desk, found after he passed away, clearly showed that he was still elaborating on his lifelong dream, namely to extend the description of the force of gravity as geometry, which had worked so marvelously well in the case of gravitation, to the other physical interactions. The *geometrization of physics*, i.e. associating a metric tensor with each physical interaction, still is an open question, and it remains to be understood, if and how this beautiful principle can be extended to encompass all the other forces. Einstein's search for a fundamental metric tensor (e.g. non-symmetric tensor or higher dimensional tensor) for the fundamental forces of *Nature* was not successful.

Hence, it should be no surprise that *new theoretical attempts along with a set of eleven recent experiments* are presented in this book to continue where Einstein was forced to leave off.

The quantization of the gravitational field has been unsuccessful, despite great efforts in this direction. The problem may be that the number of fundamental forces is *not* four forces (strong, weak, electromagnetic, and gravitational force). Perhaps, gravity is of more subtle nature than Newtonian gravity, and an interaction between gravity and electromagnetism might exist? At least, the Maxwell equations of electrodynamics and the linearized Einstein field equations, termed Einstein-Maxwell equations, show surprising structural similarity.

Geometrical theories were first anticipated by Einstein, continuously further developed by Kaluza and Klein in the 1920s as well in the 1950s, for instance by Finzi, Heim, and Wheeler, employing concepts of modern physics (symmetry, symmetry breaking, London equations, Ginzburg-Landau theory, spacetime as a physical field etc.), and have gained some prominence.

These ideas, together with the introduction of an internal eight-dimensional (gauge) space, termed Heim space H^8 , [11] by the authors, are utilized to provide an extended physical basis for explaining not only the existence of the extreme gravitomagnetic fields, but also to discuss the underlying physics to describe the results of a set of eleven recent experiments that seem to be in contradiction to current physics. Special emphasis is given in analyzing the experiments on gravitomagnetic fields, since they recently became the point of discussion [12], but might

recent report in Scientific American (December 2013) that entanglement may be related to wormholes seems to be pure fiction. According to the simulations of Loll et al. (CDT, Sec. 3.3) wormholes do not exist, but entanglement is a real physical phenomenon.

[11] In order to honor the idea of B. Heim who introduced the concept of a six-dimensional space.

[12] M. Tajmar informed the second author in February 2013 that he now believes that he did *not* measure any extreme gravitomagnetic fields. The authors replied to Prof. Tajmar

provide the key for gravitational engineering.

It is interesting to note that calculations from quantum field theory, as for instance, given by M. Kaku in his monograph *Quantum Field Theory* for the Coleman-Weinberg potential might be directly applicable in determining the coupling strength for these extreme gravitomagnetic fields, as was presented by the authors in Chapter 11 of the recent book *Gravity - Superconductors Interactions: Theory and Experiment* Eds. G. Modanese and G. Robertson, 2012. Most recently, as pointed out by A. Zee in *Quantum Field Theory in a Nutshell*, gravity might be the square of two spin-1 fields (particles of spin-1 can be described by Yang-Mills fields), an idea that might be applicable in the explanation for extreme gravitomagnetic fields.

Though the experimental basis for the existence of extreme gravitomanetic fields is not conclusive, as described in the *Executive Summary*, the impact of novel gravity-like fields on breakthrough propulsion (air and space) as well as energy generation would be enormous. As it turns out, a completely different level of novel technologies would become available. These exciting ideas, though admittedly *speculative*, are presented to the reader, and might shed new light on the nature of gravity as well as the number and type of fundamental forces that are existing in *Nature*.

Any novel theory on the geometrization of physics is required to provide statements and propositions that unmistakably should lead to recognizable facts, for instance, the existence of extreme gravitomagnetic and gravity-like fields observed at cryogenic temperatures, rather than by speculation or chance. As Einstein felt, the most important objective of any theory is to comprise as few and basic elements as possible without contradicting physical experience and, as we dare to add, in conjuncture with practical applications. For example, as presented in this text, a relationship between the phenomena of electromagnetism and gravitation might have been discovered as already surmised by Faraday in 1830 and actively pursued by Einstein. Any novel theory must be verifiable by laboratory experiments or astronomical observations. In order to **verify** a theory, it must provide a procedure how measurable information can be extracted. Since experiments do not produce physical principles, any novel theory must produce meaningful forecasts and also be falsifiable.

According to *Dirac's dictum*: a special regulator of a theory that reflects quality is its beauty. Einstein's theory of general relativity is an example of such a theory. The successful geometrization of physics combined with proper symmetries (group theory) would fit this picture as would the experimental generation of gravity-like fields at cryogenic temperatures by symmetry breaking.

Fantastic discoveries need to be scrutinized relentlessly, until they have proved beyond any doubt to be correct. Examples to be remembered are the (non-existing) gravitational waves measured by Weber, but more embarrassing was the announcement of cold fusion in 1989 (this does not exclude the existence of cold fusion). Although these experiments were not conducted properly, their incorrect (or at least inconclusive) results were nevertheless initially confirmed by teams from other prestigious universities. Any discovery needs to be verified by different

---

that there might be a physical explanation for the weak signals he reported in 2011, which were only about 1% in magnitude compared to his 2006-2008 experiments. This topic is discussed in detail in Sec. 8. However, M. Tajmar informed the second author in December 2014 that his gravitomagnetic experiments will be resumed in 2015 with improved equipment.

and independent laboratories, but also a consistent physical picture should be developed to explain the underlying physical mechanism of the novel phenomenon. Often the physical picture precedes the experiment, providing invaluable guidance and insight. The physical mechanism must clearly detail any new assumptions as well as outlining their role in producing the hitherto anomalous effect.

Verifying gravitational experiments is not an easy endeavor, since highly sensitive devices have to be produced and operated at cryogenic temperatures, often at liquid Helium temperature, *confirmed* by the now re-interpreted experimental results of Tajmar et al. Gravitational experiments are notoriously difficult as can be seen from the fact that the physics of gravitational wave astronomy, and, despite of the pioneering efforts of J. Weber since 1969, is still not an established fact. Even if experimental findings or theories eventually cannot be verified, one should not immediately denounce the serious experimentalist or theorist for failure, since the history of science has shown that every step forward is a complicated venture. Needless to say that all novel theoretical models initially contain many unclear points. But this is true even for established theories, e.g. general relativity. Moreover, for about five decades particle physicists have been working on string theories *without* a shred of experimental evidence.

In the field of gravity research, numerous laboratory experiments for the generation of gravitomagnetic and gravity-like fields were performed, in particular by M. Tajmar et al. However, their most promising results were recently reinterpreted by Tajmar et al., as mentioned above, since they could not find a physical mechanism of explaining the substantial differences in gyroscope signals, obtained from two different sets of experiments. Thus, at present, *no* conclusive experimental basis for the existence of these fields exists.

As was pointed out by the well known theoretical physicist, Richard P. Feynman in his now famous lecture *There's Plenty of Room at the Bottom*, given already in 1960, and published in the journal *Engineering and Science* (February 1960), there occur numerous strange phenomena in the complex situations of solid state physics. He prophetically foresaw an enormous number of technical applications that could arise from such physics.

Why then should it not be conceivable that a combination of *low temperature* and *solid state* physics via some kind of *symmetry breaking* might lead to additional novel phenomena in the field of gravitational engineering, caused by an *interaction of electromagnetism and gravitation*?

This, in a nutshell, is the phenomenon deemed to be responsible for the existence of the observed extreme gravitomagnetic fields, and thus is what this primer is all about.

Finally, in order for science to progress, both theorists and experimentalists have to be willing to take a certain scientific risk that is, *getting off the trodden path*. If a blind alley is met, the courage to revert one's direction of research is required. If, however, ideas of novel gravitational fields at cryogenic temperatures turn out to be true, the scientific age of **gravitational engineering** might have begun.

So far no show stopper has been encountered, but on the other hand, the smoking gun for the existence of gravity-like fields has not been detected either. There seems, however, to exist theoretical and experimental evidence, at least in the mind of the authors, to justify the publication of this exiting new material. Hence, as a first step, there is this primer.

Whether or not this primer is telling the scientific truth, or even stands for a paradigm shift, cannot be decided at this moment. Nevertheless, the authors are convinced that substantial benefit will be gained from its reading.

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Nomenclature

Note: In this book the practical engineering system is used that is, all units are expressed by SI-units, which include A, V, C, Ω

Physical Quantities

$\alpha = \dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{\hbar c} = 1/137$ = fine structure constant, coupling constant for the electromagnetic force

$\alpha_{2G} = \dfrac{G_N}{G_{gp}} = 67^2$ = coupling constant for the decay of the extreme gravitomagnetic field into an azimuthal gravity-like field

$\alpha_{3G} = \sqrt[4]{\dfrac{G_N^6}{G_{gp}^5 G_q}}$ = coupling constant for the decay of the extreme gravitomagnetic field into an axial gravity-like field

$\alpha_{gp} = \sqrt{\lambda} = 1/212$ = coupling constant for gravitophoton force

α_q = coupling constant for the force mediated by the quintessence particle ν_q

α_e^{th} = $\dfrac{g-2}{2}$ theoretical radiative correction used in Landé factor g
experimental value is $\alpha_e = 0.00115218965073(28)$

ε_0 = permittivity of free space, $8.854 \times 10^{-12} C^2/(N^1 m^2)$

$\gamma, \gamma_{IR}, \gamma_I$ = three photons mediating the interaction between real and imaginary electrons, i.e., the pairs $e^- - e^-$, $e^- - e_I^-$ and $\mathrm{e}_\mathrm{I}^- - \mathrm{e}_\mathrm{I}^-$ (electric charge is $-e$)

$\hbar$ = $1.05457266 \times 10^{-34}$ Js, Planck's constant

λ = coupling constant for quartic term of potential V

λ_C = Compton wavelength $\hbar/mc$

$\nu_{de} \leftrightarrows \nu_{de}^+ + \nu_{de}^-$ = dark energy particle (composite, spin 0), comprised of ν_{de}^+ and ν_{de}^-, which are attractive and repulsive, respectively

ν_{dm} = dark matter neutrino (negative mass $-3.23\,eV$), fourth neutrino

ν_{G_N} = graviton, cosmological spin-2 field matter, always attractive Einstein gravitational gauge boson

ν_{gp} = gravitophoton, cosmological spin-2 field

$\nu_q \leftarrow \nu_q^\ell + \nu_q^r$ = quintessence particle, cosmological (composite) spin-0 field, always repulsive, mediates interaction between dark energy and spacetime

$\nu_{gp} \rightarrow \nu_{G_N} + \nu_q$ = gravitophoton decay into graviton (attractive, weak) and quintessence particle (repulsive, spacetime expansion)

$\tilde{\nu}_G$ = extreme graviton (attractive), spin-1 field from conversion of EM, generated at cryogenic temperature

$\tilde{\nu}_{gp}$ = extreme gravitophoton, spin-1 field from conversion of EM, generated at cryogenic temperature)

$\tilde{\nu}_q \leftarrow \tilde{\nu}_q^{\ell} + \tilde{\nu}_q^{r}$ = extreme quintessence particle (composite) spin-0 field, dark energy, repulsive, mediates interaction between dark energy and spacetime, generated at cryogenic temperature

$\tilde{\nu}_{gp} \rightarrow \tilde{\nu}_G + \tilde{\nu}_q$ = extreme gravitophoton decay into extreme graviton (attractive) and extreme quintessence particle (repulsive, spacetime expansion), possibly observed in the experiments of Tajmar, Graham, and GP-B

μ_0 = permeability of free space, $4\pi \times 10^{-7} N/A^2$

$(\mu\nu)$ = abbreviated form for single component of metric tensor

$(\mu\nu)_A$ = antisymmetric single component of metric tensor

$(\mu\nu)_S$ = symmetric single component of metric tensor

ρ_D, ρ_{0D} = densities, material parameters for disk in Heim experiment

υ_{dm} = dark matter particle (negative mass -80.774 GeV), fourth lepton

ϕ = scalar function in Lagrangian, real or complex

ω_I = quantum mechanical angular velocity of imaginary electrons

$\mathbf{A}$ = electromagnetic vector potential

$AdS^{d,\ell}$ = Anti-de Sitter space of $d+\ell$ dimensions space with d spatial coordinates and ℓ time-like coordinates, *infinite* with *intrinsic negative* curvature (hyperboloid), i.e., even if matter is absent

$AdS^{3,1}$ =Anti-de Sitter space with 3 spatial coordinates and one time coordinate

$\mathbf{A}_{e_I}$ = electromagnetic vector potential from bosons by coupling of imaginary electrons

$\mathbf{B}$ = magnetic induction field vector

	$Wb\,m^{-2} = T = Vm^{-2}s^{-1} = 10^4 G$
$\mathbf{B}_G$	= general gravitomagnetic field vector
$\mathbf{B}_{G_N}$	= gravitomagnetic field vector from moving masses (*GR*)
$\mathbf{B}_{gp}^{CW}$	= extreme gravitomagnetic field vector for clockwise rotation
$\mathbf{B}_{gp}^{CCW}$	= extreme field vector for counter-clockwise rotation
$\mathbf{B}_{gp}^{EHT}$	= computed extreme field vector in GP-B experiment
$\mathbf{B}_{gp}^{GP-B}$	= observed extreme field vector in GP-B experiment
$\mathbf{B}_{gp}$	= extreme gravitomagnetic field vector from gravitophotons
D_0	= 9.14×10^9 ly $\approx 8 \times 10^{26}$ m, visible diameter of the *Universe*
$D(t)$	= diameter of the *Universe*
$dS^{d,\ell}$	= de Sitter space of $d+\ell$ dimensions space with d spatial coordinates and ℓ time-like coordinates, *finite* with *intrinsic positive* curvature (sphere), i.e., even if matter is absent
$dS^{3,1}$	= de Sitter space of *four* dimensions, spacetime of *GR* for $\Lambda > 0$, 3 spatial coordinates and 1 time coordinate
$DdS^{3,1}$	= dual de Sitter space of *four* dimensions, location of dark matter
E^4	= four-dimensional Euclidean space, Euclidean geometry, space without curvature and diagonal metric coefficients $(1,1,1,1)$
$\mathbf{E}$	= electric field vector Vm^{-1}
$\mathbf{E}_G$	= general gravitoelectric field vector
$\mathbf{E}_{G_N}$	= gravitoelectric field vector from stationary masses
$\mathbf{E}_{gp}$	= extreme gravitoelectric field vector from gravitophotons
e	= 1.602124×10^{-19} C, elementary charge
e^-, e^+	= electron, positron
e_I^-, e_I^+	= electron, positron of imaginary mass (for physical definition see Sec. 5.5.2)
e^B	= electric charge from Cooper pair-like formation, i.e., from imaginary-imaginary (quaternion) electron pairs by phase transition at critical temperature T_C
$F_{\mu\nu}$	= Faraday tensor of Maxwell equations (antisymmetric)

G_E = *Einstein's gravitational coupling constant*
$G_E = G_p + G_{gp} + G_q$ (see Sec. 2.2.1)

G_{gp} = *gravitational coupling constant for leptons*, (attractive and repulsive force) between octonion masses $\pm i_n m, n = 1, ..., 7$, $1/67^2 G_N = 2.228 \times 10^{-4} G_N$, calculated

G_N = *Newton's gravitational constant* (see Sec. 2.2.1), $G_N = G_p + G_{gp}$, different measured values:

$(6.67\ 384 \pm 1.0 \times 10^{-4}) \times 10^{-11} \mathrm{m}^3/\mathrm{kg\ s}^2$
from experiment published in Wikipedia, 2010
$6.67\ 191(99) \times 10^{-11}\ \mathrm{m}^3/\mathrm{kg\ s}^2$
from experiment, Nature, 26 June 2014
$(6.67\ 515 \pm 0.61 \times 10^{-4}) \times 10^{-11} \mathrm{m}^3/\mathrm{kg\ s}^2$
from experiment, Phys Rev, 15 July 2014
$(6.67\ 586 \pm 0.54 \times 10^{-4}) \times 10^{-11} \mathrm{m}^3/\mathrm{kg\ s}^2$
from experiment, Phys Rev, 15 July 2014
$6.67\ 369677 \times 10^{-11} \mathrm{m}^3/\mathrm{kg\ s}^2$
calculated, AIAA, July 2004[298]

G_p = *gravitational coupling constant for hadron-hadron interaction*

G_q = *gravitational constant for dark energy-spacetime interaction*, $4.355 \times 10^{-18} G_N$, from *EHT*, calculated

$g_L = 2(1 + \alpha_e^{th})$ = Landé factor

$g_{\mu\nu}$ = general metric tensor in spacetime $(\mu, \nu = 0, \cdots, 3)$

$g_{\mu\nu}^{(ab)}$ = single component of metric tensor, $a, b = 1, ..., 8$

$g_{\mu\nu}(H_\ell)$ = metric tensor of Hermetry form, $H_\ell, \ell = 1, ..., 16$

h = $\hbar \times 2\pi$

H^8 = *Heim space*, eight-dimensional internal space attached to each point of spacetime

H_ℓ = *Hermetry form* (metric sub-tensor from double coordinate transformation), $\ell = 1, ..., 16$

I_{Pl} = $\ell_{Pl}^2 = \hbar G_E / c^3 = 2.56 \times 10^{-70}\ \mathrm{m}^2$, *Planck information*

$\mathbf{j}$ = electric current density resulting Am^{-2}

$\mathbf{j}_{gp}$ = electric current density resulting from quaternion Cooper pairs (London equation)

k_B = $1.3806505 \times 10^{-23}$J/K, *Boltzmann constant*

$\mathscr{L}$ = Lagrangian density

ℓ_{Pl} = $(\hbar G_E / c^3)^{1/2} = 1.615 \times 10^{-35}$ m, *Planck length*

$\mathsf{M}^{d,1}$ = Minkowski space of $d + 1$ dimensions

	infinite globally flat space, with d spatial coordinates and one time-like coordinate
M	= four-dimensional Minkowski spacetime of *SR*, short denotation for Minkowski space $\mathsf{M}^{3,1}$ with diagonal metric coefficients $(1,-1,-1,-1)$
m_e, m_p	= electron mass and proton mass
m_{Pl}	= $(\hbar c/G_E)^{1/2} = 2.176 \times 10^{-8}$ kg, *Planck mass*
N	= number of turns of superconducting coil in (original) Heim experiment
$n^B_{e_I}$	= number density of *imaginary (or quaternion) Cooper* pairs
$\mathbf{q}_I$	= imaginary quark (for a physical definition see Sec. 5.5.2)
r_e	= $\alpha\lambda_e = 2.82 \times 10^{-15}$ m, classical electron radius
R^3 , T^1 , S^2 , I^2	= subspace structure of H^8 , *responsible* for: mass, charge, organization, and information
t_{Pl}	= $(\hbar G_E/c^5)^{1/2} = 5.389 \times 10^{-44}$ s, *Planck time*
t_{tp}	= instant of time, turning point of cosmic motion, where the direction of motion of the *Universe* changes from expansion to contraction
$V(\phi)$	= potential function in *Lagrangian*, sometimes denoted as $\Phi(\phi)$
$\mathbf{v}$	= circumferential velocity of rotating disk or ring
$\mathbf{v}_A$	= average circumferential velocity of rotating disk or ring
v_{sh}	= circumferential velocity of sample holder

Subscripts and Superscripts

cr	= indicating a critical value of a variable where a phase transition is assumed to take place
i, f	= indicating the initial and final state of a physical system
a, b	= indices for internal coordinates of space H^8 running from $1, ..., 8$
i, j, k	= spatial indices for spacetime running from $1, 2, 3$
μ, ν	= spacetime (Greek) indices running from $0, 1, 2, 3$

Acronyms

AB	= Aharonov-Bohm
ACME	= Advanced Cold Molecule EDM experiment
AIAA	= American Institute of Aeronautics and Astronautics
AMS	= Alpha-Magnet-Spectrometer A dark energy experiment on board the international space station ISS
A.U.	= Astronomical Unit, 1.5×10^8 km
BBN	= Big bang nucleosynthesis, formation of chemical elements
BICEP2	= Background Imaging of Cosmic Extragalactic Polarization
CBR	= Cosmic Background Radiation
CCW	= CounterClockWise
CDMS	= Cryogenic Dark Matter Search in Minnesota
CDT	= Causal Dynamical Triangulation
CERN	= Centre Europeèn pour la Recherche Nucleaire
CFR	= Compact Fusion Reactor
CFT	= Conformal Field Theory (scale invariant theory related to hyperbolic space)
CMBR	= Cosmic Microwave Background Radiation
COBE	= Cosmic Background Explorer Satellite
CS	= Coordinate System
CV	= Control Volume
CW	= ClockWise
EDM	= Electric Dipole Moment
eEDM	= electron Electric Dipole Moment
EGP	= Einstein Geometrization Principle
EHT	= Extended Heim Theory (using the idea of B. Heim of internal gauge space, but otherwise is completely different from the work of B. Heim)
EM	= ElectroMagnetism
ER	= Einstein-Rosen bridge of 1935
EPR	= Einstein-Podolsky-Rosen entanglement gedanken experiment of 1935
ESA	= European Space Agency
ESO	= European Southern Observatory
GAB	= Gravitomagnetic Aharonov-Bohm effect
GODQ	= God Quantizes (in relation to Einstein's saying: *God does not play dice*)
GP-B	= Gravity Probe-B
GR	= General Relativity
GSI	= Gesellschaft für Schwer-Ionenforschung,

	Helmholtzzentrum, Darmstadt, Germany
IPCC	= Intergovernmental Panel on Climate Change
ISS	= International Space Station
JPC	= Joint Propulsion Conference, held yearly by AIAA
$\Lambda - CDM$	= Lambda-Cold Dark Matter, Λ is Einstein's Cosmological constant, the term denotes a cosmological model of six parameters
LENR	= Low Energy Nuclear Reactions
LEO	= Low Earth Orbit
MPI	= Max Planck Institute
NASA	= National Air and Space Administration
NASP	= National Aero-Space Plane
NLSM	= Non Linear Sigma Model
NOM	= Non-Ordinary Matter
OM	= Ordinary Matter
PandaX	= Particle and Astrophysical Xenon Detector, Chinese dark matter search experiment
ps-GR	= Pseudo Complex General Relativity
PMT	= Poly Metric Tensor
QFT	= Quantum Field Theory
QM	= Quantum Mechanics
QP	= Quantum Physics
SLS	= Space Launch System
SM	= Standard Model
SPS	= Solar Power Satellite
SQID	= Superconducting Quantum Interference Device
SR	= Special Relativity
SSTO	= Single Stage To Orbit
SUSY	= SUper SYmmetric particles
TSI	= Total Solar Irradiance,
TP	= Turning point, at the instant of time t_{tp} the direction of motion of the *Universe* changes from expansion to contraction
TSTO	= Two Stage To Orbit
UFO	= Unidentified Flying Object
WIMPS	= Weakly Interacting Massive Particles
WMAP	= Wilkinson Microwave Anisotropy Probe

ZPE	= zero-point energy
ZPF	= zero-point fluctuation

COLOR Usage in Text
COLOR Usage in Text

Red = *Red* is used to indicate text passages or formulas describing incomplete or incorrect physics

Blue = *Blue* is used to indicate text or formulas related to the Feynman path integral

Violet = *Violet* is used to indicate generally accepted formulas of current physics

Azure = *Azure* is used to indicate symmetries and associated groups

SpringGreen = *SpringGreen* is used to indicate text passages representing novel physics or formulas

GreenTea = *GreenTea* is used to indicate text passages or formulas containing improved physics that might need further modification

Yellow = *Yellow* is used to indicate text passages or formulas for coupling constants

LightGray = *LightGray* is used to emphasize text passages or formulas of general interest

If any anti-gravity device is ever to be developed, the first thing needed is a new discovery in fundamental physics - a new principle, not a new invention or application of known principles, is required.

A.V. Cleaver:
Electro−Gravity: What it is or might be
Journal of the British Interplanetary Society,
Vol. 16, 1957[4]

1 *Emerging Physics for Gravity-Like Fields*

PHYSICS, as we know it, is based on the *belief* of the existence of **exactly four fundamental forces**. There are two long range forces (interactions), namely electromagnetism and gravitation. Gravitation is believed to be always attractive, while electromagnetism can be both attractive and repulsive. In current physics it is assumed that forces between particles are mediated by special particles, termed *bosons*. The bosons that mediate long range forces between the charged particles, i.e., particles having mass and/or electric charge, are the hypothetical graviton and the photon, respectively. The other two interactions are the weak force (β decay, radioactivity) and the strong force (holding together atomic nuclei), which are of short range, i.e., their range is about 10^{-15} m.

On the other hand, current physics has no explanation for the existence of exactly four fundamental forces, that is, there is a *belief only* on the existence of four fundamental interactions as, for instance, expressed by Sarkar[210] . The question therefore arises, are there any additional fundamental physical interactions?

B. Heim[275]in the late 50s of the past century, was the first to present a novel physical idea for the construction of a poly-metric tensor to encompass all physical interactions, something that Einstein tried to achieve after he had completed his general theory of relativity. This approach is generally called the *geometrization of physics* (our approach in this book is somewhat different, since we do not assume that all of physics can be derived from pure geometry), since each physical interaction is associated with its proper metric tensor. The difficulty lies in the construction of a poly-metric that can represent all physical forces. Heim introduced the concept of internal gauge space composed of three subspaces. Each of the subspaces has a special physical meaning, and the combination of subspace coordinates following certain selection rules is resulting in a set of metric tensors, which are associated with physical phenomena. However, as it turned out, this subspace approach was not sufficient, since the concept of **information**,

crucial in quantum mechanics and statistical physics, was missing (Sec.9.6). In addition, without the information concept, the vital relationship between energy and information as expressed in the equivalence principle of Szilárd and Landauer (Sec.9.4.1), cannot be established. As it will turn out, this principle is crucial in the evolution of the *Universe* (Sec. 9.9.1).

For many years W. Dröscher cooperated with Heim and co-authored Vol. III of Heim's[269,280,283] work. Heim tried to develop a unified theory of quantum mechanics and gravitation including a cosmological model. It is still an open question in how far this attempt was successful. Heim used his own mathematical and physical terminology, but the basic definitions of this terminology were not presented. This makes his books very difficult to read. There are also errors in some of his calculations. In particular, his formula of the mass spectrum for the elementary particles does not seem to be correctly derived. In addition, his concept of elementary particles comprising concentric zones of increasing density, is not compatible with the experimentally confirmed quark picture[1]. However, his work contains a large number of novel ideas, and especially his concept of internal subspaces for the construction of a poly-metric seems to give a consistent *classification scheme* for all physical interactions and particles (fields) when supplemented by an information subspace, i.e., adding a fourth subspace.

This idea was followed up by the authors[166] in 2002 [2], and because of the extension from three to four subspaces, was termed *Extended Heim Theory* (*EHT*). However, all other aspects of Heim's work are *not considered* [3] in *EHT*, because the focus of the present work is on gravitation. *EHT* predicts a **conversion** from electromagnetic into gravitational fields (electroweak-gravity interaction) that is, gravity-like fields could emerge from electromagnetic fields under certain experimental conditions by the means of symmetry breaking. These novel gravitational fields, also termed *conversion fields*, however, should be many orders of magnitude stronger than fields resulting from Einstein's *GR*, mediated by their own gravitational bosons, which are *spin- 1* fields. The physical concepts of *EHT* will be described in Sec. 5.

[1] Quarks are pointlike centers within hadrons, possessing their own quantum numbers, but do not exist as free particles. The strong force, binding quarks in a hadron, acts like a rubber band. The further quarks are pulled apart, the larger the potential energy becomes, eventually getting larger than the rest mass energy of two quarks, leading to quark pair production. Hence, no free quarks can be observed, at least not below temperatures of about $T \approx 0.2$ GeV when quark confinement occurs.

[2] This was the first of our AIAA papers on the subject of propellantless propulsion. It was an attempt, but clearly fell short in several aspects, e.g. mathematical rigor, physical consistency etc. However, it contained already the idea of six fundamental forces. We argued that gravitation should be both attractive and repulsive, and might be engineered similar to electromagnetic fields.

[3] *EHT* is **not** Heim theory, despite the similarity of the names. The name *EHT* was *selected to honor* B. Heim's idea of internal gauge space. The concept of internal space in *EHT* is reminiscent of B. Heim's initial six-dimensional approach, but otherwise the two approaches are employing different physical concepts and there are **no further relationships**, except for the name, of course.

All is not well with contemporary physics, or, the trouble with experiments.

The authors

2 *Recent Experiments Challenging Current Physics*

THIS section comprises a more detailed discussion in order to further elucidate the implications of the set of recent experiments/observations, introduced in the previous section, that seem to require *major extensions* of the SM of particle physics as well as the SM of cosmology, together with the introduction of unconventional novel physical concepts.

In several important cases these experiments seem **not to confirm established, so called advanced physical theories**. Moreover, since the MOND predictions *are* most likely correct, it appears as if, at least to some extent, this might indicate that Einstein's *SR* and *GR* are not telling the complete story about gravity. Of course, on the Planck length scale at which spacetime becomes quantized, or in the case where *GR* is predicting singularities the concept of continuity in Einstein's *GR* most likely does not apply. In addition, by introducing new types of matter it will be shown that an extension of *GR* should be considered.

In particular, current extensions of the SM of particle physics, which are based on the concepts of supersymmetry and superstring theory etc., so far were not only *not confirmed*, but instead seem to be *at odds* with several of the recent experiments to be discussed below.

For instance, even current models of quantum gravity, that are the only alternative to (currently dominating) string theory, probably might **not be in accordance** with ESA Integral satellite measurements.

Numerous new experiments have been conducted during the last several years and novel, unexpected observations as well as measurements have been reported, providing clues that the four fundamental forces in physics may need an *extension*, in particular concerning the nature of gravity. Sometimes these experiments confirm *GR*, and sometimes there seems to be a contradiction. In addition, there are measurements that seem to indicate that advanced concepts in physics like string theory, quantum gravity, and supersymmetry are not compatible with these experimental findings. In particular, widely accepted supersymmetry may have been disproved by recent LHC experiments as published in BBC News on 12 November 2012[199] as well as by the ACME experiment.[85,88] The current (low) limit of the eEDM is a clear indication that the processes and superpartners (*selectron* and *neutralino*) used in the Feynman diagrams of SUSY cannot be correct, since the predicted eEDM was **not** detected. So far all SUSY superpartners are of positive mass.

This would have far reaching consequences for those particles predicted by these theories. Hence, there could be room for new physics outside of *GR*, for instance, regarding the existence of gravity-like fields.

2.1 Implications for the Standard Models of Physics and Cosmology

In this section we briefly present the major physical implications of recent experiments for both the standard model (SM) of particle physics and the SM of cosmology. Details will be discussed in the subsequent sections. The structure of both standard model is self-contained and it seems that for practical purposes the physical world is described down to distances at the order of 10^{-18} m (they are working in many instances to a high precision). However, apart from conceptual issues with the SM of particle physics concerning the mass hierarchy and the life time of particles, dark matter or dark energy particles do not exist, nor does gravity. Coupling constants must be supplied from the outside as well as particle masses. Furthermore, extreme gravitomagnetic or gravity-like have no place in the two SMs. Moreover, different types of matter, as assumed to exist in *EHT*, that come from employing different numbers systems (i.e., using all four number systems that possess a division algebra as discussed in Sec. 9.3.1), are clearly outside the SMs, and thus the striking physical consequences of these novel types of matter will remain undetected within the SM framework. In other words, the SMs are definitely correct, but, according to the founding principles stated in Sec. 4.1, the world of physical phenomena both on the largest and smallest scales is infinitely larger. The two SMs allow a (largely) correct but highly limited view of the *Cosmos* and the matter it contains. The experiments discussed below are perhaps the first indications of an overall much larger picture that most likely is transgressing our present imagination.

2.1.1 LHC and ACME versus String Theory and Supersymmetry

The LHC so far did *not* find any of the many new particles predicted by string theory and supersymmetry, nor were any particles produced that could be associated with dark matter.

Moreover, the theory of supersymmetry seems to have been *invalidated* by both the ACME experiment and recent LHC measurements (summer 2015). This should have major implications for the Higgs field, which is a scalar field, predicted by the standard model. The Higgs particle was found in LHC data (July 2012), and has a mass of about 126 GeV [12]. If supersymmetry is incorrect, the fine tuning of the mass of the Higgs boson becomes a problem, since the contributions from fermions and bosons above a few TeV cannot cancel any more, and the cutoff has to take place at the Planck energy, that is, the mass of the observed Higgs boson, m_H, is to be obtained from the equation

$$m_H^2 c^4 = m_0^2 c^4 + b\, m_{Pl}^2 c^4, \tag{1}$$

where m_0 is the (unobservable) bare mass of the scalar Higgs boson in the hypothetical case that vacuum fluctuations are not present, and m_{Pl} denotes the Planck mass and b is a constant, which for present purposes can be set to -1. Inserting the numerical values into Eq. 1 gives $1.26^2 \times 10^4\,\mathrm{GeV}^2 = m_0^2 c^4 - 10^{38}(\mathrm{GeV})^2$. Since the mass of the Higgs boson $m_H << m_{Pl}$, the bare mass m_0 of the Higgs boson must be of the same magnitude as the Planck mass, that is, $m_0 \sim m_{Pl}$, which is **not** an acceptable result. This would mean that the bare mass of the Higgs boson

[12] *Note.* We are inaccurate here, following the customary use. Actually the mass of a particle is given by E/c^2, where E denotes energy and c is the speed of light.

The more important matter is that ideologies preclude discovery.

Robert B. Laughlin: A Different Universe: Reinventing Physics from the Bottom Down, p. 116, Perseus book 2005

11 *The Road to a Different Age*

THERE is no doubt that gravitational engineering would lead to a different age. In this book we not only describe possible new physics, but also portray a vision how we might be able to enter into a different age, but, as so aptly expressed by R. Laughlin, a different mindset is needed. Several of the aspects of the novel technology derived from a deeper understanding of the nature of gravity are already vividly described by G. Daigle in non-mathematical terms in his recent book *Gravity 2.0*[16] and in[17] [1].

Naturally, there will be objections against such a vision and this type of technology, not only because of the perceived dangers of its applications, but also as a result of the novel ideas proposed, as already reported by I. Stevenson in 1958 in his famous article *Scientists with half-closed minds*,[18] since a massive extension of current physical concepts together with a change of mind is mandatory. At the same time, numerous cherished concepts of theoretical physics developed over the last fifty years seem to have to be abandoned, forced by recent experimental evidence.

On the other hand, there has been no fundamental progress in physics since the 1960s. The reason for this standstill in the knowledge of *Nature* might be sought in the fact that the fundamental principles of the so called advanced physical models beyond the standard model (SM), simply are not realized by *Nature*. This impression seems to be justified, as recent experiments seem to contradict these assumptions.

[1] We avoid the term new age that was en vogue in the 1960s. The only outcome of this movement is aptly described in Chap. 12 *The Dark Side of Protection* in R. Laughlin's book cited above. In particular, this attitude, i.e., a yearning for protection, seems to be present in the Germany of today. The detrimental effect to society is all too obvious.

The pillars of advanced theoretical physics beyond the SM of particle physics are based on the ideas of Kaluza and Klein (1926), that is, the existence of a space of higher dimension is postulated, i.e., there should be ten real spatial dimensions and one time dimension. Physical particles are vibrating in this hyperspace in the form of quantized geometrical entities termed strings. String theory (e.g. Zwiebach 2009[98]) has become the leading theoretical model of particle physics and gravity, but seems to contradict several recent experiments as discussed in this text (in particular geometry is *not* physics according to *EHT*). The same holds true for the SM of cosmology that postulates a hot big bang coming from a singularity in space carrying infinite energy. In addition, there is the multiverse idea that in conjunction with string theory leads to a landscape of 10^{500} parallel existing universes. Again, these ideas seem to contradict recent experimental facts, and, moreover the existence and nature of dark matter and dark energy that comprise about 95% of the matter of the *Universe* remain unexplained.

In contrast to these ideas, the founding principles of *EHT* as expounded in Sec. 4.1 are based on totally different ideas. Every physical quantity in physics remains finite and singularities are excluded. The total energy of the *Cosmos* was, is, and will be zero. These simple statements have severe physical consequences as demonstrated in Secs. 5.2.4 (types of matter and particles) and 5.5.3 (groups in physics). Hence, hyperspace does not exist, nor are there any muliverses. Instead, there seems to be a deep relationship between physics and mathematics in the form of number systems and physical phenomena, in particular with regard to the types of matter that can exist as outlined in Sec. 9.3.1. This might have the (most astonishing) consequence that the material *Cosmos* might have a nonmaterial basis.

The introduction to the **emergent physics of gravity-like fields** as well as the current status of laboratory generated gravity-like fields as presented in this Primer, should have convinced the reader that there is both theoretical and experimental evidence for their existence. These fields, if confirmed by further experiments, are clearly outside current physical theories including the so called advanced physical concepts, e.g. supergravity or superstring theory.

The existence of these novel gravity-like fields is based on the set of founding principles of *EHT* as discussed in Sec. 4.1. In particular, the idea of extending the number system mentioned above, utilizing the set of quaternions and octonions as explained in Sec. 9.3.1) give rise to new types of matter, i.e., in *EHT* there are three or seven types of imaginary matter (novel particles of gravity-like fields) as well as particles of negative mass (dark matter). In addition, there is the precursor of all mass, namely dark energy from which all matter finally is made. There are **no** higher real spatial dimensions (this idea now seems to be in contradiction to recent experimental evidence), and thus theories like supersymmetry should not exist.

However, physical time plays a *special role*, because time can appear as **bound time**, that is, in connection with spatial coordinates as in *EM* or *GR*, for instance, the time derivative of the magnetic field is connected to the spatial derivative of the electric field $\frac{\partial B}{dt} \backsim \frac{\partial E}{dx}$, which means time and space are connected, requiring the presence of *positive mass*. Time in the form of **free time** that, for instance, is occurring in the equation of the magnetic field generated by symmetry breaking in the case of superconductivity, i.e., the London equation does **not**

A *Glossary of Physics Terms*

Note: For a conversion from CGS to SI units, the electric charge and magnetic field are replaced as follows:

$$e \to e/\sqrt{4\pi\varepsilon_0} \text{ and } \mathbf{H} \to \sqrt{4\pi\mu_0}\mathbf{H}.$$

Note: The reader who is not that well versed in mathematics, nevertheless, should carefully (repeatedly) study the glossary. He will, step by step, get accustomed to the physical jargon, and simply needs to remember the physical picture that accompanies most of the definitions. It is not necessary at all to understand the exact mathematical formulation. Citing A. Einstein (somewhat freely): Don't worry about *your* mathematical difficulties, *mine* are still greater. Replacing *mine* by *ours*, the authors agree. Explaining the physics of (complex) mathematical quantities by utilizing geometrical pictures is much more useful than presenting rigorous mathematical definitions, because pictures (concepts) lead to insight about the nature of the reality (remember A. Einstein) of a physical object. For instance, any reader (student) who, for the first time, is exposed to the $\mapsto$ *Riemann curvature tensor* $R^{\mu}_{\nu\alpha\beta}$ feels (more or less) terrified. However, with a little bit of geometry, its physical meaning can be revealed and its mathematical derivation is (relatively) straightforward.
There are legions of excellent books in theoretical physics. For those readers who are seeking a *gentle but serious* introduction to theoretical physics, we recommend the recent book
Theoretische Physik by *M. Bartelmann et al.*, Springer 2015, 1315 pp.
This is a unique volume (in German) that was edited with great care in full color and superbly illustrated too. It provides a highly readable, very well structured, pedagogical account of all areas of modern theoretical physics. In addition, there are numerous mathematical boxes that explain (by examples) the underlying mathematical structure of physical theories in a formally correct way, but accessible also to those readers with only basic mathematical skills. The authors provide full solutions to all exercises. We would have liked to see introductions to *general relativity* and the early universe and also to *relativistic quantum mechanics and quantum field theory* as well as a somewhat more comprehensive introduction to *group theory*, in particular explaining the mathematical jargon of groups. Hopefully, these topics will be included in a second edition.

B *Glossary of Symmetries and Groups in Physics*

Note: Central to physics are conservation laws, which follow from symmetries (e.g. symmetry of the Hamiltonian or the Lagrangian as used in path integrals, or spacetime symmetries). In turn, symmetries are represented by mathematical groups, and thus are playing a most important role in all areas of physics. The group concept and its application to physics is difficult to grasp, as was already noted by H. Weyl in the 1930s (so called *Gruppenpest*), and therefore a glossary of group terms has been compiled to aid the reader (hopefully). In the following, an elementary glossary (for a comprehensive treatment see the books by E. Zeidler) of mathematical terms is provided, which, although only a few of these concepts were utilized in this primer, should enable the reader to understand some of the more advanced mathematical concepts generally used in theoretical physics. The problem is that these definitions normally are not explained, and their physical meaning generally *cannot* be deduced from the purely mathematical definition. Therefore, the explanation of these terms is done through examples and, where possible, their geometrical meaning is given.

Note: The following books were used in the preparation of the glossary of the terms for mathematical groups. These books emphasize the application to physics and are recommended by the authors, but, of course, there are many other excellent books in group theory (in particular Chinese authors). The video lectures on group theory of the **African Summer School**, 2004 by Prof. M. Koch are highly recommended as well as the video lectures by Prof. A. Zee on *QFT* (Quantum Field Theory). There are also outstanding other lectures on general relativity, cosmology, quantum mechanics, and particle physics in this excellent videotaped course.

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Böhm, M.: *Lie Gruppen und Lie Algebren in der Physik*, Springer, 2011, 505 pp. (Highly recommended - if you can read German).

Frappat, L., A. Scirriano, P. Sorba.: *Dictionary on Lie Algebras and Superalgebras*, Academic Press, 2000.

Georgi, H.: *Lie Algebras in Particle Physics*, 2nd ed., ABP, 1999, 320 pp.
If Feynman had written a book on group theory. Certain knowledge needed.

Greiner, W., Müller, B.: *Quantum Mechanics Symmetries*, Springer, 1994
(*Similar to the Landau volumes*– but more readable. Check the other volumes. Highly recommended for learning the subject).

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