

# Musings of a mortally ill physicist.

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### I. PROLOGUE.

This is presumably not without drama. At the time I am writing this my death is around the corner. I am suffering from metastasised cancer approaching the end stage. It has spread in my brains – I may still have quite some time but I do feel already the characteristic symptoms in the form of the all encompassing fatigue going hand in hand with the so-called brain fog. This started roughly a year ago, getting diagnosed with esophagus cancer and a medical roller coaster ride followed. I can claim to have seen some of the inside of medical hell from very close by.

I actually exploited the occasion to chase a long standing item on my bucket list. I will introduce myself underneath and right now you just need to know that I am a very dedicated and actually rather successful theoretical physicist. I have written literally hundreds of physics papers, these texts which are extremely matter of factly and littered with equations.

But I do also have a bit of a reputation as a more literary writer, be it entirely resting on popular pieces I wrote describing physics research accomplishments. I had this desire to challenge myself and take up the task to produce a text having more of a literary pretence.

As a next circumstance, intertwined with my health troubles I lived in this last period in my life through a most amazing, rather miraculous personal experience. I have a strong urge to share this with others. In a way it is a very physicists affair that I in first instance would like to share with members of my species. But at the same time it is deeply rooted in peculiarities of the physics culture that may not be widely realised outside the community. The underlying sentiments go back a long time, in fact all the way back to Greek antiquity, where philosophers like Plato laid the ground work for this affair. It propagated through the ages with Spinoza adding a late renaissance update turning in the impersonal God of Deism. In this era that religious believes ruled the mind especially the physics incarnation of these believe systems were not even perceived as particularly religious since. they were rooted in very rational argumentations – these belief systems acquired the status of *meta-physics*.

Fast forward to modernity. It may be appear that natural science and religion are antagonistic. There is a very outspoken group of scientists that get a lot of public attention. These are mostly biologists disseminating a very strong anti-religious sentiment. Their spokesmen with among them Richard Dawkins are rabid *atheists*. Atheism is by itself also a belief system, the belief that everything is explained by the available scientific knowledge. Humans, consciousness and whatever else one may find mysterious, it is all about the symphony of molecules, chemistry organized to the extreme.

But eventually this knowledge rests on the more fundamental insights offered by physics, explaining the molecules in terms of its underlying mathematical theories like quantum physics. To a degree the peculiarities of the physics culture faded a bit away from the public eye. The bottom line is that at least among the top echelons of this community, typically theorists owning Nobel prizes, one discerns a culture that strongly contrasts with the biological atheists one, exhibiting instead an outspoken "spiritual", "enlightened religious", whatever, signature. This is very alive and kicking, but largely hidden from the public eye, a bit like a secret cult.

When I was young I was somehow detected by some of the "popes" of this "physics church". I do have some first hand stories in store regarding personal initiation rituals that I endured being admitted to the priest class. I think these are good stories and I cannot

resist to use them as an entertaining way to give the reader an idea regarding this physicist's cult. Yet again, when you are very well at home in the history of the intellectual traditions of the physics species, this may not surprise you all that much. But I do expect that it may take some of you by surprise given that it has faded away quite a bit from the contemporary public eye.

But this is just a context for the main story: a very personal experience that was very forceful, overwhelming. I am absolutely sure I am not fooling myself: I lived through events that escape any rational explanation seemingly being part of the "magic-", "miracle-", "supernatural-", whatever realms. Call it foresight, visions or even clairvoyance, it is an experience where my overly rational brain just had to submit to the notion that it could not make *any* sense out of it.

It may well have been mere coincidence, but this *no-nonsense clairvoyance experience* somehow intermingled with some of the physics church spirituality. Being surely acutely aware that in all likelihood I have just been fooling myself, this however turned into a cocktail of events having the pretence of a kind of a new testament bible story. It somehow introduces more of personal sentiments in this otherwise extremely impersonal belief system which I perceived as a potent source of solace living through the cancer hell. You may take all of this literal as some kind of post-modern gospel, but I perceive it myself as more of an allegory. No clue what it all means but this way of telling the story supplies hopefully some interesting food for thought.

Before I start this endeavour I feel I have to spell out very explicitly my precise position with regard to all the metaphysics that you will encounter. I will work hard to explain why Einstein is my hero, while he also has the status of the number one prophet of the modern physics church. You may have picked up that Einstein referred to the strong opinions of the Lord when it comes to the systems behind reality, quotes like "our Lord does not play dice" and "our Lord is subtle but not malicious". But this Lord is actually entirely metaphorical, referring to the "central dogma" of the physics church which can be captured by this Lord creator being actually an excellent *mathematician* that shaped reality guided by the Platonic perfection of the math! With regard to the real axis of religious attitudes Einstein stressed that he considered himself as an *agnost*. We just do not understand enough of these metaphysical matters to afford any opinion. I actually became aware of Einstein's **agnostic attitudes**, feeling actually pleased that I had figured out the same wisdom myself

independently over the course of time.

## II. NOT A CELEBRITY.

Let me start introducing myself. I am a physics professor in the Netherlands approaching rapidly the mandatory retirement age, and as announced dying from cancer. I believe it is fair to claim – people who know me from close by may agree – that I am a quite classic type physicist, the kind of person who was called at a young age to dedicate life and existence to this holy cause. Einstein is my number one hero, followed by a long list of other real physicists.

It is official that my career has been successful according to accepted standards – I got appointed in the dutch system as part of the academic elite through a Spinoza prize (“the dutch nobel prize”) and a fellowship with the dutch Royal Academy of Sciences (KNAW) – a similar status as a fellowship of the Royal Society or the US National Academy. I have a respectable publication record with the ubiquitous hundreds of papers. I am actually myself still a bit flabbergasted by my **citation record**. It is passing a total of 35000, with a yearly flux that has been steadily increasing approaching now the 3000 according to Google. Think about it, somebody finds it necessary to type a reference to a paper of mine *ten times a working day*.

But frankly, I perceive myself as a rather unimportant person. I belong to the best in physics but the issue is that there is not much sociological glory in this realm. When you want to be in the limelight, get into rock music or football. It is simple. The substances that causes so much joy in my brains and the brains of other physicists just triggers severe headaches and feelings of anxiety in the heads of 99.9 % of the remaining part of mankind. Celebrity status of my person means that there may be something like a hundred physicists who think of me in this way. Nothing as compared to a mindless influencer on tik-tok selling lipsticks.

But there is a reward, special to this trade that arguably may be more satisfactory than to be public celebrity. It is the potentiality of immortality. Pythagoras, Euclid, and so forth lived 3 millennia in the past and their names are still resonating as inventors of mathematics that changed the destiny of mankind. Followed in a more recent era by Newton, Maxwell, Einstein, part of the long list of the creators of modern physics. It is a charm of physics

education to learn about the many minds that acquired immortality by adding in one or the other way crucial parts to the overall fabric forming this science.

But there is a dark side. To explain this to students I made up the quote "epsilon-Einstein", referring to a metaphoric story that goes as follows. "There is something like a heaven with a heaven's gate but when a physicist dies he does not find St. Peter waiting at the gate, but instead it is Einstein. Einstein will ask *have you scored  $\epsilon$  of my production? If so, please come in and enjoy the physicist's heaven. If not, go to the hell of normal creature after-life where you have to endure all the time small talk.*"

What is the meaning of  $\epsilon$  ("epsilon") Einstein?  $\epsilon$  refers to the greek letter for a soft "e", but it also encodes for a particular mathematical contraction. In the 1970's the theory of the critical state realised at phase transitions was flourishing in the physics community. The "strongly interacting" version of this is on the one hand very beautiful but also an occasion where it is fundamentally impossible to obtain reliable mathematical solutions. All kinds of tricks were devised to get somewhere, the most prominent one being the "epsilon expansion". It is an example of a physicist's thought that sounds at first rather absurd. As it turns out, the description of this critical state is critically depending on *dimensionality*. It is typically easy to compute it reliably in dimension four ( $d = 4$ ), while in three dimensions hell breaks loose. But an approximation scheme was invented computing it in dimension  $d = 4 - \epsilon$ , in principle order by order in  $\epsilon$  as the small number. But this expansion is so called *asymptotic*: when  $\epsilon$  is infinitesimal it yields the correct answer but when it turns finite this expansion diverges! You get the point:  $\epsilon$  Einstein means "a very small but eventually finite fraction of Einstein's physics legacy."

But this is a tall order for any physicist. Reality is that progress is usually incremental, and much of the outcomes of such research is routine, circular, repetitive and only rewarding in terms of citations. Is my personal  $\epsilon$  finite? Perhaps, but I am not convinced and it will play a key role in my supernatural experiences as I will explain later.

### III. A DINNER WITH BOB SCHRIEFFER.

A rather crucial motive that led to my initiation in the physics denomination has been through senior theoretical physics peers, often equipped with a Nobel prize. It seems that when one is so good enough at it to earn a prize one is automatically devoted to the divine

case. I heard many good stories of them, sharing this undertone that we are dealing with a subject matter that is greater than mankind. I would like to tell one story in particular that was very important for me when I was in a phase of my career fighting myself into the class of privileged physics professionals.

To sketch the scenery – this happened in 1992. I had been very lucky with my career up to this point. It turned out that my PhD thesis work from 1986 became shortly thereafter of quite some significance, it is now a bit legendary and called "Zaanen-Sawatzky-Allen" where admittedly the real mastermind is my PhD advisor George Sawatzky. But this launched my career through a good burn into orbit. In 1987 I moved from a provincial institution (Groningen) in the Netherlands to a famous Max-Planck-Institute in Germany where a bit to my surprise I evolved in no time into a young "rock star", as testified by the fact that after half a year I got a real (tenured) research job. But the sky was the heaven, and with help of the dutch I managed to land in 1990 a soft-money job at the famous Bell labs in the USA. You may have heard about it – it has a legendary status as perhaps the most efficient and productive science production facility ever. It was owned by physicists and my personal "Murray Hill" (nick name of the laboratory) adventures could be worthy a separate enjoyable story. I can testify, it was *fantastic*. Part of its success was surely its sports-like competitive culture that drove people to excel. There were dangers – I remember well my dear wife Christa threatening to divorce from me when I did not give in to her request to chill out from my extreme working ethos – this was out of love, she felt she had to protect my mental integrity.

I got early on the message that I was a perfect fit – I did deliver – and that I could count a regular job after the soft money would run out in 1993. Two department heads started to operate on my behalf in 1992 to find a member of staff position for me. To their great surprise all doors were closed! Soon thereafter it became clear why. In early 1993 Bell labs came effectively to an end, being in essence cancelled by the executive floor of the AT&T telephone company who owned it. This is still regarded as among the greatest crimes against science. One should perhaps not blame AT&T - as a commercial company they had to deliver stockholders value and in this regard it had been better for the company to just burn cash instead of subsidising a fundamental science lab. Instead, the US government should just have nationalised Bell labs in one more national lab being an order of magnitude more efficient than the established national lab infrastructure born in the atomic weapon

programs. They did not, not surprising since US governments are in such matters usually complete idiots.

But I was in a deep trouble – I had counted on the Bell labs job and in the mean time the job market for physicists was in a historic mayhem. Next to the corporates shutting down their operations (besides Bell also IBM), there had been an enormous overproduction of physics PhD's all looking for research jobs. But much worse, the cold war had come to an end with the adverse that the most important employer for physicists – the US military-industrial complex – was no longer hiring. Last but not least, a little army of astonishing Soviet physicists came to the west picking up the good university jobs. Physics was one of the view things in the Soviet Union that were hugely successful, of unsurpassed quality per individual.

This was panic – there were only a few job openings in the US that fitted my person and there was an enormous supply of candidates. One of these openings was in Florida, in the state capital Tallahassee that had just received a large package of federal money to build a new high magnetic field laboratory. They were looking for a theorist and I invited myself over to present a seminar, hoping that this would influence their search.

At this point the legendary Bob Schrieffer enters the story. Among the great surprises in my early physics education was the instance where we were informed (I believe after two years or so) regarding the great achievements of very modern physics in this 1970's perspective. Surely, this was boom time of high energy physics with its huge accelerators and the breakthroughs leading to the standard model. But this was in the public view and the big deal for us novices in this divine craft was to learn about the *BCS wave-function explaining superconductivity*. Have you ever heard about it? Whatever, its **discovery** in the mid 1950's was generally regarded in the 1970's as a paradigm changing event that altered the way that mankind thinks about reality.

It is about superconductivity, the fact that in some metals at low temperature the electrical resistivity vanishes completely. It was experimentally discovered in 1911, in fact in Leiden University: my present employer. All the big physics minds of this era tried to explain it, including Einstein, to no avail. But it was taken up in the 1950's by the great Bardeen who also fathered the transistor. Bardeen recruited Bob Schrieffer as graduate student – Bob came from a wealthy family of Florida orange plantation owners. Bardeen was famously employed by the rather provincial University of Illinois Urbana-Champaign.



It is in the middle of the mid-western prairie having a reputation of being as boring as it comes in the US. Apparently Bardeen was a bit of an autistic and he really liked the peace of the country side, with his presence actually turning "Urbana" into a condensed matter hot spot. With his transistor Nobel prize Bardeen could afford to completely concentrate on the very risky superconductivity mystery. Being a genius, he dugged out a variety of new facts associated with superconductivity that were quite instrumental in guiding the mind in the right direction. He also mobilised mathematical help in the form of the high energy theory postdoc Cooper as well.

Here is where the mystery story starts.

Back to my seminar – Schrieffer had been called by Florida's governor to help out pulling the new magnetic field lab off the ground. To my delight, who was in the audience of my seminar? Bob Schrieffer on the second row! I saw an opportunity to seduce this great man with my physicist' charm. I had success, halfway my talk I got a note passed on from Schrieffer stating that he had to leave because of administrative responsibilities but he invited me to go together for dinner!

Bob had in the early 1990's full celebrity status, having the reputation to be a flamboyant man. He picked me up at the motel. Famously, he liked cars specifically in the form of Jaguars – "Jags". The best way to get into cars – become a petrol head – is by living with the Autobahn's in Southern Germany and trained like this I could sincerely appreciate Bob's Jaguar XJ6.

To my great satisfaction Bob told me that he sincerely enjoyed my seminar. It reminded him of the golden days in the 1950's and 1960's where great things happened, to continue complaining that he finds that too many of my generation just got overtrained with the mathematical techniques that his generation developed. The effect according to him was that they turned into mathematical technicians, devoid of vision and thoughtfulness. He made clear that he found me exceptional: he found me a real physics guy operating like they did during the glory days! This made me very happy. The remainder of this enjoyable evening revolved around Bob telling me all kind of stories, and I felt like an apprentice guided by the hand of the master into the insider knowledge, the tricks of this sophisticated trade.

To get this intuitive "I recognise somebody of my kind" by somebody carrying around a Nobel in theoretical physics has perhaps more than anything else contributed to my own

sense of belonging to this species of "real physicists". In the time that followed I collected actually a whole bunch of such Nobel medal decorated senior coaches. It just happened naturally, usually they approached me, in no time finding out that I am "interesting". The big deal is that I also feel it myself as motivated by the desire to avoid the menace of boredom: "real" physicists are somehow never boring according to "real" physicist.

Back to the mid 1950's and the BCS – Bardeen-Cooper-Schrieffer – story. Its legendary status revolves around the fact that it all hinges on a single mathematical expression: the "BCS wave-function". Wave-function refers to quantum physics and the big deal is that superconductivity can be viewed as a macroscopic manifestation of the inherently mysterious and intriguing quantum physics. Perhaps more than anything else it was like a Rosetta stone, unlocking all the peculiarities of the superconducting state in a precise and disciplined mathematical language. After it became available in 1957 it spawned a quite large field aiming at exploring all its corners in the superconductivity labs, with precision guiding by the BCS theory. This was, and to a degree still is, a monumental field of research in physics.

Arrived at the restaurant Bob explained to me that we are all part of a worldwide "conspiracy" that is completely hidden from the public eye. He stressed that the process of discovery in physics is in one or the other way a rather supernatural, mythical affair. He claimed that anybody who has lived through the process of discovering a mathematical equation shedding a different light on reality – part of the definition of physics – perceives this as a supernatural event, suddenly looking into a world unrelated to our daily biological existence. This was for him very personal, because he discovered the greatly powerful BCS wavefunction all by himself.

During the dinner he turned into a very intense, remarkably personal testimony hitting home the mystique. He told me that after being loaded up with all pieces of Bardeen's puzzle, he left Urbana in early 1957 for the winter holiday. Taking a subway in New York he stared out of the train window and suddenly – *the image of the BCS wavefunction appeared on the window glass!* Bob directly inferred that this was the Rosetta stone, he hurried back to Urbana and in a couple of months of hard mathematical work it appeared that it had in a remarkable way decoded the whole portfolio of superconductivity mysteries, delivering a number of highly non-trivial predictions for novel experimental phenomena that were subsequently confirmed! This has the reputation of one of these revolutions in physics driven by high precision mathematical insight.

Bob then continued arguing that he was far from unique with this type of experience. He claimed a well organised and rather powerful cult on the planet, having the theory floors of academic physics departments as temples, with the best and brightest theorists often equipped with a Nobel prize as the high priests of this denomination. These priests have somehow the capacity to receive these mathematical visions that turn into the great game changers of mankind. Think again Newton, Maxwell, Einstein, and so forth, all of them tapping from this divine source of deep knowledge that is way beyond the material existence of mankind as envisioned by the biologists. Surely, this is accompanied by an army of "physics monks" (like me) populating the physics departments, in essence apprentices that should be chasing their moment of awakening hoping it will come.

#### IV. IT IS PLATONIC.

There are many ways to tell this story of the "physicist church" but I liked the Schrieffer version most. It somehow fits the present era. When you are well educated in the history of philosophy this "church" worshipping an Upper Being that once in a while reveals Divine Wisdom in the form of mighty Mathematical Equations goes back all the way to the greeks of antiquity. My perception is that the novelty for us living in the twenty first century is actually in the contrast with the present Zeitgeist. In whatever way, the very rationalist' believe in the natural sciences explaining all the mystery of reality, the atheism of the biologists, is the prevailing outlook on reality. The traditional religions with their personal Gods, the miracles, the promises of having a great after life as a reward for obeying the dogma's, and so forth, it has become much less influential than it used to be.

But in the religion dominated societies of the past the Schrieffer's "physicist's church" was not seen as a religious construct. It was all happening at the rational end and instead it had the status of a metaphysics construction. Serious, physics like theory of reality except that it is not testable. A way to view it is that our tolerance for untestable theories has spectacularly declined due to the staggering success of the testable ones. With regard to Schrieffer's church I share my personal attitude with Einstein: the only view that makes sense is *agnosticism*, I perceive the case that I will fortify underneath as solid and unambiguous evidence that there are realms of reality that we really *do not understand*. We may afford the luxury to try to capture it in a metaphoric language borrowing from classic religions.

My intention will be to push this to an extreme later in this text with my personal story that I will frame as a new testament biblical allegory with myself in the role of Jezus serving Einstein's mathematician God. Whatever it means ...

This Schrieffer experience seems the first time that I got personally confronted with the church notion. Arguably, it is a bit of an elite-theoretical-physicist thing. On the working floor of mundane physics research which was also for me the daily environment one did not hear such stories. But Bob's story has nearly a catholic type of spiritual spin to it, with the wave-function revealed in the train window vision. It is like Lourdes! But Bob was authentic – I have no doubt that he really experienced it in this way. But a next aspect is that when this all happened in 1957 the BCS wave-function had this very special oracle-like quality. It was just plainly mysterious where it came from but it worked, it decoded the physics. When I learned it first it had this status like a very secret language key decoder – yet again like a catholic priest dealing with sacramental bread representing part of the body of Jezus.

On a side, when I started as junior Professor in Leiden the first lecture course I had to present was supposed to explain BCS theory to physics master students. But this was in the early 1990's and in the intervening era gradually "BCS" got demystified. Instead of this Rosetta Stone magical wave function, we learned step by step that superconductivity is actually controlled by very general physics emergence principle that we also see at work in the mundane context of solid stuffs like rocks. I produced Lecture Notes that are presently somewhat legendary that perhaps for the first time succeeded in removing completely all the supernatural wave-function magic from the BCS theory spelling it out in a non-nonsense language.

Yet again, Schrieffer' story is an anecdote but it captures a widespread sentiment among the better theoretical physicists. As I already emphasized, later in my career I continued to bump into top-grade theoretical physicists often decorated with Nobel medals that in one or the other, implicit or explicit way take part in this denomination. In fact, a very closely related sentiment is even more strong in an adjacent community. What is precisely worshipped out there? This inner sanctum is formed from *mathematics*.

What is your relationship to mathematics? For the vast majority of mankind it is basically a collection of tricks, to be learned by heart and endlessly exercised, that is unpleasant to learn. It tends to cause widespread headaches in high school and students would like to drop it as quickly as possible were it not that one has to learn a lot of these tricks for certain well

paid professions.

But how about the following historic quote: *Mathematics, rightly viewed, possesses not only truth, but supreme beauty cold and austere, like that of sculpture. without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry.*

This was written by Bertrand Russell, the famous twentieth century mathematician-philosopher.

Does this ring a bell? I am prejudiced that only a very small fraction of mankind shares the emotion expressed by Russell. The relation between mankind and mathematics is not the most easy one. In the first place, mathematics is somehow in its mathematics way complicated, and one needs kind of a special brain to handle and these are relatively rare. But there is more to it, it seems. It seems that not everybody is "hearing" or "seeing" the austere supreme beauty of Russell. It is like hearing music, some of us are more musically than others and at least in my reference frame such musical "intelligence" is somehow related to the capacity to "hear the math sing". Some of us mathematically gifted call ourselves "mutants", some kind of next version of Homo Sapiens characterised by essential mutations that give us the capacity to think differently.

Looking at myself, in high school I did not like math all that much, it was the "book of tricks" sentiment. But I do remember that my father who was a mathematician in disguise (he made his income as Shell manager) being quite upset that they removed completely the axiomatic Euclidean geometry from the high school teaching program. My father stressed that this was the first occasion for the developing human brain to be confronted with the mathematical music ... all sacrificed in name of utility (book of tricks) by a gang of deaf educational bureaucrats!

After entering University this changed. Fact of the matter is that when studying physics initially it is math course after math course after math course, In fact, it never ends. Even as senior theoretical physics professor every second week or so I stumbled into yet new mathematical hocus pocus. To decode it, I had to stare at equation dense text, do all kind of exercises giving my brain the time to rewire, culminating in yet a completely new insight! There is so much mathematical substance discovered in the course of time that according

to mathematicians the "universal mathematicians" who is at home in all the subfields no longer exists since this knowledge no longer fits in a single brain.

During this training in increasingly advanced mathematics my "mathematical ear" started to work – I fully endorse Russell's praise, and I am proud about it. I found out that to quite a degree I was initially just *scared* of its eerie powers, increasingly my brains just learned to submit without protest to its overwhelming authority.

So far so good, but this is math. What is the essence of *theoretical* physics? it is a mystery and a miracle, to my strong opinion the most obvious one we can be aware off. I am quite sure that I share this perception with many of my professional peers. Perhaps the most catchy strap line is due to the theorist Wigner who wrote a paper in 1960 with as title "*the unreasonable effectiveness of mathematics in the natural sciences*". Wigner actually starts out with the Russell quote in the above.

This grand story started with Newton in the 17-th century finding out that he could capture the mechanical- and gravitational parts of nature with equations acquiring the status of absolute physical law, captured in his "Philisophia Naturalis Principia Mathematica", in fact all one needs to know in order to guide a man to the moon, already so powerful. Such mathematical supermachines continued to be discovered since then, culminating in the 20-th century grand theories of physics: general relativity and quantum physics. These both rest on very fanciful, beautiful mathematics loaded up with Russell's austere supreme beauty, at the same time being of an unprecedented consequence to mankind.

Black holes have become only physical reality recently but the mathematics predicting them was figured out by Schwarzschild while in the trenches of the first world war, shortly after Einstein released his seminal first General Relativity paper. It is a bit a matter of taste but I belong to a crowd that has elected general relativity ("GR") to be the champion most sublime pure, supremely beautiful mathematical theory describing an important part of nature – actually mostly the cosmos. GR rests on Riemannian non-euclidean geometry, often considered as *the* highlight in Russell units of 19-th century mathematics. This differential geometry is feared by physics students because it is hard to learn but the reward is immense: I suffered through it and never had so many shivers down the spine when I started to see the immense esthetical beauty of GR.

Quantum physics is even more "abstract" which seems to mean that it is harder to find mostly visual system metaphors to support an intuition of how the mathematical machine

works. Perhaps the math is a bit lower in Russell units than the Riemannian affair. But the consequence for mankind has been truly overwhelming: handing over the equations to the engineers, they learned to play god and pull off real miracles. Your smart phone – it is just a testimony of knowing how to manipulate nature knowing the laws of quantum physics in combination with "Maxwell theory" (electromagnetism). The ultimate playing-for-God demonstration has been the banging of the atomic bomb, the Trinity affair of 1945, completely designed by the physicists based on their understanding of the quantum physics of nuclear matter. It seems that once in a while mankind has to be reminded of its spectacular consequence – presently this unfolds in the form of the hit movie "Oppenheimer". The famous quote by Oppenheimer referring to the Hindu Gita when he saw for the first time the mushroom cloud captures the sentiment: "Now I am become death, the destroyer of worlds." As a consequence of the equations mankind can play for God employing the nukes ...

You should have realized it already: this is what Bob Schrieffer was talking about with his referral to with his band of Nobel-prize laureate theoretical physicists being the high priests of an ultimately rational but deeply religious cult having a quite hidden existence in society. All these mighty equations were born in similar visions as the wave-function in the train window of Bob. There is always a sudden moment where the powerful equation sheds its very bright light on reality, coming to the discoverer as a divine, supernatural disclosure. Although perhaps not record holding, the BCS wavefunction does have plenty of Russell credits as one of the monuments of quantum physics.

Call it a religion –it is surely a powerful affair, forced by ultra-rational considerations to accept something of mythical proportions. This is way more watertight than the bible! Actually, the roots are about as old. As more often with really important insights, the classic greek philosophers had kind of figured it out already. Mathematics was born in this classic greek culture by monuments like Pythagoras, Archimedes, Euclid to name a few. When you are a bit at home in this tradition, you will have noticed that mathematics played a quite central role in the general philosophical outlook of the Greeks: freshly invented, those that understood should have been dumbstruck. They literally did the ground work, a case in point being Euclidean geometry as a system departing from a handful of axioms that by logical reasoning explodes in a bonfire of theorems revealing elementary Russell values. All by itself, as a machine made of eerie parts.

The powers that are so unique for math were appreciated by the Greeks. In fact, the philosopher Plato introduced a metaphysics that captures Russell's supreme beauty and Schrieffer's cult in a remarkably precise way. He called it "the theory of forms". This amounts to the postulate that parallel to our material world of rib eye steaks, fast cars and so forth there is an equally real *parallel* world formed from mathematical objects, the "forms". By construction such forms are *perfect*, a mathematical straight line is absolute straight while the straightest line in the material world is produced by an extreme ultraviolet chip printer, but this line is still jittering on a nanometer scale. These forms capture the non-physical essences of things of which objects in the physical world are merely imitations.

In summary, it is just giving another name to Russell's stern perfections. But the real genius of Plato is reflected in a very simple question that at one point or the other is asked to any contemporary novice in mathematics, including many theoretical physicists. It is a kind of a pure-math department public secret: *Is mathematics discovered or invented?*

When you vote for "discovered" it means that the mathematics has just a separate existence, it is lying there to be found by humans! Henceforth, the "universe of forms" whatever you want to call it is as much part of reality as a rib-eye steak.

Although there is a bit of a secretive atmosphere surrounding this "Platonic question" I got the message that about 95% of all pure mathematicians vote for "to discover". It is just an overwhelming sense when one delves in math that it is just a pre-existent reality, being a bit of an insult to think that humans can *invent* it as they invented a cork screw once upon a time. Upon choosing "to discover" one is regarded as "Platonic". There is more to reality than the biologists have figured out.

## V. A BIBLICAL STORY OF PLATONIC PROPORTION: THE PREAMBLE.

You may now have an impression that I am myself a bit of an equation-church-zealot, after my hard selling of these old thoughts in the above paragraphs. But this is not quite the case. As an adolescent I was engaged in a lot of "magical thinking", varying in a typical 1970's guise from Marxist Utopia, via hippie style alternate realities fuelled by consciousness altering chemicals such as "acid", up to the political correct exaggerations that live on until the present day in the form of wokeness. I got in the grip of physics relative late in my twenties feeling liberated by the absolute no-nonsense "I know exactly what I am talking



about” attitude of physics on daily basis. As many of my peers, we are aware of the Platonic stuff, we allow ourselves to dream a way along the theme once in a while, but at least speaking of myself I handled it as a pleasing thought but no more than that.

Belief systems need narrative and the case in point is for instance the bible, especially so the new testament reporting on the adventures of Jesus. Surely these are typically sprinkled with motives of miracles if not plain vanilla sorcery (like walking over water). Although of a different, much more no-nonsense quality the recent history of my life appears to be of such a magical, religious nature but now unfolding in the Schrieffer church! All of the above have been preliminaries, setting the stage for the weird personal story that I will share with you soon. But I need to sketch first some more detailed personal circumstances, to frame the big story that will unfold thereafter.

Let’s pick up the story line. As I argued, I belong to the category of physicists that are considered as successful within the system. However, I am aging and I am unfortunately a citizen of a country (the Netherlands) with mandatory retirement, setting in at the 67-th birth day. In my case this is the unholy April 17 2024. To keep going as a physicist a perfect void is appearing as the threat. As a consequence of some kind of obscene, exaggerated egalitarianism the physics professor is supposed to abruptly halt the activity of his/her physicist brain, to commit instead to the empty headed I-just-want-to-enjoy life existence of a typical middle of the road pensioner being released from the confines of a boring job. In this regard more civilised countries like the USA have the *tenure* system – it is up to the professor to decide when it is time to enjoy the leisure coming with really old age – usually around age 75.

Let’s pick up my time line in 2018, 6 years from this retirement red line. As the last of my regular job adventures, I went for yet another year long sabbatical to my second Alma Mater – Stanford University. I have been cherishing this long standing connection, not only because of the benefits of this exquisite institution located in the middle of world’s high tech powerhouse (Silicon Valley), but also because the department is the number one in the world in my traditional core business of fanciful condensed matter physics.

This revolves in the first place around large scale experimental- and computational efforts, supported by a couple of empirically minded top notch theorists. In the course of time I became something like the European delegate in this effort, having long standing highly productive collaborations with several of the big groups. This success story repeated itself

also during the 2018-2019 sabbatical, more about it in a moment.

But upon my return to Leiden, the mandatory retirement lit up brightly on my radar; less than five years to go and the continuation of a serious physicist's life needs quite some planning and manoeuvring. Staying in Holland would be a dead end and it looked like we somehow had to emigrate elsewhere. Options started to materialise. In the first place China. I have a long history of helping them out building up a physics tradition. I have quite a large number of friends that are influential in the Chinese system and a reputation to be very Chinese friendly. Matters as that I love their food, I made myself popular early on by answering the question "what do you like to eat" with "optimise strangeness". The good news is that people like me are regarded as very valuable in China and in all likelihood I could have landed a senior advisor job coming with very comfortable material circumstances.

Yet another opportunity opened up actually in Stanford, in the form of a blank cheque offer to join them yet again in an advisory senior role, only pending whether their lavish funding would continue to flow. Finally, dutch retired professors tend to be rather popular in Germany where there is much opportunity for aging scientists – this would be especially attractive for my dear wife Christa who is a German national, having still some nostalgia having left Germany some thirty years ago.

I was kind of busy of these matters when the COVID pandemic hit hard in early 2020. We went in lock down, a state of affair that lasted with varying intensity until spring 2022. But this heralded the beginning of the miracle story I want to tell.

As for everybody else, the lock down forced us in social isolation. I just stayed home nearly all the time, only getting out for supermarket shopping. Directly after the beginning of COVID, zoom appeared as the standard communication facility which was a most beneficial circumstance. We got a lot of work done through the zoom screens! But something extraordinary happened between me and physics. In a magical way extremely interesting physics started to rain down on me. In my own perception, every second day or so that I switched on my laptop I found some tasty new physics bit in my mailbox.

I was working with a variety of parties. In the first place, the aftermath of my Stanford sabbatical where several projects that we started continue to unfold during the pandemic. I had in addition several adventures with Chinese partners and, last but not least, the dutch so called "strange metal consortium" that had been going on for a while started to deliver at a high pace. Finally, together with my intimate string theory friend Koenraad Schalm

we had been supervising a local research group where the hard work is done by master- and PhD students, as well as postdocs. Although the group was rather limited in size because of the petering out of the funding, we were blessed with a gang of exceptionally gifted young students. This research revolves around the AdS/CFT correspondence, a ploy by string theorists allowing to use fancy black holes to compute properties of extremely strongly interacting quantum matter. We concentrated on using the computer to explore what happens under more realistic, real life circumstances and this came alive brilliantly in a genuine group effort.

The bottom line is that I lived through the absolute productivity maximum of my career, getting something like twenty substantial physics stories done. Halfway the COVID period I lived like a hermit, being tied to my physics producing laptop with my social life limited to wife Christa and beloved oriental shorthair cat Lola. Once again, the portfolio was quite diverse. Especially with regard to the dutch consortium and Stanford it was the ubiquitous "shooting from the hip". My experimental- and computational friends dumped their data in my laptop with the request "do you discern anything profound in the data". Rather magically, time after time I did lifting the story to a higher level. This paid off in the form of around *ten* "glossy papers" in the period **2018-2022**. "Glossy" refers to the shiny cover of the prestige journals Science and Nature, and just a notch lower the Nature clones like Nature Physics and Nature materials. Plenty of scientists would be happy with only one such score in their whole career.

But once again, I am not bragging: it just landed in my laptop and I had a great time deciphering this good physics. I have to admit that I allow myself a bit of a superstitious emotion. As if the God of Einstein at the centre of Schrieffer's cult, can be pleased by doing the kind of right stuff in physics research, and when you are so lucky to please him or her he/she opens up the "telephone line to God", dumping the good stuff in your laptop.

## **VI. MY ENCOUNTERS WITH RUSSELL'S AUSTERE BEAUTY.**

What has this to do directly with Russell's supreme beauty and Schrieffer's divine visions? I was referring to the empirical side of physics, focussed on experiment, and that is a different affair. It is no-nonsense, feet on the ground, with the core business in getting the machines to work such that they produce unambiguous *data*. It is of course the great triumph of western

civilisation during the age of enlightenment to stop philosophising in favour of interrogating nature directly with machines. This surely revealed that "Nature has more imagination than any human", with experiments demonstrating that matters are typically completely different from any human anticipation.

Physics is in this regard quite similar to the other empirical sciences, except that eventually everything revolves around finding out whether the data can be married to profound equations. To stand a chance finding these equations one has to filter the deep meanings lying buried in an enormous amount of data streaming out of the machines where nearly all of it is irrelevant. A good name for it was introduced by the Bell labs legend Phil Anderson, a master of this art: he called it the *detective work*, patiently sifting through a multitude of experimental facts, with a keen eye for things that are *anomalous*, not behaving according to the expectations of the established lore. In this way one collects pieces of the puzzle and the next step is in the guise of a jigsaw puzzle in trying to find the gross patterns that may be captured in equations encoded in this collection of strange experimental facts. You encountered this in the Schrieffer story, referring to Bardeen collecting the BCS pieces of the puzzle.

But the grand climax, the point where Schrieffer's cult shows itself, is when this puzzle suddenly solves itself completely by the discovery of the divine equation excelling in the Platonic values of Russell's austere supreme beauty. Bob's story about the BCS wavefunction in the train window is case in point, but the history of physics is a progression of such magical events. This is where the inner sanctum of the cult is, although obviously such events are very rare.

At least my kind of theoretical physics professional is the middle man. On the one hand, we are supposed to stand knee deep in the messy and confusing reality propelled forward by the experimental machines. On the other hand, reaching above our heads we discern the supreme beauty of Russell discovered by the mathematicians. Once again, the real reward which occurs very rarely is the realisation by the theorist that such a mathematical jewel fits experimental reality – the Schrieffer grand revelation experience. The borderline between math and theoretical physics is actually a bit shady – there are plenty of examples of people employed in physics departments having sufficient talent as mathematician to be actively engaged in chasing the mathematical beauty. I am myself lacking this talent – I am a *consumer* of math and I am just quite good at deciphering the physical meaning and

relevance of the equations for reality – I am more or less precisely in the middle.

All along part of the progress of physics came from the propulsion coming from the mathematical side – searching for equations that somehow relate to physical reality hoping to hit the jackpot in the form of equations that fit. This tradition is raging until the present day mostly in the hands of the community of *string theorists*. What is theory of strings? Perhaps you just ignore it – all you need to know is that the origin is in the community that landed the standard model of high energy physics in the 1970's, that subsequently got for mathematical reasons obsessive regarding a particular collection of mathematical theories. One thing is clear: this community produced since the early 1980's a *bonfire* of mathematical constructions with the supreme beauty, cold and austere, of Russell's mathematics. String theory rests on the grand mathematical theories of physics – quantum theory and general relativity – and extends these in surprising ways littered with amazing mathematical allure. The propulsion has been all along in the beauty of the math but the trauma has been that despite a lot of suggestions after all these years a direct, unambiguous relationship with physical reality could not be established.

Both General Relativity (GR) and string theory became important for me in a rather late stage of my career. When I was a student GR had faded away in physics departments, and only the mathematically inclined students took the sophisticated course. I skipped it, as many of my peers of my generation. Instead I completely focussed on the more empirical oriented field called "quantum condensed matter physics". By counting heads it used to be the largest subfield of contemporary physics, in part spurred by applications like the cell phone, but also flourishing as a fundamental research area aiming at understanding the nature of matter in terms of the fundamental quantum theory.

For peculiar reasons that I will not explain, I started to learn GR around the turn of the twenty first century, I was already over 40 years of age. For even more peculiar reasons I studied string theory intensely around 2006 – this is highly exceptional, at this point in time I was apparently the only condensed matter theorist that was string theory literate. Admittedly, an important part of the motivation was just hedonism, I am susceptible to the Russell austere beauty things and I indulged in the wonderful box of mathematical jewels that one encounters studying GR and string theory.

In a strangely long lasting, very patient development I diffused in some kind of sub-conscious way to my Schrieffer-like discovery moments associated both with string theory

and GR. The revelations happened very recently but this story goes hand in hand with my present condition as a mortal human: suffering from cancer. I feel immensely satisfied with these discoveries: they will not bring me any sociological glory but I perceive them as turning my personal epsilon in the epsilon Einstein affair to become quite finite.

## **VII. THE EXTRASENSORY PERCEPTION: THE UNREASONABLE FORE-SIGHT.**

Let's pick up my personal time line during the summer of 2021. The COVID lock downs started to ease. I had settled in the physics-hermit existence, living in social isolation having a great time with physics delicacies that continued to rain down in my lap top, as I discussed. I was in a way a bit worried. Old man become more solitary and could it be that helped by the COVID circumstances I was on track to become a real eccentric hermit like life-form, avoiding social contacts with other humans? Whatever, hesitantly I started to get out of my study to slowly pick up the pre-COVID routine.

But then something happened – I perceive it as the most unreasonable affair that I ever encountered. In one way or the other, it is beyond any rational explanation. Despite my agnost outlook in these matters I just allow myself to frame it in a spiritual metaphor of biblical proportion – the best way I have figured out to capture the narrative. The correspondence with the bible (new testament) is roughly as follows. The role of God is taken by the God of Einstein, the mathematical creative genius at the origin of creation who is also chief behind the heaven's gate guarded by Einstein. Provocatively, my person takes the role of Jesus, not so much as the son but instead as some kind of prophet sharing a destiny with Jesus in the form of paying the prize for receiving the gospel in the form of extended physical suffering that eventually ends with my dead.

Crucially, the gospel is in the form of two finite epsilon Einstein accomplishments. I can even discern the analogues of the apostles. The most obvious finite epsilon accomplishment is associated with the AdS/CFT correspondence referred to in the above. I will be long dead before the full impact of this powerful insight will have had the opportunity to substantiate – real science is an extremely patient affair, real important novelty takes at least ten years to substantiate. But I have good hopes that I have sufficiently seeded my epsilon AdS/CFT insights in the heads of my coworkers, that they will profit from my martyrdom

to successfully spread the words of this gospel. Surely, as a quite relaxing circumstance I will be long dead anyhow before this has all happened. Why should I worry about personal glory? Knowing that you will die is sometimes a very relaxing circumstance.

This is quite something, why do you find me ascending in such religious gibberish? I remember vividly the event that triggered all of it. It was one of these remarkable post-worldwide-climate-change summer days in the Netherlands, the kind of weather that never occurred in a recent past in the form of a bright blue sky and very pleasant temperatures that is like the Californian bay area climate. I still remember the event as a kind of physical experience. Suddenly a jolt bubbled upwards from my deep inside. It was substantial, as if I could grab and hold it in my hands. It hit me with some form of absolute understanding, there was no doubt, I have perhaps never felt so convinced of anything in my whole life. I got the sudden, all encompassing insight that *my time was running out*. I got signalled that I would die some time soon. And this was absolutely certain.

This is an authentic testimony. It should be clear by now that I am by default very sceptical regarding supernatural, magical perceptions but this was *foresight*, bigger than normal life, non-negotiable and devoid of anything like phantasy. Is there anything real about the extrasensory perception thing, the clairvoyance giving the capacity of precognition, the ability to predict future events? I always sided with the Skeptical Inquirer pursuit, but after this *physical* experience I am no longer so sure.

The immediate response of my system was in the form of a deep sadness. Life has been a party for me and I realised that unfortunately the party is coming to an end. These feelings continued to reverberate for a while during this summer. Slowly the sad feelings morphed into one or the other kind of acceptance of this fate that I could not avoid. I found some kind of peace with my destiny. You hear this more often – people who are mortally diseased may find themselves in a state of acceptance – the best word is perhaps peacefulness, nothing left to fight against, just let it happen and enjoy life as much as possible as long as you can. I suspect that some kind of automated mental program is at work, rooted in biology, given the fact that death has been indivisible part of life since its very beginning.

## VIII. HOW PHYSICS INTERVENED WITH THE FORESIGHT.

Quite remarkably, this foresight intermingled with yet another mental process. Perhaps it got a bit obscured in the course of time but looking back in my remembrance it just went hand in hand, unfolding in unison. This revolved around physics, actually associated with the two subjects that had been with me for a long time that I already introduced in the above, the two finite epsilon things. All along these continued to intrigue also after many years, somehow rooted in an intuition that there was a lot more to know than I had managed to isolate. These are examples of these life long pursuits by physicists, where the intrigue continuous coming but where the revelation stays out of reach for a long, long while.

A first obsession started around 1999. This was initially motivated by a rather practical affair. Some soul mates of mine had introduced the notion that the quantum incarnations of the liquid crystals known from flat screens and so forth may exist and the question was regarding the general physical properties of such stuff. I attacked this with fanciful quantum field theoretical duality constructions – I gave way to my Russell’s math reflexes. I then discovered that there had been a tradition of the kind, actually linking this theme in an indirect mathematical way to general relativity. This was the reason for my serious learning of GR , when I was already over forty years of age. This pursuit continued evolving, during the years that followed. I used to keep it for my best, mathematically inclined young people. This got more or less to a successful completion in 2016 – we wrote a bulky review. I expected that it would be completely ignored but as a lucky circumstance the theme flared up elsewhere and to my satisfaction this hard work is already more than a hundred times cited.

But somehow it was not done – underneath something way bigger was going on and I could not quite lay my hands on it. But this started to move during the COVID hermit period. I continued working on it, slowly, taking all the time that was plentiful available because of the lockdowns. I started to ask the good questions – usually the big deal – and more or less coincident with the I-will-die-foresight suddenly the understanding of what is going on exploded! I was awed – I had discovered kind of the last chapter of the General Relativity book! It has dealings with the brew of Einsteinian spacetime that is talking to matter in the form of crystals. It seems that what comes out is rather inconsequential for the understanding of our universe, but in its perfect Platonic incarnation to shed a com-



pletely new light on hitherto unidentified mathematical relations between different branches of geometry. The physicist or mathematician may take a closer look at crystal gravity – I worked hard to explain this as well as possible in this bulky paper.

Although it may take a long while before it is disseminated in the community such that the full scope of this discovery may substantiate, I am utterly convinced that this has a finite epsilon in the epsilon Einstein affair. I will not shy back to push it hard standing at heaven's gate!

The crystal gravity revelation came to me rather precisely in the period that I was digesting my finite life time foresight. Is this mere coincidence or more than that? This was not yet however the full story yet, there is more of the same kind to come.

I already alluded to the fact that since 2007 or so my primary focus of my research had been on figuring out whether the AdS/CMT mathematical wizardry of the string theorists. may relate to the physics of extremely quantum physical, strongly interacting electrons forming the "strange metals" as observed in the laboratory. I already stressed it as a bonfire of beautiful math, finding myself in a rather unique role as middleman to condensed matter reality. Propelled by the equations, this developed very rapidly in the hands of staggeringly competent string theorists in the period 2007-2013. It then slowed down giving us the opportunity to write a 600 page textbook summarising these accomplishments that appeared in 2015 **book**. But all along it continued to be a mystery story – I called it myself the "whispers of the holographic oracle". It was quite an experimental mathematical affair, just computing all kinds of stuffs in the mathematical language of GR, "pulling it through the dictionary (the duality)" and just observing the story it was telling regarding the quantum physics. The charm was into sort of staring at black hole horizons and finding out that these are coding for the weird flows of extreme quantum stuffs, just intriguing.

But this was somehow suggestive towards the higher level of general principle. It was characterised by some eerie sense of familiarity as if it was revealing something very general, that at the same time was warped (or even maimed) by special effects in the mathematical set up that have no direct bearing with reality – for the physicist's, matters like the (matrix) large N limit, extreme relativity and supersymmetry. Surely, what we really wanted to decipher was the *general principles* that seemed to be generically encoded in this machine.

Perhaps you see it coming – again while digesting the foresight and being enlightened by crystal gravity I got suddenly hit as well by an overarching, penetrating *real understanding*

of this *AdS/CFT generality* that I had been chasing so long. I needed here a mathematical key – I learned this from my brilliant young string theory friend Blaise Gouteraux (“finite density bulk geometry is *covariant* under scale transformation”) – and together with my rather special interdisciplinary cocktail of physics knowledge (right now I may be unique in this regard) the pieces of the puzzle fell into place.

This realisation was exalting. Surely AdS/CFT is main stream and a result of a large scale community effort that delivered an amazing number of stunning results. But there is yet this final step of really understanding what the machine is telling in terms of universal physical law. In this regard I discovered the game changer in the context of the application to earthly quantum systems.

As real good physics comes, it is simple and elegant while the principles are eerily powerful and general. The issue is still whether the in a way messy systems – the strange metals – that can be made in the laboratory are given in to the principle. Although highly suggestive, the unambiguous, undeniable “smoking gun” experimental evidence has still to be delivered. I don’t expect to live long enough to witness such an event. But I tend to follow Einstein: “Our Lord is subtle but not malicious” and when the math shows this beauty to be possible and natural, it would be malicious for Einstein’s God to not grab the opportunity ...

I presume you get a sense of why I announced it in this biblical metaphorical way. Once again, this magical foresight affair telling me that my days were nearly over. Surely, I took you through a lengthy exposition regarding the deeply ingrained quasi-religious attitudes of physicists in the form of the Schrieffer cult worshipping Platonic values in the mathematics applying to nature. This God of Einstein metaphor where this God may have an attitude to once in a while establish a telephone line to a mortal. The Schrieffer type hallucinations may occur and this lucky subject may feel that he has bagged some finite epsilon Einstein units.

Frankly, I find both my decoding of AdS/CFT and my discovery of crystal gravity belonging to this category. Despite my citation tsunami and so forth I used to be quite worried about my epsilon Einstein factor. Would LDA+U, Zaanen-Sawatzky-Allen, stripes to call some of my huge citation earners by name be remembered a 100 years from now? I was sceptical, these are in the present time frame quite practical things, popular among the foot soldiers of 2023 physics, but this is not in the league of eternal physics.

This then got spiced up in my reference frame with the foresight, like Jezus receiving

the gospel knowing that Golgotha would be the conclusion. I found this at least in one regard to render an obvious advantage. It is just a fact of life that in most cases when you come up with a truly new important insight it may take very long before it becomes disseminated by the public mind, leading to sociological success. A lively example is how Einstein himself was quite frustrated with how his famous miracle year papers were initially completely ignored, being eventually picked up by the highly influential Max Planck. But many years later, Einstein was even never rewarded with Science prizes for relativity since it continued to raise controversy. I have myself experience – even the humble LDA+U lay dormant for some ten years as "sleeping beauty" before it went viral.

I just know, both the crystal gravity and the AdS/CFT decoding are way ahead of their time. But I am just convinced – on the long run these are unstoppable because they embody true physics substance. But we are social animals and it the desire to be rewarded by positive attention by other humans is engrained in our biology. In Science this can be quite frustrating given the typical long delays in the recognition of genuine new insights. But when you know that you will soon die, why worry about it? I perceived this myself as a remarkable form of true freedom, real autonomy, in these matters becoming completely shielded from conformism by the impending death.

## **IX. CONSERVING THE PHYSICS GOSPEL FOR MANKIND.**

Back to the main story. You may imagine that I felt a deep sense of urgency after being hit by the foresight forming a cocktail with the sudden physics visions. I surely kept this completely for myself. I had this strange sense of absolute certainty but at the same time it was not an affair that I deemed fit to share with anybody. Even my dear wife and life companion Christa did not have the slightest sense of what was going on, except then perhaps that I had a bit of an unusual mood. The story was of course way too flaky to make public in any way, I had to wait for the hard evidence that substantiated a year later.

The bottomline is that in the foresight summer of 2021 I got myself into a writing frenzy. I had seen this physics gospel – crystal gravity, AdS/CFT – and it was a matter of highest urgency to grab it on paper so that it would not get lost for mankind when I would fall away. In hindsight, the benefit is that it turned into hard physical evidence for the foresight story. You may check it in Google citations. Besides substantial contributions to a number

of regular research papers I produced during autumn and winter 2021/2022 two very bulky manuscripts, basically sizeable book formats except than that in the present time it is just a better idea to keep this kind of material open source.

Once again, the general relativity story landed as a monograph type of affair as crystal gravity. It is really a stand alone story, describing a hitherto unidentified rich gravitational reality. It is characterised by layers of structure that can be peeled off as described in Sections 4 to 7, to arrive at the core in Sections 8 and 9. This seems all rather inconsequential for physics but in its Platonic perfect mathematical form it reveals hitherto unrecognised connections between different branches of mathematical geometry and topology. I remember well that I greatly enjoyed writing it. I perceived it as a typical example of the Platonic notion that math is *discovered*, at a point I had a very strong sense that this story was writing itself. Unfortunately, this is entirely above the heads of the untrained, it will be even quite unfamiliar territory for many theoretical physicists. I know it is real – I gave one presentation and this was – gloriously – the first of the weekly general relativity seminar at the famous department for applied mathematics and theoretical physics (“DAMTP”) of Cambridge University, the home of the former Stephan Hawking and worldwide seen as centre of contemporary general relativity. I took this highly competent crowd by surprise, and they cheered it!

But I invested even more energy in the AdS/CFT strange metal affair. I actually abused somewhat the request I got to organise a short (three lectures) course for a band of dutch elite theoretical physics students to write a very extensive (220 pages) ”Lecture notes on quantum supreme matter”. I used perhaps at most one third of this material for the actual lectures – the students liked it a lot, I got it across to these young and flexible minds that something substantial is going on. But in fact I felt a need for an update of the 2015 book. Since then quite a number of matters had been clearing up in my head and altogether the big story of AdS/CFT applied to condensed matter physics had got much better in focus.

I feel myself actually a bit isolated – in one way or the other, I perceive this part of the AdS/CFT agenda as a revelation, by far the most interesting mathematical machine that is presently available to explore. But by and large, right now it has kind of a bad press. In the period 2007-2013 or so it was for a while the main focus of the string theory community. From my side only compliments, the pace by which they pressed one after the

other gem out of this machine was just breath taking. But by 2013 the low lying fruit was picked and obvious practical success had not been substantiated. It was all very intriguing but the relationship with reality continued to be quite ambiguous. In the intervening years since 2015 various key insights started to merge in my head, eventually climaxing in what I am utterly convinced of is the decoding of the "whispers of the holographic oracle". This is what I am spelling out in the "lecture notes", dwelling at length on subjects as the Fermion sign problem (condensed matter), the notion of universality underlying conformal field theory (statistical physics) and of course the AdS/CFT magic itself. To quite a degree this is all context and the action is concentrated in Section VI. Dear physics reader, I am basically trying to lure you into having a closer look, hoping that this will contribute to the propagation of this monumental piece of physics. In Section VI it all comes together, directed by the grand principle of "covariant universality" whatever: I am still searching for a good name for it.

## **X. HOW THE FORESIGHT TURNED INTO THE EMPEROR OF ALL MALADIES.**

Given the foresight, both the lecture notes and crystal gravity were written in a frenzy, my person being convinced that the remaining time was quite limited. By spring 2022 I felt I was done capturing all this physics in lengthy texts. The business of the life of a globalised physicist like myself started to seriously pick up with COVID petering out. I found myself again busy sitting in airplanes, finding hotels, give talks, having dinner conversations with intellectual friends in pleasant restaurants all over the world. For a short while the foresight moved to the background. But then in April 2022 the first signs of serious trouble reared their head, although these were at first not recognised as such. I started to suffer from bouts of esophagus *spasms*. You should have suffered through cramp in the calf, esophagus spasms are very similar: very painful as long as it lasts but now radiating from the esophagus. I remember well the first time that it happened, I had the jolt of realisation that this was the first direct signal of the foresight-trouble: I was quite scared!

In hindsight this was indeed signalling big trouble, in the form of a malignant esophagus cancer that was growing. It turns out that the esophagus cramps are not typical for this condition. But it does happen and these patients are unlucky because these cramps are the

most painful side effects that this cancer can cause. I reported it to my GP, and he advised to have it checked out in the hospital when the cramps became more severe since it could be this rare syndrom of an esophagus tumor.

In August 2022 the cramps became more frequent while my general health condition started to decline. I had a very busy travel schedule in September, starting with a highly entertaining retirement symposium of an old friend in Geneva. The bomb burst at the conference dinner where pieces of meet got stuck in my esophagus causing horrible cramps. I hurried back to the Netherlands where an emergency endoscopy revealed the presence of a rather large tumor.

Esophagus cancer is an infamous killer – when it metastasises it is very aggressive, not reacting to chemotherapy and so forth; it belongs to the small group of cancers where not much progress has been monitored in the treatment in recent years. The statistics is merciless: 20 % 5 year survival after first diagnosis. But I was lucky, there was no sign of spreading and I went into the treatment mill. A medical roller coaster ride followed where I did descend in the abyss of medical hell. In the autumn I recieved in a 5 week period Intense radiation treatment that was greatly successful, followed in January by esophagectomy surgery. Due to unforeseeable complications this went badly wrong with the effect that I spent three weeks in coma in the intensive care unit (ICU), nearly dying in the process.

You may know about the greatly destructive effects of an extended stay in the ICU on the physical condition – I felt like a flattened cockroach when I came to conciousness late January, lacking even the strength in the body to hold up a book to read. A lengthy uphill battle followed, recovering strength in late February that I could go home. Despite all this mishap I got the message that actually the cancer treatment went as well as things come, it looked like I was ”clean”. I remember that I was contemplating that after all the foresight had been a delusion at the least to the degree that whatver had caused this extrasensory signal had not quite figured in the remarkable powers of modern cancer medicine.

But there was a caveat – by the second surgery in January by sheer coincidence the surgeons had detected a small patch of malignant growth on my peritoneum. This spot is highly unlikely for esophagus metastasis and subsequent genetic marking showed it to be unrelated! This saved the foresight – in April I started to suffer from horrible nerve pains in my leg and the MRI scan revealed that there were a couple of big clumps of metastatic tissue present in the lowest part of the spinal chord. This was successfully quieted down by

a huge radiation dose but in summer 2023 it became clear that this had further metastasised in my brains, while there was also quite some growth in my peritoneum. Although not sure, a small primary like growth was found on a kidney – the present working hypothesis is that this may be the primary tumor responsible for the present out-of-control metastatic growth that will eventually kill me. It would be ironic, the greatly malignant esophagus cancer being defeated by medical technology but the foresight saving its skin by triggering another menace that will have full success killing me!

In practice these medical adventures constituted more or less a day job. However, especially in autumn 2022 I had quite some time and energy left. In a wonderful way the "telephone-line-to-God" frenzy petered out in perfect synchrony with the growing intensity of my medical activities. The pleasant surprises raining down on my laptop started to dry out, but instead the research in my Leiden group flared up spectacularly during this autumn. A bunch of highly motivated master student pushed hard the very impressive computational machine put together by an excellent group of PhD students and postdocs, that is using cutting edge numerical general relativity of a similar kind as used for the black hole mergers dualizing this in "quantum computer like" physics in the AdS/CFT boundary.

I have never encountered such computer work producing such a rich, real world scenery! This numerical AdS/CFT is an amazing affair, and it produced a breath taking slur of intriguing new results, that we managed to decode to a degree. For a while it even looked like that this unlocked the great secrets behind the strange metals – it could still be in the mean time I am less convinced. Whatever, this was a fantastic physics adventure more on the detective work side although this time elevated by exquisite computer work. And it all happened in this perfect synchrony with the cancer treatment, physics again saved the day!

We had nailed the bulky paper reporting on these matters late autumn and this was the last real physics research I got done. After getting out of the ICU the energy and concentration required for physics were just lacking. But I could pull yet one other trick. I had been getting kind of quite unusual very general ideas in the context of quantum gravity. At the end of the day this is the only thing the string theorists really care about and during the AdS/CFT times I listened to many of their stories. This is about the most fundamental realms of physics but I found it way too slippery to work on, there is too much of a sense that nobody has really any clue what to do. So I kept my perhaps somewhat weird ideas in these realms to myself.

But when you know that you will die why should worry about embarrassing yourself with flaky thoughts? Suffering from cancer, writing is for an intellect like me perhaps the best way to keep going so I decided to try to grab my weird quantum gravity ideas in a simple, accessible text devoid of equations. I was again taken by surprise – as equations are pre-existence according to real literary people I know the same is true for stories. They already exist and the writer has just the privilege to capture them on paper. This story just started to write itself! I worked on it everyday during the whole spring and the finished manuscript received enthusiastic responses of various proofreaders, including a publisher of a very credible publishing company who wants to publish it as a book.

In fact, this text started its life as an attempt to write an introduction for this book. But it became way too long for this purpose and I took up the writing of this way more personal story as the last serious challenge that I may cope with as long as my brains are working. The good news is that right now I am still managing to produce text although at a much slower rate given that the growing tumors in my body suck up a lot of physiological energy. But obviously, I am getting this one done as well!

## **XI. EINSTEIN'S GOD BECOMING PERSONAL?**

Arrived at this point it appears I have to hurry. The tumors in the brain are growing – I had to pause the writing just before this because of a bad period. But I have to bring this to a conclusion.

What has been going on? One may think about it as a twist serving a dramatic story line. I turned the strictly impersonal deist god who is entirely detached from any type of individual human emotion, the God of Einstein, Spinoza, Schrieffer and so forth, into something way more biblical and thereby highly personal. This "telephone-line to God" productivity sentiment, getting extremely serious by the foresight, you'll die soon but you are rewarded by the epsilon Einstein visions that however have to be captured in the form of an exciting physics testament.

Surely, all of this may be just mere coincidence. However, the way I described it is *authentic* – I just experienced this personalized Physics religion as just bigger than life, it just happened in my reference frame. Whatever it means, the foresight experience was just factual and it obviously amplified everything else. I can't help but the sudden visions



in general relativity and AdS/CFT seemingly triggered by the foresight appear to be too much of a coincidence to be just accidental. I am an agnost, and sceptical about the interpretation of the events as presented. However, I perceive a pragmatic benefit. It gave a most satisfactory way to deal with death that cannot be avoided. Having the luxury keeping the brain busy with so much meaningful activity, somehow in harmony by the awareness that time is running out has been a source of very effective solace. In this regard my personalized version of Einstein's god appears to be a very effective substitute for the solace Christian people receive from their Christian God that is in first designed it seems for this purpose. The benefit of the Einstein version is that even the most rational among us have to admit that this represents true mystery, one cannot afford to have a real opinion.

Let me end this story with a final anecdote starring Bob Schrieffer: I find this very tragic note appropriate as an end of this piece of prose. What I did not quite realize since it was kept deliberately secret is that Schrieffer was suffering from *bipolar disease*. It seems to be more often the case that this horrible brain disease occurs in people that are genius, knowing another one from close by I am wondering whether this genius is somehow rooted in the disease. Apparently Schrieffer was diagnosed at a rather young age, kept functional by Lithium to the degree that he could completely hide it.

But in the early 1990's when I learned to know him he had a reputation of having rather erratic mood swings. I witnessed myself at an earlier stage Bob having a physics debate in front of the blackboard with an old buddy of his. This was fierce, polemic is healthy but this was more like a volcanic eruption! But there was more. He was known to sponsor a collection of junior cronies. I believe I landed myself on this list visiting Talahassee and I already testified regarding his very warm, fatherly attitudes. But he also supervised juniors that were of course critically dependent on Bob's support that he did not like. There were really nasty stories in the rumour mill regarding the truly abusive way that Bob was dealing with them, violently destroying their careers. In hindsight this could all be blamed on his disease, being the pleasant and flamboyant character in his manic phases turning dark and mean when the depression took over.

In 1996 he was even elected to the very responsible position of President of the American Physical Society, as a testimony how well he controlled his disease. But apparently the disease got much worse in the years that followed. A horrible accident happened. As I already explained he liked fast cars. In 2004 he had accumulated so many speeding tickets

in Florida that his drivers license was revoked. He had however lived for a long while in Santa Barbara, California, before moving back to daddy's orange plantations in Florida.

The story is that in 2004 he landed in San Francisco and somehow managed to purchase a fancy Mercedes sports car even without driving license. He drove down to Santa Barbara along the famous coastal California State highway 101, which is a fun road to drive for a petrol head in a good car. But then Schrieffler smacked with a speed of over 100 mph into a van loaded with Mexican workers, killing at least two of them and injuring another six or so! Despite his Nobel prize and so forth the court was merciless: this was murder with a typical prison term of 15 years that was reduced to two years because of his reputation and the circumstances, somehow the bipolar condition. But he was sent to a high security Californian state prison populated by serious criminals.

We found this all very tragic – compared to this agony even my cancer state is one of grace and harmony.