The properties of space.

S.J. (Bas) van Stekelenburg

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Abstract

Quantum physics, general relativity and the standard model of particle physics represent our best understanding of the universe. New physics explores super-symmetry, extra spatial dimensions, strings, branes and multiverses. Current mainstream reasoning is from division to unification. This manuscript introduces the reversed process from unity to division. The behaviour of reality, our theories, laws and constants are explained from structural properties. I conjecture reality to be a 3-dimensional elastic fabric of space with variable elastic resistance. Time returns to just being a measure of change as a consequence of these properties and familiar spacetime with elastic properties emerges in views on reality. As a result of the conjectures all current theories are views on reality, splitting up what is really only one single object. Variable elastic resistance is the property that determines the scale of things, including the masses in our standard model. The speed of light is conjectured to be variable. The Schwarzschild solution follows from the microscopic properties of space. The machinery for energy deforming spacetime in general relativity is provided. Energy is deformed space. The debate on the interpretation of quantum physics is concluded. Quantum physics is itself an interpretation. It is necessary to assume the existence of carrier topologies. These carrier topologies support the existence of fermions and quantisation in an otherwise too simple topology. A new contribution to the spectral redshift of distant galaxies is submitted, influencing our interpretation of the accelerated expansion of the universe. Research on the computational power of numeric elastic fabrics could lead to for instance a pseudo quantum computer. Many fields of physics will be touched, and their participation will be required in new research, to quantify the conceptual, to examine the conjectures and consequences, to find solid objections and experiments and to build a new generation of numeric particle accelerators.

keywords: space properties, variable speed of light, new spectral redshift contribution, black hole structure, interpretation of quantum physics, numerical quantum computer.

Albert Einstein [1]: The aim of science is, on the one hand, a comprehension, as complete as possible, of the connection between the sense experiences in their totality, and, on the other hand, the accomplishment of this aim by the use of a minimum of primary concepts and relations.

1 Introduction

Do we live in a universe? Serious people are considering reality to be a hologram on the edge of the universe. They are contemplating on multiverses, extra dimensions and accelerated expansion of the universe. Serious people have been pondering almost a century over the interpretation of quantum mechanics[2] and how energy warps spacetime. Physics and mathematics give us the latitude to do so. From the moment I finished my first quantum mechanics class, I have wondered how it could work so well and still feel so unnatural as a definitive answer. My intuition protested then and it has done so ever since. This fascination has put me on a path that is now crossing yours. Here is what I think is happening.

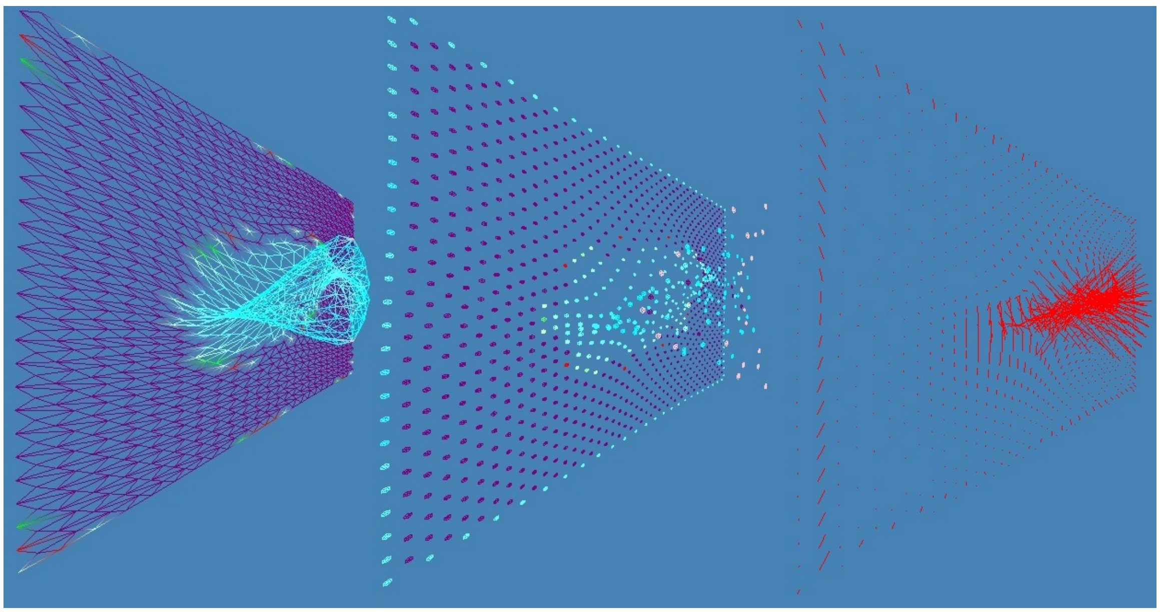

Figure 1: *What if only space exists with some properties and this suffices to be reality? Our current views are derived from it. Sketching from left to right a slice of reality (a deformed slice of space), a derived scalar field and a derived vector field.*

Imagine living in Newton's universe before 1915 and wondering why gravity would act instantaneously over incredible distances. A question that was answered when Einstein published his theory on general relativity [3] [4], a hundred years ago. Gravity doesn't act instantaneously. Why a hologram, extra dimensions, accelerated expansion? These why-questions are also disguised how-questions and beg to understand the machinery behind assumptions. Implicit in the conjectures proposed hereafter, the answer is "no, there isn't". There is no hologram, no multiverse, no extra dimensions or accelerated expansion of the universe. Reality is simpler and prettier. Some solutions to current physics problems, as mentioned throughout this manuscript, are found in table 1. Obviously, as we are talking conjectures, this manuscript proposes a new field of research and argues the relevance of proving the conjectures and consequences.

Before we get to that, let me be suggestive in mentioning what may be the Achilles heel of both physics

Table 1: *This table shows some of current physics unsatisfactory conceptual situations and conjectured solutions*

Conceptual problem	Conceptual solution
Physics is based on behavioural principles, laws and constants	Physics is based on the structural properties of an object.
Interpretation of quantum mechanics	QM is itself an interpretation
Machinery for general relativity	Energy curves space because energy is curved space
The extreme composition of a black hole (singularity)	Black hole behaving more like a resonating cavity than like a mass concentrated in a point.
No link between Schwarzschild solution and microscopic properties of spacetime	Schwarzschild solution can be linked to microscopic properties of space
Dark energy and accelerated expansion of the universe not intuitive	two new contributions to galaxies spectral redshift (variable lightspeed and variable size carrier topology)
Multiverses, extra dimensions and holograms unsatisfactory	automatically ruled out if conjectures are right
Quantum mechanical vacuum has erratic behaviour and no machinery	Smallest scales have smooth behaviour
No explanation for the existence of a preferred scale in nature	explained through variability of elastic resistance of space
Extreme machinery by inflation to explain uniformity of background radiation	explained through wavy and dispersive character of space, using elasticity and variability of elastic resistance.
Machinery of dark matter	Galaxy is behaving more like a resonating cavity than like a lump of mass

and mathematics. "Division comes with conflict" (Krishnamurti [5]). In science division is essential to progress. Mathematics defines different objects like a zero and a one. Physics distinguishes concepts like fields [6] and spacetime. There may be side effects to this act of division. Side effects such as a non intuitive definition for continuity, incompleteness theorems, infinitely many types of infinities, point particles, multiverses, extra dimensions, all beauty and weirdness combined. This possible Achilles heel is a source of motivation to construct and investigate the conjectures and the machinery that might circumvent unwanted division-effects. The opposite of division is unification and doesn't it seem sensible to use both strategies? Current physics therefore is doing the unifying after the division is done. The suggestion is to also do the unifying before the division is done. At least one can argue that until we have the definitive answers we should do both. Can we afford not to?

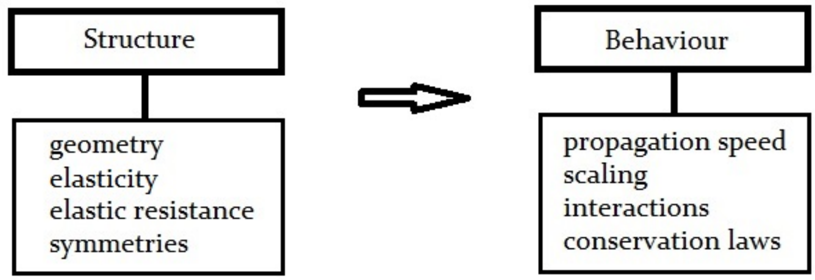

Figure 2: *Two types of properties are modelled. On the one hand the structural properties are fundamental properties of the fabric of reality. These properties give rise to possible behaviour. This behaviour can be modelled by behavioural properties. The speed of light is an example of such a behavioural property and is expressed by a constant c in equations. The scale of things follows from the structural properties. Planck's constant is related to the scale of things. Structural symmetries lead to behavioural conservation laws[7]. The structure and scale of local forms lead in turn to properties such as mass and charge. How much space is used to form local structure is related to the gravitational constant. A question is if any of the behavioural constants are really constants or perhaps more complex functions.*

This unifying before division may need some more explaining. Assuming that the universe really exists, which to me comes naturally, the next natural thing to assume is that the universe has fundamental structural properties, that govern it's behaviour. Nature checks no list of laws to behave properly. Constants, laws and principles are man-made results of structural properties. The speed of light as a constant for instance is a behavioural property and not a structural property (see also figure 2 on page 4). Its local or global value and constancy should follow from structural properties. Planck's constant, the gravitational constant and the fine structure constant are no different. In this approach any theory that uses these constants in the description of reality is a derived perspective, a derived view on reality and not a direct one to one description of reality. Properties of a steel rod are for example its density and elastic modulus. A constant that is derived from those properties is the propagation speed of sound through the rod. A model of the rod of steel consists of pseudo-atoms that relate to each other and behave like the real atoms. The model behaves like steel with a certain elastic modulus and a wave equation can be derived from it. That wave equation with the constant for the propagation speed is not the model for steel. The wave equation describes and predicts the behaviour of propagating waves through steel. The description of the universe needs objects, their properties and relations. Relations between objects can be eliminated when there is only one single object, hence the unifying before dividing. When only one single object and its structural properties are the starting position, any division or behaviour must be explained by these structural properties. In the case of the speed of light, I conjecture that the elastic resistance of space (about to be introduced) is the structural property responsible.

Hereafter the word space, or fabric of space, is always used as the name of this one single object. Space is different from spacetime. Spacetime is derived from the properties of the fabric of space. Current theories must find their place in the new setting, where the distinction between energy and space in general relativity is removed and where the distinction between particles and vacuum in quantum physics is removed. We

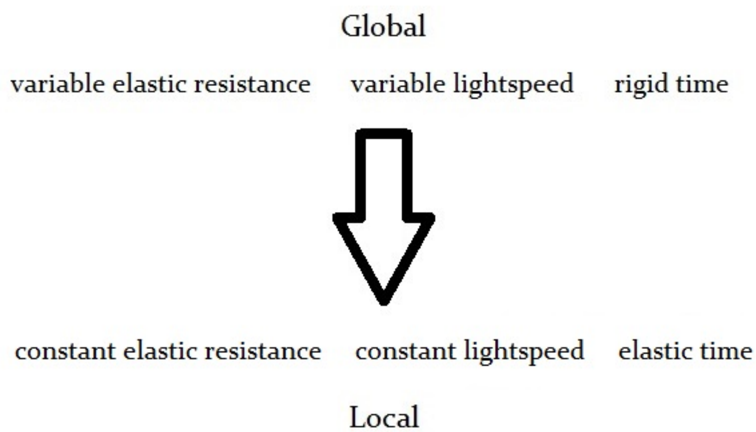

Figure 3: *Space on a global scale has variable elastic resistance and thus variable speed of light. Global time is a rigid measure of change. Locally, when differences in deformation become negligible, elastic resistance becomes more constant and thus the speed of light becomes more constant. As a result of a locally constant speed of light and our perspective of locally existing objects, familiar spacetime emerges and local relativistic time is flexible. In the earlier not so stretched universe of a big bang model (remember that elastic resistance is a function of the deformation of space) the speed of light was lower than it is here and now.*

only have one object at our disposal.

> *The sea is just lots of moving water and we see waves. Is the universe like the sea, just lots of moving space and we see particles?*

2 Conjectures

My main conjecture is that reality is this one single object called space having the following properties that determine its behaviour: (i) Space has a three dimensional geometry, diffeomorphic[1] to Euclidean space. (ii) Space deforms perfectly elastically and contains potential and kinetic energy. (iii) Space has variable elastic resistance which increases with increased deformation of the fabric of space.

Deforming and resonating space can locally be perceived as a particle. Space changes everywhere and all the time, giving rise to all phenomena that we experience, giving rise to behavioural properties, to mass, charge, constants and laws. Concepts such as symmetry, symmetry breaking, entropy (the arrow of time), linearity and non linearity are woven into the properties of the fabric of space.

Feynmann [8] writes:"The subject of elasticity deals with the behaviour of those substances that have the property of recovering their size and shape when forces producing deformations are removed". Physics

[1] The shape of space remains smooth (differentiable to high enough order with respect to its dimensions) everywhere.

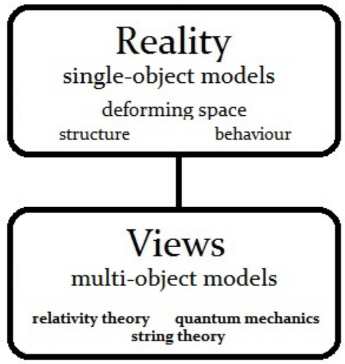

Figure 4: *A two level paradigm. Reality is 3 dimensional deforming space. The first level holds the description of reality by means of a single object, its properties, its form and the way it changes. All theories that consider more than one single object like for example quantum physics, relativity theory or string theory are views on reality.*

has no tradition in which space is referred to as a material or a substance with properties such as elasticity. Nevertheless the word elasticity feels natural and is therefore used in the context of the fabric of space. This manuscript isn't the first to do so (see for instance [9]). The Latin word modulus means measure. Elastic modulus is a measure for resistance to change and a generic term for some specialisations (Young's modulus, shear modulus, bulk modulus). It is used almost exclusively in the material sciences as a constant. However, space is not just any material. I therefore propose (and intuitively prefer) the use of elastic resistance in stead of elastic modulus.

Time, as a measure in describing change, is a consequence of the properties of space. (i) A useful measure for time, hereafter referred to as global time, is ticking at a steady rate (although strictly speaking just a predictable rate would suffice). Global time helps in describing the behaviour of the fabric of space. (ii) Local awareness experiences local 'Einsteinian'-time as a measure of change in spacetime. The concept of spacetime emerges from deformed space when reality shapes a local observer or 'local awareness' that notices relative change in locally observed objects, like rulers and clocks and particles. Some complex 'observer'-wave thinks it sees another separate wave and experiences change and time in a local way while in fact only the unity of reshaping space exists. In reality the wave formation shows no beginning and no end. It cannot separate from another 'entangled' wave. Global time is defined rigid, local time is experienced flexible, seemingly elastic. One could speak of a shift in perspective (figure 3 on page 5) from a single global space object with variable elastic resistance and rigid time dimension to local space with rigid elastic resistance (constant speed of light) and flexible time dimension (spacetime).

The mathematical model for deforming 3-dimensional smooth space is a 4-dimensional Riemannian manifold. The time dimension does not change shape (predictability) and is a global measure for the rate of change. A global universal clock is ticking at a constant rate (constant being a bit more restrictive than just predictable which would also suffice). Local time from the concept of spacetime as we measure it with our local clocks is a relative measure and a derived concept. Unlike global time, the three spatial dimensions can change shape described by diffeomorphisms [10] [11]), which means they can deform and their shape

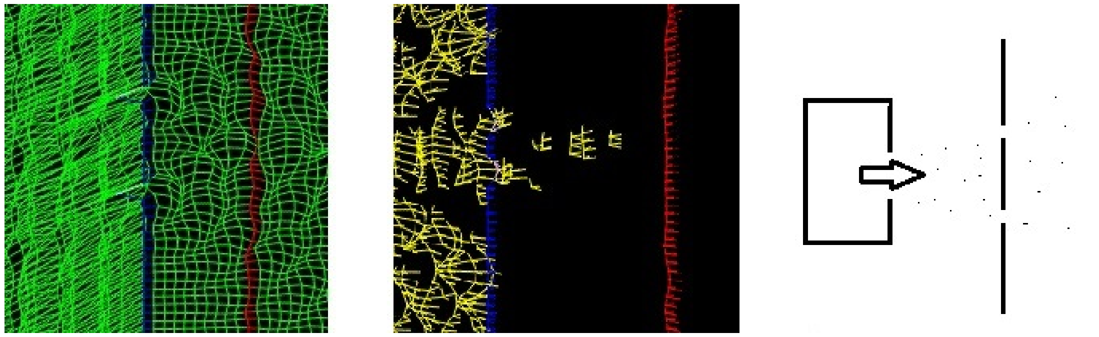

Figure 5: *An 'artists' impression of a two slit experiment. On the left only deforming space is depicted. In the middle and the right picture the space is interpreted as some particle generator creating an interference pattern on a screen through (i) distinguishing apparatus from environment, (ii) distinguishing the relevant outputs (the 'ticks' and 'flashes') and (iii) interpreting the outputs by identifying them with modelled objects and concepts in theories. Interpreting quantum mechanics: "what really happens when the electron goes through one or more slits and hits the screen?".*

remains smooth. At any particular moment in time, a diffeomorphism on a subset of 3D Euclidean space describes the 3D shape of space.

Answers have already popped up automatically. The machinery behind relativity theory is that energy deforms space because energy is deformed space. Quantum mechanics doesn't need an interpretation because it is itself an interpretation of reality. A measurement apparatus and its environment are derived concepts from the form of space (see for example figure 5 on page 7). There is no way of saying where the apparatus begins or ends. It is in a way just deforming space measuring deforming space and the interpretation can only be made by deforming space that has developed enough awareness. In reality the apparatus is always completely entangled with its environment. In quantum mechanical terms: the wavefunctions of apparatus and environment were completely entangled all along so a measurement is nothing more than the whole, progressing in time. There is no collapsing of a wavefunction into an entangled state with the apparatus at the moment of measurement. The interpretation of the measurement depends on the imagined experimental setup. What is the particle and what is not? What is the slit and what is not? A measurement result is only part of the total development of the machine and its environment. You just don't get to see everything. Answers to the former why questions about multi and extra stuff are implicit in the properties of space. We return to accelerated expansion later. An alternative to theories on objects, that do not really exist, is to build a tool that models realities' structural properties to mimic its behaviour. The software, that has produced the included triangulated pictures, is such a first generation model of reality and reveals some of the future obstacles we face in this approach.

A two level paradigm relates theories to reality (figure 4 on page 6). One level holds theories on reality that use one single object and its fundamental structural properties. A second level holds theories that interpret reality from a dividing perspective, a human local perspective. In this new paradigm all the theories of today's physics belong to the second level. Current physics theories use more than one object to describe the universe. Through division, theories represent views on reality. They interpret the first level (figure 5 on page 7), that aims to describe the whole thing in a one to one correspondence to reality. The first level of the paradigm is about unity, the properties of nature and how it really works. The second level is about how nature is experienced from a local (human) perspective. The second level is about the self referential potential of space itself. It contains views on reality and thrives on division, distinction, ordering, relations and the particle view.

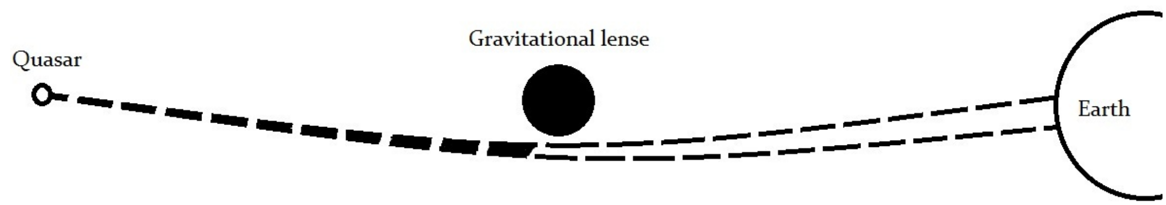

Figure 6: *A thought experiment. The light from a rapidly pulsating light source that travels close to the gravitational lens travels faster than the light further away from the lens because closer means more deformed thus stiffer fabric thus faster light. The pulse phase on the fast track therefore shifts relatively to the slow track. Herein lies the possible opportunity to test the variable lightspeed prediction.*

Conceptually for small scales quantum physics shows up when we assume that separate objects exist. Because these objects do not exist, nature protests and we measure only probabilistic behaviour and entanglement as a result of splitting up what is really one whole thing. The mathematics, best describing the probabilistics of division, uses only two objects, namely a field on a manifold. To calculate properties mathematics needs other objects, operators. The operator is like the machine that measures in reality. The operator works on the field. The machine works on its environment. The operator produces probabilities for the outcome. The machine produces outcome with certain probability, nicely related to the operators probabilities. We define a measuring device in an experiment as separate from its environment, generating specific output also separate from its environment. We define a particular system on paper and assign to it a field in spacetime. In other words, the whole form of space becomes (i) in reality a measuring device (for example a particle accelerator) in an environment and (ii) on paper a field of complex numbers in spacetime and a procedure to quantise the field. The predictable behaviour of space turns into (i) the probabilistic behaviour of bleeps, dots, stripes and numbers as real output and (ii) the probabilistic behaviour of the system of particles in spacetime on paper. Physicists are tempted to conclude from experiments that reality is really quantised because the mathematics work so well in predicting its probabilistic behaviour. Yet, the vacuum has to be attributed some remarkable properties (hints from a derivative theory?) In the new description of reality, fields are derived from the structure and change of the manifold and represent a view.

Specific distortions with their specific size and symmetry locally ”relax” the fabric. A subgroup (the highly symmetric ones) of all possible distortions is represented in our standard model of particle physics [12] [13] as the known fermions and bosons. In the new paradigm we will extend the standard model and search for the form, the internal structure of particles.

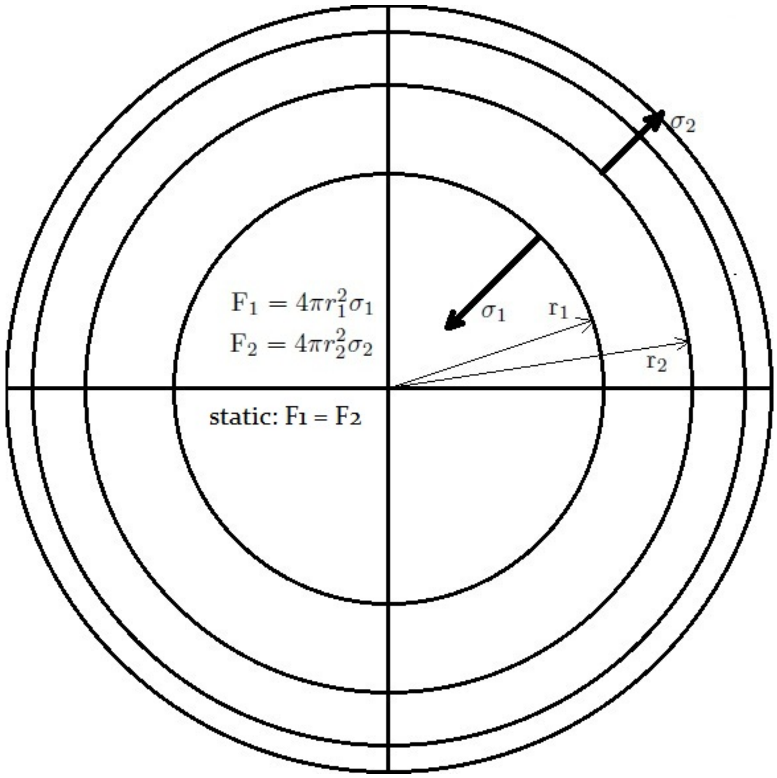

Figure 7: *Stretched space. A large mass pulls space toward the centre of the picture. Further away from the centre the tension gets smaller. In a static situation the volume of space does not move and forces on the inside of the ball-slice of space balance forces on the outside of the slice. If not, the volume of space starts to move and deform. The metric of space depends on how the tension in the fabric stretches space. In case of Hooke's law this dependency is linear (twice the tension means twice the deformation) and that doesn't produce the Schwarzschild metric.*

General relativity is derived from reality when deformed space is considered as many (highly deformed twisted, stretched, compressed, 'high frequency') small scale deformations that, all working together, pull in large scale space deformation, or in more familiar words energy, fermions and bosons, curving empty space. So the machinery behind relativity theory is that energy deforms space because energy is deformed space. Historically curved space was deduced from the equivalence principle by Einstein. The variability of the speed of light needs to be incorporated into the mathematics of general relativity. For situations, where this variability is negligible, nothing really changes but for black hole calculations things will change. This manuscript is calling out to experts to help judge the situation.

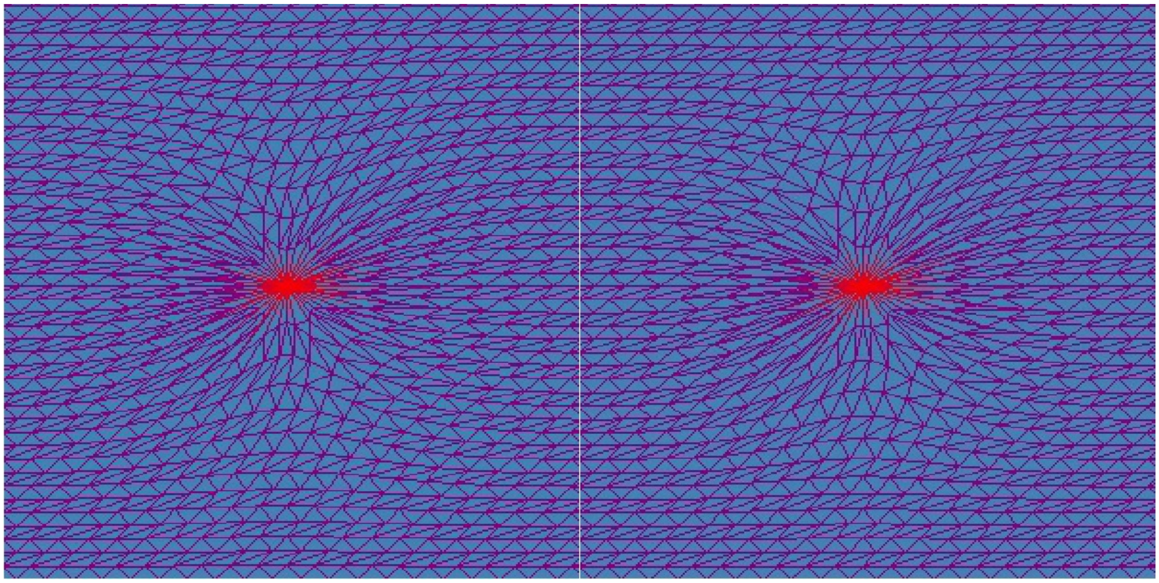

Figure 8: *A numerical sketch of slices out of two different spaces containing the same pseudo black hole. In the left space the elastic resistance of space increases more with deformation than in the right space. Therefore curvature spreads out more in space. Curvature doesn't decrease as fast with increasing distance as $1/r^2$, as it does in case of constant elastic resistance. The more the elastic resistance of space increases as a function of deformation, the slower curvature decreases with distance from the black hole. When you cut the picture in half, lay the halves on top of each other on a computer screen and toggle with a software tool between the spaces the feel for differences becomes quite clear.*

3 Variable speed of light

Is there any basis, any evidence, that supports and suggests this variable elastic resistance property? Yes, it is in the Schwarzschild solution from Einstein's field equations outside a spherically symmetric energy distribution, which has the (space-like) form: $d\sigma^2 = -\left(1-\frac{2M}{r}\right)dt^2 + \frac{dr^2}{1-\frac{2M}{r}} + r^2\left(d\theta^2 + \sin^2\theta d\phi^2\right)$. If you are willing to believe space has elasticity, the behaviour of space displacement as a result of tension cannot be described by Hooke's law because in a static situation space displacement would behave as $1/r^2$ (see also figure 7 on page 9) and it behaves more like $\sqrt{(1-\frac{2M}{r})^{-1}}$ according to general relativity. Both solutions suffer from extreme behaviour near the centre of the energy distribution (with variable elastic resistance, this extreme behaviour near the centre becomes more smooth). Computer simulations (figure 8 on page 10), that numerically simulate this elastic fabric, show that when we assume variable elastic resistance, increasing with displacement, metrics can be produced that shift towards the Schwarzschild solution[2]. The other way around, we can use variable elastic resistance to explain the form of the metric of the Schwarzschild solution for big enough radius. The Schwarzschild solution is a manifestation of a property on the smallest of scales

[2] When the speed of light is not constant (a direct consequence of the conjectures) over space the Schwarzschild solution for the metric only holds locally as an approximation and is not a global solution anymore. So deducing the behaviour of elastic resistance as a function of deformation from the Schwarzschild solution is also an approximation.

that creates behaviour on celestial scales. To my knowledge current physics describes no established relation between the Schwarzschild metric and the properties of the vacuum as a 'quantum foam'.

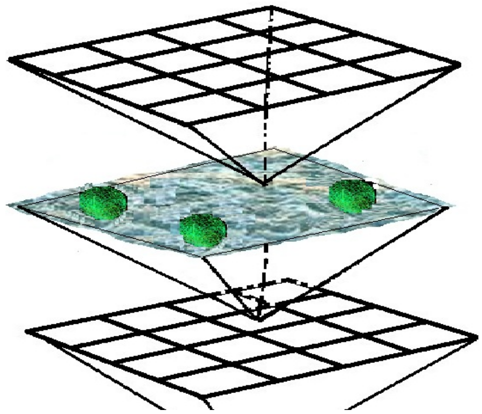

Figure 9: *A sketch to illustrate practically flat space at small and large scales and in between carrier topologies and space waves of relatively chaotic form.*

There are considerable consequences to my conjectures. One would expect these consequences to immediately disqualify the conjectures and do they? Some necessary and possible consequences are discussed and I expect a whole new prosperous field of research in the quest to come to terms with the consequences. The variability of the speed of light is an important and direct consequence of the variable elastic resistance of space. The more space gets stretched, the stiffer it becomes. The stiffer space is, the faster light travels. General relativity considers the speed of light to be a constant so Lorentz invariance has a global character. This changes because now the speed of light will vary from place to place depending on the elastic resistance of deforming space. General relativity loses its absolute global character. Normally on earth and practically anywhere else this variability is negligible. Near much larger denser amounts of energy, when space expands more substantially non uniformly, Lorentz invariance becomes more and more local. In the neighbourhood of a black hole space distorts significantly so the speed of light will differ significantly from the speed of light on earth. In earth-like situations compared to outer 'empty flat' space differences are small and hard to detect and there is something else. Contrary to what one might expect tests for the variability of the speed of light are not trivial for another reason. Experimental tests are hard if not impossible as Christoph Schiller [14] describes: *"Since the speed of light enters into our definition of time and space, it thus enters, even if we do not notice it, into the construction of all rulers, all measurement standards and all measuring instruments. Therefore there is no way to detect whether the value will actually vary. No imaginable experiment could detect a variation of the limit speed, as the limit speed is the basis for all measurements. That is the irony of progress in physics. The observer-invariance of the speed of light is counter-intuitive and astonishing when compared to the observer-dependence of everyday Galilean speeds. But had we taken into account that every speed measurement is whether we like it or not a comparison with the speed of light, we would not have been astonished by the invariance of the speed of light at all."*

Hopefully it may still be possible to measure the variable speed of light. Here is a thought experiment, deduced from a suggestion by Henk van Beijeren from the university of Utrecht. Consider a rapidly pulsat-

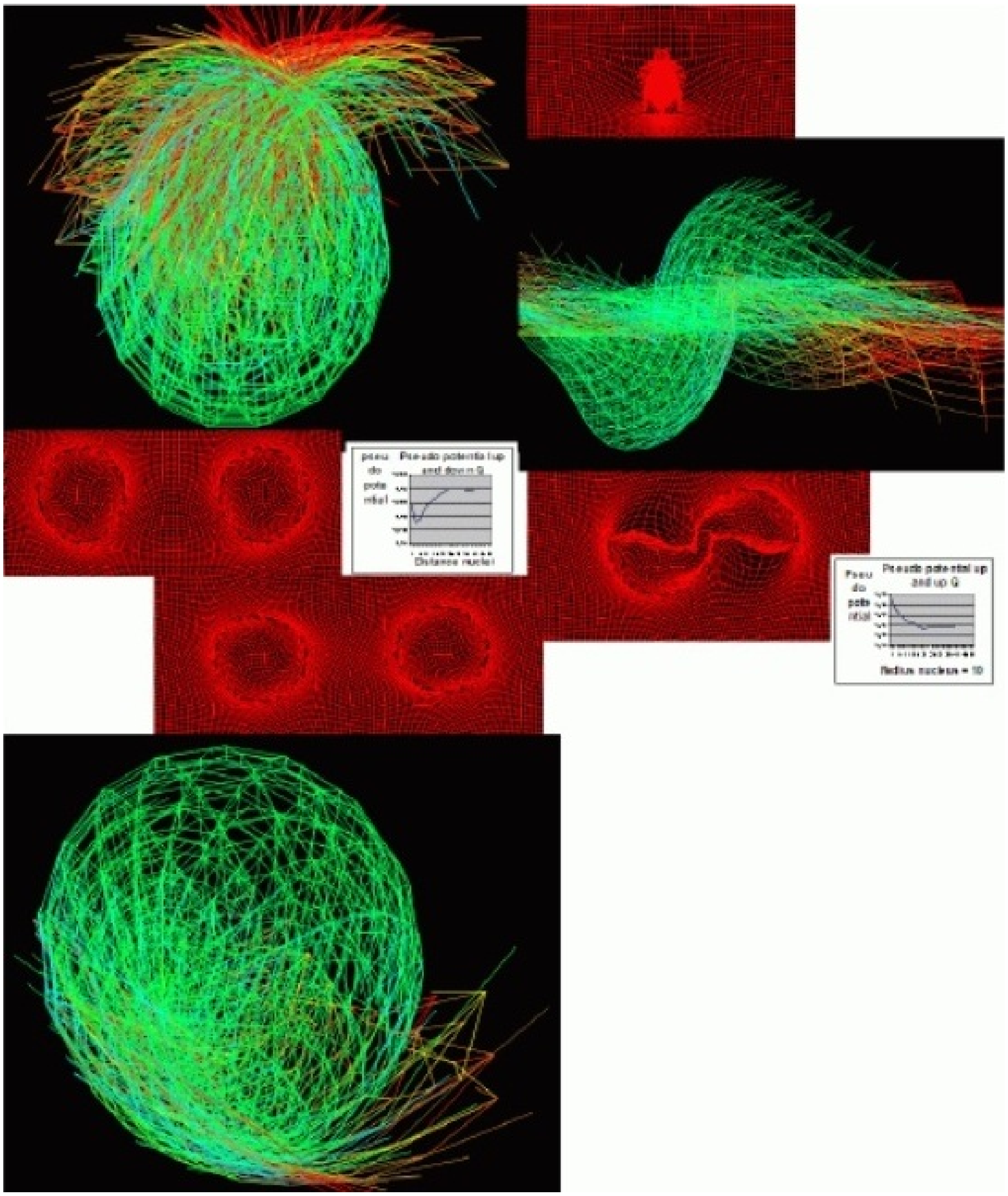

Figure 10: *Carrier topology sketch. Space deforms diffeomorphically using Legendre polynomials. Two experiments are illustrated with in each case two spherically symmetric deformations overlapping each other. The distance of the centres of both 'pseudo-particles' is varied and the total length of the grid is calculated as a measure for potential energy of the global deformation and stretch. The pictures illustrate close-ups of the hart of both 'pseudo-stable' configurations in the situations in which the potential energy is lowest. In the case of the appearing ball the symmetric deformations are mirror-images of each other. In case of the wavy image they are identical.*

ing bright star (Quasar) behind a massive gravitational lens (figure 6 on page 8). The light that travels close to the lens travels faster than the light further away from the lens because closer means more deformed thus stiffer fabric thus faster light. The pulse phase on the fast track therefore shifts relatively to the slow track. The wavelength also temporarily increases in the more stretched fabric. Practically this is a difficult experiment if at all possible. To name a few problems: (i)The light rays do not join up at one point on earth. A number of coupled measuring devices spread over the surface of the earth (a device on the moon perhaps) is needed to be able to measure a shift. (ii) The difference in distance, that both rays travelled to the measuring apparatus, introduces a shift in phase and (iii) there is no telling which pulse from one ray belongs to which pulse from the other ray unless some event marks them. (iv) Yet another complicating factor is that space gets stretched in radial direction and squeezed in tangential direction towards the centre of a spherically symmetric mass (squeeze changes linearly with a change in radius). Thus light travels slower tangentially when closer to the centre of mass. Hopefully someone will come up with more efficient experimental set ups.

Another perhaps more realistic experiment can be done, using two atomic clocks at different heights from the surface of the earth. Prediction is that the highest clock will go faster than the lower clock but just a little slower than predicted by general relativity, because the speed of light is just a little slower at higher altitude (instead of being constant). However, there is no indication of how the elastic resistance of space hehaves over such small distances in such a weak gravitational field. Realistically speaking the difference may very well be unmeasurably small for realistic timelapses and probably other measurement errors, specifically in measuring heights, will destroy any chance of succes.

4 Objections

As part of the effort to refute the proposed conjectures it is obviously necessary to think of as many relevant objections as possible. These objections in turn need to be investigated with scrutiny and may lead to important necessary consequences for the conjectures to survive. Here are some.

The objection. The topology of space may be too simple to provide for fermions. (Ben Bakker, Vrije Universiteit Amsterdam)
The response. A new concept needs a new word. I call the concept a carrier topology. It reflects the idea that, in the simple topology of diffeomorphisms of Euclidean space, structures are needed that mimic other topologies, enabling local energy resonances. Carrier topologies must be able to form in the proposed simple topology. This is a necessary consequence. Locally the tension of space can be relaxed through the formation of carrier topologies that resemble balls, tubes and possibly even toruses and knotted tube formations (see an example in figure 10 on page 12). The topology of these carrier topologies is still simple and the same as the topology of the rest of space. Different topologies would lead to non equivalent symmetries. In the proposed paradigm only one topology exists and no topology change is allowed. In the structure of carrier topologies symmetry and symmetry breaking both play a role. So balls are not perfect balls, tubes are not perfect tubes and toruses are not perfect toruses. They are open along a small surface. Waves of space can resonate in and on the carrier topology. It serves as a cavity resonator. Carrier topologies become the bases for deformations that represent fermions and bosons. It is tempting to assume that balls enable bosons and toruses enable fermions. To enable fermion properties, the alternative (maybe even a better more natural one depending on the ease of formation and stability) is that torus-like resonances exist within the carrier-ball. The topology of space is already sufficient to enable bosons. To produce a basis for fermions one would

expect associated Legendre polynomials and specifically toroidal functions to be helpful mathematical tools. A carrier topology is in a way the analogue of a string [15] or brane. The information, stored in the extra dimensions, is absorbed into the complexity of the resonating form of the cavity resonator. Generalised Laguerre polynomials are among the tools to create 3D spherical oscillations within the carrier topology. Some progress has been made in constructing carrier topology-balls. Using Legendre polynomials to create spherical symmetries, two mirror images have been brought together at different distances in space to shape space. At an optimum distance of the centres of the symmetries, a measure for the total potential energy of the space reaches a minimum, suggesting a stable configuration. No dynamics are involved however so stability can not be shown yet. Showing stable dynamic behaviour will be among the greatest challenges we will face with a possibly huge pay-off.

The objection. Restricted deformability by variability of the elastic resistance of space does not ensure quantisation properties. (Ben Bakker, Vrije Universiteit Amsterdam).
The response. The existence of quantisation is explained as follows. Quantisation is expressed by carrier topologies. The size of carrier topologies results from scaling. Scaling results from the combination of variable elastic resistance and the availability of only a finite, specific amount of energy in the fabric. The existence of a preferred scale in nature suggests that (i) the symmetry in nature cannot be perfect or that (ii) the universe has some boundary of a certain scale that by some mechanism, like a resonating cavity, determines the scaling in its interior or (iii) perhaps some other reason beyond my capabilities. I prefer the first explanation because the mechanism is clear and possibly testable. Todays physics lacks a mechanism for scaling so the scale of things remains implicit in Planck's constant. Variable elastic resistance and resulting restricted deformability provide for symmetry-breaking. The moment flat space contains energy and is curved, different neighbourhoods can have different properties. Too much deformation of a certain volume by a limited amount of energy is counteracted by an increase in the elastic resistance of space. The energy will disperse, will rather be somewhere else and spread out[3]. To make a small circle out of a stiff line takes disproportionately more energy than making a larger circle. The carrier topology therefore needs a certain minimum amount of volume to become stable. Quantisation indirectly results from restricted deformability. Space at the smallest scales is smooth and practically flat as opposed to chaotically fluctuating in quantum physics. More chaotic behaviour exists at larger scales, providing for the possibility of interpreting a chaotic vacuum that supplies vacuum energy from which particles can come into short lived existence constrained by Heisenberg's uncertainty principle (figure 9 on page 11).

The objection. Variable elastic resistance will have consequences for the superposition principle. Dispersion phenomena should be anticipated and why have we not noticed them yet?
The response. This is another opportunity for testing the conjectures. Have we looked for these effects yet? We may already have noticed them. Maybe data already exists that supports or rejects the conjectures. It will probably not be easy to interpret the data in this light. Dispersion through local variations in the elastic resistance may effect structures and may even be a driving force behind the concepts of decay and half-life in nuclear processes. The previously mentioned matter of the uniformity in the background radiation seems supported by this phenomenon of dispersion.

The objection. The fine structure constant $\alpha = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{\hbar c}$ (where e is the elementary charge, $\hbar = h/2\pi$ is

[3] this behaviour of restricted deformability and dispersion will also be instrumental in explaining the uniformity in the background radiation we measure, as an alternative to the theory of inflation, and in the mechanism for a soft frequency cut-off (an ultraviolet limit).

the reduced Planck constant, c is the speed of light in vacuum and ε_0 is the electric constant or permittivity of free space) may not allow for the suggested variation in the speed of light (Henk van Beijeren, Utrecht University).

The response. There are a number of constants in the formula for the fine structure constant. Restricted as we are to earth all data that is not from considerably deformed space will support there constancy. I submit there is reasonable doubt as to the constancy of for instance Planck's constant. The scale of things is a result of the non constancy of the elastic resistance of space that restricts the deformability of space. To apply curvature to space requires more and more power, non linearly growing, for larger curvature and the available energy is limited. Think of it as bending a line into a circle. It gets harder and harder quickly to make the circle smaller when elastic resistance increases with increasing curvature. Planck's constant reflects the scale of things in the universe. The properties of space, figure 10 on page 12 and figure 11 on page 16 give rise to the idea that the carrier topology changes size when it moves from a place in space with lower elastic resistance to a place with higher elastic resistance. The scale of things changes a little and, as such, so would Planck's constant. That does not necessarily mean that the change in the speed of light must cancel the change in Planck's constant. α and ε_0 may not be as constant over space as we have assumed. And there is always the possible influence of our assumption, that the speed of light is constant, on our construction of equipment, our measurements and their interpretation. Other arguments and lines of thought against the objection can still only be out of reach or just out of my reach. I don't think this objection is strong enough to disprove the proposed conjectures at this moment. I do think it is an opportunity to hold our current beliefs against new light in new research and delve into historic experimental data. Although the gravitational constant is not in the formula, now may be the moment to relate it to Planck's constant. The gravitational constant originates from the amount of space necessary to construct local shapes that, with their specific size and symmetry, locally "relax" the fabric. The amount of space, necessary to construct the particle-shapes, gets pulled away from the surrounding space which deforms as a result and this in turn sets the stage for a value for the gravitational constant. As such Planck's constant, reflecting the scale of things, is a building block for the gravitational constant G as G follows from the scale and amplitudes of deformations.

The objection. It is not wise to work on physics from the outside-in and try to establish contact with current physics somewhere along the line. (Jos Engelen, university of Amsterdam)

The response. What is there to be afraid of? No result is a result too and often an important one. It prevents others from taking the same steps and the process may provide inspiring ideas. And there is another concern that supports the idea to take a step outside the environment, trying to oversee the situation. Working from the inside may never get us to where we want to be. We may always be forced to use our behavioural constants, while there may be reasons behind them. It might be so that, to get where we want to go, the situation requires that we first have to let go of lots of what we thought we knew and all at the same time. Trying to connect with ongoing physics, a candidate for connecting would be the physics of causal dynamical triangulations [16]. It uses only 2 constants, the gravitational constant and the cosmological constant. The way to go may be to try to get rid of the constants and introduce specific structural properties such as elasticity and elastic resistance for the simplexes that are used in building the model universes. This step (right or wrong) is fairly straight forward from the outside-in and not trivial at all from within ongoing physics. In fact, from the inside, the suggestion has been made to increase the number of constants if the models were to fail. Another interesting candidate for sharing ideas in the development of shapes of space is the conjectural theory on strands [17]. Two other candidates, both using linear elasticity theory, are (i) the physics developing the Elastodynamics of the Spacetime Continuum (STCED) [9] and (ii) The physics of

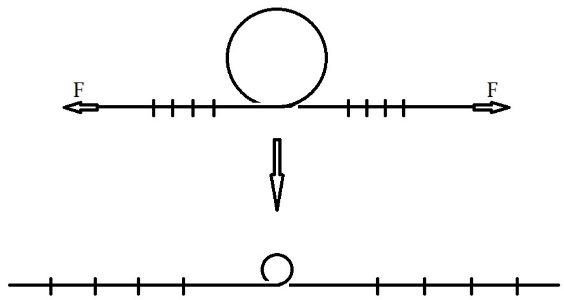

Figure 11: *Redshift by space expansion has three contributions. One is from the expansion of space. One is from an increasing elastic resistance of space (thus increasing the speed of light) and one is from the shrinking of the carrier topology as a resonance cavity. In a younger universe atoms are a bit bigger and send larger wavelength photons. These waves get stretched even more during their travel to earth and the contribution to the redshift introduced by the expansion of space is considered too large if we do not subtract the effects of changing sizes in atoms. Depending on the size of the contributions to the redshift this could mean that accelerated expansion is the wrong conclusion from our data.*

tube dislocations in gravity [18].

5 More consequences

Lots of physics will be touched and should be examined for possible consequences. Some consequences are discussed here.

Necessary consequence. When the speed of light c is variable and space is stretched differently throughout the evolution of the universe we have to revisit our astronomical data. After all wavelength λ and frequency ν are related by $\lambda\nu = c$. We have to discuss our conclusions on red shifts of stars and models for the expansion of the universe. Current physics assumes one reason for redshift by space expansion. The new paradigm introduces yet another reason apart from variable lightspeed. The expansion of space influences the size of carrier topologies (see figure 11 on page 16). Depending on the relative size of the contributions to the redshift this could mean that an accelerated expansion of the universe is the wrong conclusion from the data.

Necessary consequence. The age of the universe as we now calculate it is incorrect. The speed of propagation increases when space is stretched or reasoning back in time everything slows down. Global time is still ticking at a steady pace. A consequence is that the age of the universe as we now calculate it is incorrect. See also table 2 on page 17. Furthermore a big crunch scenario would also be questionable because there will come a time during the collapse at which the existing space deformations will give enough counter pressure, more or less analogous to a collapsing star where the gravitational force is counterbalanced by the internal pressure of the body. A more fluttering while oscillating universe may be a better alternative model for our universe.

Table 2: *This table shows the relations and change for some variables when space expands. The up and down arrows show raising or lowering of the value of the variable with space expanding. The symbols f and g represent functions. All behaviour now depends on the shape of f and g. One would expect g to behave like a square root. Function f has at least one known restriction. It has to approximately produce the Schwartzschild metric , far enough from the event horizon. Basic assumption is that f and g are monotone increasing functions for increasing* $d\sigma$*, the metric of space.* $d\tau$ *is a local time interval.*

Elastic resistance r	$\uparrow$	$f(d\sigma)$
Lightspeed c	$\uparrow$	$g(f(d\sigma))$
Wavelength λ	$\uparrow$	$\int_{\lambda_0} d\sigma$
Frequency ν	$\downarrow$	$\frac{c}{\lambda} = \frac{g(f(d\sigma))}{\int_{\lambda_0} d\sigma}$
Time $d\tau$	$\uparrow$	$\frac{d\sigma}{c} = \frac{d\sigma}{g(f(d\sigma))}$

Necessary consequence. The internal structure of what is known as a black hole behaves more like a resonance cavity. It is not a singularity anymore. The gravitational force is counterbalanced by the internal outward pressure of wildly moving space. This balance introduces, sketches in a way, a soft cavity wall or energy barrier. The internal structure of 'black holes' becomes complicated in the new paradigm because there is no such thing possible in this one single object as energy that collapses into a point. The black hole is more like an absorbing and leaking resonating cavity filled with 'noise' that is probably modulated by resonances in the cavity. It is a chaotically waving highly deformed volume of space where both extreme stretch and compression play a role. The speed of propagation behaves erratically in a black hole.

Possible consequence. Galaxies resemble resonance cavities filled among other things with dark matter. Waves of all kinds of different scales fill the universe and it stands to reason that in the vicinity of galaxies space/energy is pulled in of wavelengths and form that we cannot detect directly yet. Like black holes, on a different scale, the galaxies behave as cavity resonators. One would expect this energy to be distributed in a more or less spherical form around the centre of a galaxy, depending on how the galaxy was formed over time. The excess energy, we are getting familiar with as dark matter, may be of a gravitational wave character, rather than of an elementary particle character.

Possible consequence. Numerical experiments may be able to create and test symmetries on different scales. The standard model has three families of particles that behave similarly and have different mass scales. Once we establish that carrier topologies can exist, then for different volumes new resonating constructions are imaginable, all living in this simple topology. One would expect larger constructions to behave similarly when of the same structure as their smaller relatives. New creational physics, building structures in the computer, may test these kinds of speculations.

Possible consequence. Numerical experiments may support in the search for new particles. Maybe numerical experiments in a new generation of (numerical) particle colliders can be constructed that simulate colliding shapes of space to help in search of creating the right circumstances and colliding the right particles in the real world. Numerical simulations that manipulate elastic spaces can possibly be of help if we can come to control those spaces in the computer. Control over numerical spaces comes in two flavours, (i) designing shapes that take on a life in space or (ii) the evolutionary behaviour of space where shapes or particles emerge from more noisy space movement.

The conjectures and consequences are of a qualitative nature and the step to either quantitative results or refutation will most likely require a considerable effort. It will probably take a multi disciplinary effort in which cosmologists, astronomers, theoretical physicists, mathematicians, computer experts and physics engineers play their parts. Two types of research are proposed. The effort to research the real world is to find testable predictions, to think of ways to test them and build the experiments to produce real results. The effort to research the abstract world has a theoretical and an engineering side. The theoretical effort is to mathematically build geometrical spaces as diffeomorphic copies of reality and to create operators that work on these spaces. There are two types of operators, direct and intermediate operators. A direct operator can derive properties directly from a space such as momentum or location of a local distortion. Think of this as analogous to quantum mechanics where an operator derives momentum from a systems probability distribution. Intermediate operators are an intermediate between the two levels of our paradigm from figure 4 on page 6. They are methods to project these spaces onto other geometrical spaces. An intermediate operator for instance takes a space-form into a probability distribution in a flat 3D space for a specific system. Then our familiar operators from quantum physics take over.

From an engineering point of view numeric spaces have to be built that are digitised copies of parts of our universe. Computer models consist of collections of numbers. These collections represent 3 dimensional space of a particular form with the ability to change elastically. Space changes according to algorithms that represent the properties and behaviour of space. To jump to traditional physics, the computer models represent experiments and are for instance interpreted as particles that collide or as a two slit particle/wave experiment or in principle as any physics experiment possible in the universe. These computer models could be the first of a new generation of numerical particle colliders. All triangulated pictures have been constructed with computer software (build using C♯, .NET, XNA) that strives to become a first generation numerical particle collider. The problem with the current software is that with time passing by the shaping of the fabric cannot be controlled yet. Creating stable moving forms is a challenge. The fabric evolves into interesting shapes. However, there is no control over them and no insight into stable structures. Energy in the form of created shapes falls apart, leaks into space as if evaporating like the waves from a pebble dropping in a pond instead of the created shape moving around. The problem is to shape two successive moments in time so that the next moment in time that is calculated from these two consecutive moments still holds the stable shape and so does the next and so forth in a Markov chain of order 2. It is like shaping a cube of elastic material in the real world. The cube will vibrate uncontrollably unless you can find a way to push it in some special way to make a stable shape that is travelling around. Another future challenge is to find the internal structure of the symmetries in nature (in other words build a standard model with extra inner structure, figure 10 on page 12). How can we shape and control the fabric so symmetries that represent particles can exist and move in a way that is analogous to what we find in the real world? A new field of physics is needed to create this new level of complexity and to create new inner structure of known and maybe unknown objects from our real world.

The digital particle collider can be seen as a collection of points in elastic connection with their neigh-

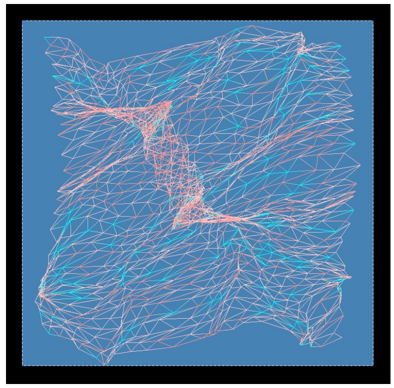

Figure 12: *Uninterpreted its a slice of deformed 3 dimensional fabric of space. Interpreted you can see a stringy wave*

bouring points. The collection is an elastic 3 dimensional entity that can be deformed and that vibrates perfectly elastically guided by its variable elastic resistance. To control and investigate the collection, representing the fabric of space, all kinds of tools have to be built to manipulate and examine the status of the fabric. The space can expand and collapse or behave like a 3-torus or a ball. Think of a 2 slit experiment or a wave that bounces off a wall. In principal any real world experiment comes within reach given enough memory and computing power. Its like trying to create a particle collider within the numerical particle collider. A primary challenge is to create a moving and more or less stable deformation. How can home made symmetries live for a while and go from A to B without dissipating like the waves from a pebble in a pond? Does variable elastic resistance of the fabric create scaling of things and how can fermions be created in this simple topology? Parallel to this creation effort runs the effort that searches for evolutionary ways to find new stable structures in these flexible spaces, just by putting certain shapes of energy in the spaces and letting them go about their business. Will stable resonances with complex inner structure come to being? This evolutionary path will perhaps show us the steps in complexity that have to be taken to come from simple structures to more complex ones that exhibit other topological features and more complex properties.

Possible spin-off, for other fields of research than theoretical physics, is in considering the numeric fabric as a new type of computer. We have to learn how to program and interpret the fabric properly. Problems, defined as some initial form of the fabric, move and evolve into answers. Possibly the fabric (i) can support mathematical calculations or (ii) is of use in string theory when extra dimensions are added (figure 12 on page 19). The numeric fabric may become the analogue of a quantum computer in the real world.

The numeric fabric is a first attempt to mimic reality in the computer on the basis of its basic properties. The model for space consists of an array of points (See figure 13 on page 20). Each point is connected to twelve neighbouring points in the grid. The connection between two points can be described by a spring with constant or variable elastic modulus. When the length of all springs is equal the grid has a Face Centred Cubic structure. Three versions in time of this space-grid are held in memory and are related as in a Markov chain of second order. This basically means that a new space-form at time T_3 is calculated from two older versions at times T_1 and T_2. The next position of a point at time T_3 is depending on its speed at time T_2

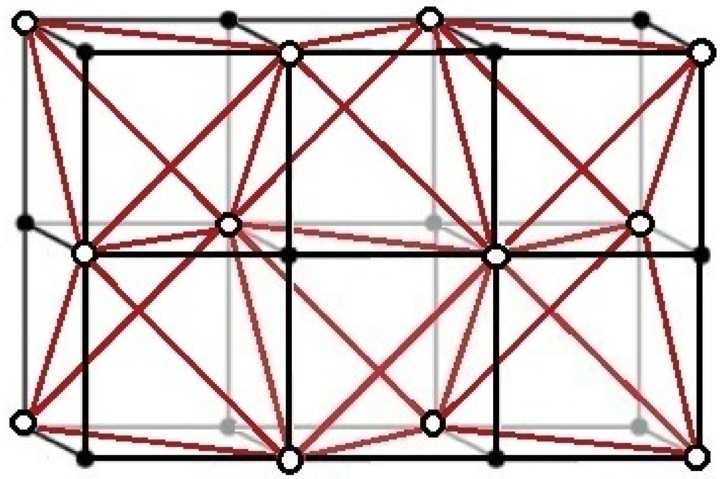

Figure 13: *A face centred cubic structure can be constructed from a cubic structure by leaving all the black points out. The red lines represent springs between neighbouring points. Each point has twelve equal neighbours so twelve red lines should end on a lattice point.*

calculated from positions at times T_1 and T_2 and the positions of the twelve neighbours at T_2. A three dimensional cube with opposite sides identified (in other words a three-torus) represents a stable structure where all points are surrounded by twelve neighbours. Alternative structures are easily realised. Balls for example, constructed from points within a certain radius (points on the surface have less than twelve neighbours), are easily constructed and will oscillate, collapse and expand, under the influence of potential and kinetic energy. Resonance cavities of all sorts of shapes, where all edges are held fixed in space and the interior is elastic space, are other examples. These face centred cubic structures (or structures where points are interacting with 4, 6 or 8 neighbours because these structures all behave pretty much the same dynamically as is to be expected) and Markov chains in the computer are nothing new. New is the way they will be used to model reality where a challenge for these structures is to produce carrier topologies and particle-look-alikes with behaviour that can be explained as bosonic and fermionic behaviour. Physicists will need to learn how to control these elastic numeric fabrics and their computational abilities.

6 Conclusion

Paraphrasing Neil deGrasse Tyson paraphrasing Benjamin Franklin: It seems impossible to predict future benefits from my research but I am sure it is going to be taxed.

In conclusion, given the proposed conjectures in this manuscript, theories such as quantum physics and relativity theory become views on reality. They become derived interpretations. A direct description of reality will only contain (i) the shape and properties of space, (ii) symmetries and symmetry breaking to characterise, group and relate shapes, and (iii) the process flow of deforming space that enables a global concept of time. Local time and Lorentz invariance emerge from the process of locally defining systems as separate from their environment. Among the challenges will be (i) to mathematically equip the manifold with elasticity and variable elastic resistance, (ii) to integrate carrier topologies, tensor and spinor fields into the form of the manifold, (iii) to show that variable elastic resistance is enough to bring scaling into the manifold and (iv) to build stable carrier topologies in a controlled environment.

I ask the physics community to participate in the attempt to prove or refute the proposed conjectures. As long as the conjectures are in the running all kinds of research results can be anticipated from new physics and tools for teaching physics to a new programming language for a new kind of 'quantum'-computer based on a numeric elastic fabric. The computational power of numeric elastic fabrics may for example become of interest in protecting our economic infrastructures. Can we afford not to do the research that may advance a frontier and provide us with the machinery and explanations that make our current theories such a success? Let us do everything within our power to make sure that we are right if we dismiss what could arguably be considered the simplest solution.

nullius in verba. (motto of the Royal Society)

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8 Glossary

Carrier topology: a smooth structure of deformed space that has a simple topology and that has certain stability in time. Such a structure, mimicking the topology of a ball or torus, is the basis upon which particle fields can be integrated (carried if you will).

Elastic resistance: a measure for the tendency of space to resist change under the influence of stress.

Properties of space: (i) a 3 dimensional smooth geometry, diffeomorphic to Euclidean space, (ii) elasticity and (iii) variable elastic resistance. It is just constantly moving continuous smooth space (in classic terms containing potential and kinetic energy) however twisted and turned it may be at some scale.

Space: space is the word specifically reserved for the object in the main conjecture.

Diffeomorphism: a diffeomorphism is an isomorphism of smooth manifolds. It is an invertible function that maps one differentiable manifold to another, such that both the function and its inverse are smooth.

Manifold: a manifold is a topological space that resembles Euclidean space near each point. More precisely, each point of an n-dimensional manifold has a neighbourhood that is homeomorphic to the Euclidean space of dimension n. Although a manifold resembles Euclidean space near each point, globally it may not.

Riemannian manifold: a smooth manifold with a smooth section of the positive-definite quadratic forms on the tangent bundle. (Or from a smooth manifold, equipped with Riemannian metric (smoothly varying choices of inner products on tangent spaces), which allow one to measure geometric quantities such as distances and angles.)

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