Biological heuristics applied to cosmology suggests a condensation nucleus as start of our universe and inflation cosmology replaced by a period of rapid Weiss domain-like crystal growth*

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Abstract

Cosmology often uses intricate formulas and mathematics to derive new theories and concepts. We do something different in this paper: We look at biological processes and derive from these heuristics so that the revised cosmology agrees with astronomical observations but does also agree with standard biological observations. We show that we then have to replace any type of singularity at the start of the universe by a condensation nucleus and that the very early period of the universe usually assumed to be inflation has to be replaced by a period of rapid crystal growth as in Weiss magnetization domains.

Impressively, these minor modifications agree well with astronomical observations including removing the strong inflation perturbations which were never observed in the recent BICEP2 experiments. Furthermore, looking at biological principles suggests that such a new theory with a condensation nucleus at start and a first rapid phase of magnetization-like growth of the ordered, physical laws obeying lattice we live in is in fact the only convincing theory of the early phases of our universe that also is compatible with current observations.

We show in detail in the following that such a process of crystal creation, breaking of new crystal seeds and ultimate evaporation of the present crystal readily leads over several generations to an evolution and selection of better, more stable and more self-organizing crystals. Moreover, this explains the "fine-tuning" question why our universe is fine-tuned to favor life: Our Universe is so self-organizing to have enough offspring and the detailed physics involved is at the same time highly favorable for all self-organizing processes including life.

This biological theory contrasts with current standard inflation cosmologies. The latter do not perform well in explaining any phenomena of sophisticated structure creation or self-organization. As proteins can only thermodynamically fold by increasing the entropy in the solution around them we suggest for cosmology a condensation nucleus for a universe can form only in a "chaotic ocean" of string-soup or quantum foam if the entropy outside of the nucleus rapidly increases. We derive an interaction potential for 1 to n-dimensional strings or quantum-foams and show that they allow only 1D, 2D, 4D or octonion interactions. The latter is the richest structure and agrees to the E8 symmetry fundamental to particle physics and also compatible with the ten dimensional string theory E8 which is part of the M-theory. Interestingly, any other interactions of other dimensionality can be ruled out using Hurwitz compositional theorem. Crystallization explains also extremely well why we have only one macroscopic reality and where the worldlines of alternative trajectories exist: They are in other planes of the crystal and for energy reasons they crystallize mostly at the same time, yielding a beautiful and stable crystal. This explains decoherence and allows to determine the size of Planck´s quantum h (very small as separation of crystal layers by energy is extremely strong).

Ultimate dissolution of real crystals suggests an explanation for dark energy agreeing with estimates for the "big rip". The halo distribution of dark matter favoring galaxy formation is readily explained by a crystal seed starting with unit cells made of normal and dark matter.

That we have only matter and not antimatter can be explained as there may be right handed matter-crystals and left-handed antimatter crystals. Similarly, real crystals are never perfect and we argue that exactly such irregularities allow formation of galaxies, clusters and superclusters. Finally, heuristics from genetics suggest to look for a systems perspective to derive correct vacuum and Higgs Boson energies.

*version 1 was submitted 09.06.2019 to the university library as a letter to Prof. Smolin, Perimeter Institute; this present version 2 for OPUS server as a preprint has title, abstract, polished English and proper formatting added but otherwise the same contents.

Introduction

The abstract summarizes and suggests to the reader that heuristics derived from biology in fact may provide really powerful heuristics where and how to search for fundamental and new solutions in cosmology and fundamental physics.

One has to stress that the six principles in biology are really well established, proven and apply to really broad areas of biology. Thus they are solid ground but unfortunately rarely recognized or applied in cosmology.

However, as most of cosmology is speculation it would be much better to apply such principles which already are proven to agree well with observation and are found in everyday biology and often also in many complex, self-organized or highly structured other systems in physics.

Moreover, in general, in cosmological theories there is no life, no explanation for life, no interest in life, no meaning, no warmth, no wabi-sabi (Japanese philosophy: a touch of imperfectness in perfect pictures creates the real beauty). No wonder that from such a cold, heartless physics picture of the world all real answers on the world are missing including the start of our universe itself. It is high time to consider laws observable in biology, biological principles and in particular the philosophical perspective biology has also in fundamental physics. This should be implemented also in cosmology and also done when looking at the universe as a whole.

The introduction here starts from very simple biological principles. The different results sections elaborate on these to sketch how the results promised in the abstract can be derived (they only sketch this, they do not really show it, otherwise I would be a different person and would have booked my ticket to Stockholm).

The discussion sections correspond in their numbering to the results sections and discuss more in detail which physics, which formulas and which mathematics would be required to deliver the results suggested in the abstract (without being able yet to fully formulate the mathematics). Don´t be disappoint but rather be inspired to form your independent and accurate mathematical theory from our heuristics. If the paper could stimulated this, I am already thankful and pleased.

Biology tells you:
1. Proteins fold (spontaneously in water, the order created increases entropy of the solvent);
2. crystallization happens similarly as a self-organizing process;
3. Nothing makes sense without considering evolution, birth, death and selection (Dobzhansky´s statement);
4. Genetics and phenotype show that “natureness” is nonsense in biology, the lowest level influences easy the highest;
5. Real is only one world, quantum trajectories are happening somewhere else, we only observe a clear genotype.
6. DNA carries information in its structure setting the stage for life and self-organization instead of chaos.

Now I translate these principles into a clear theory of the Universe, using these principles as heuristics to identify the correct cosmology and following exactly these biology arguments 1. to 6.

Results

1. **Proteins fold:** You see here emergence from chaos! However, higher ordered structures usually do not arise from explosions in biology, but rather by well-defined and highly selected order creating processes. A key observation to this end is protein folding. Since many years I study this in simulations (e.g. Sarukhanyan et al. 2018). Instructive are genetic algorithms that explore a very large conformational space by evolution (habilitation topic; Dandekar and Argos, 1996; 1997): In protein folding no miracle happens (as postulated in current big bang theory; inflation is worse, Chen et al., 2019) but rather the entropy increases in the solution outside (proteins that fold usually swim in water with some ions; e.g. König & Dandekar, 2001). This allows to arrive in biology at well-ordered highly structured protein structures. There are more such self-organized processes in biology, but never there arises order from an *explosion*.

   A big bang theory, even if including alternatives to inflation is simply the wrong model from this perspective (Chen et al., 2019).

   Instead I would suggest a process of crystallization from strings or from a spin-foam, but having in principle up to n-dimensional loops. They have to interact and the maximum, stable interaction you have is with a 4D world and this leads at least here, in our world, to all the other ingredients we have in our special physics such as the natural constants regarding velocity of light, elementary charges and Planck´s quantum.

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2. **Crystallization happens spontaneously:** What crystallizes? Well, probably strings or a chaotic spin-foam (loop-quantum gravity is probably the better formalism to tackle this) and when the spin-foam becomes a stable network,

it is crystallized and forms spontaneous order. The entropy in the outside, the total string ocean of chaos increases. However, that harms nobody ("outside" there is no ordered universe or clear space-time but only a "string soup", a chaotic spin-foam). Furthermore, then the crystal grows like magnetic domains or so-called Weiss domains in magnetization (Devizorova et al., 2019). Only when a certain size is formed (exactly the size till which usually the inflation phase end is assumed) the crystal expands normally (as a consequence of general relativity (Lemaitre universe), long shown to be the case).

The inflation scenario is anyway in serious trouble after there were no perturbations visible 2016 in the BICEP/2 experiments (Chen et al., 2019; Ade et al., 2018) and people such as Steinhardt and Turok propose since long time inflation-less scenarios such as two membranes clanging against each other (Khoury et al., 2004).

However, the biologist knows, hand clapping produces no spontaneous order - instead, a well-ordered process such as crystallization does.

This would be a first explanation how one of the biggest questions in cosmology is answered: why is this universe so life-friendly? Well, because self-organization and a fine-tuned crystal happened at the start and like the beautiful microscopic features of a snow flake illustrate, also life and live-friendliness happens when the whole process is something as ordered as crystallization.

In addition, already salt crystals show that you can have two atom types in the crystal, and our universe relies on dark matter (Ouellet et al., 2019) and normal matter. Moreover, a crystal is well-ordered but never perfect and so you have the right small fluctuations as condensation starts for super-clusters, galaxies etc. so difficult to foresee in inflation. Moreover, halo regions are governed by dark matter, simply because the crystal formed like this at its crystallization as a condensation seed. Similarly, growth of Weiss zones or any crystallization process is self-limiting and leads to a macroscopic but not infinite crystal. This is so much more plausible as the decay of an overheated inflaton (Albrecht et al., 2015) that otherwise leads to inflation forever…

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3. **Nothing makes sense without considering evolution** (Konashev, 2019 on Theodor Dobzhansky´s famous statement): The selection of universes over time, first suggested by you in 1996 building on black holes was an inspiration for me when looking what happens at crystals as the basis for our universe (our current domain of universe visible in our observation horizon as well as many other universes):
   First of all, crystals do not exist forever, they decay and are formed anew. Our universe exists since about 14 billion years. It is philosophically difficult to suggest it exists only since a finite time but should exist for ever in future. Moreover, there is dark energy suggesting that something drives out our universe. In my crystal theory this is very clear: proteins decay routinely and are new synthesized in the cell. Now the crystal-universe is in contact with the chaotic string soup /chaotic quantum spin foam "outside" and this interferes constantly with the compact structure of the crystal and ultimately tears it apart – in my theory this is the source of "dark energy" (Huterer and Shafer, 2018). What is more: as the force is "outside" our domain, this force tugs constantly and all around the crystal. Hence, you may have the behavior of a scalar field currently assumed for dark energy but really only shown for the Higgs boson.
   Secondly, you only can start from an energy-rich universe (as we actually did) if these crystals are reborn from time to time. It may be that black-hole like processes are involved as suggested by you already in 1997. However, at the very least, if conditions are favorable choosing a certain way of two strings / quantum-loops to interact, so that they stabilize themselves, attract more strings from the chaotic string soup (or quantum loops from the spin-foam). These form a condensation point of crystallization (a crystallization seed). This can happen from time to time anywhere in the string-soup, replacing the older crystals removed and torn apart by dark energy.
   Third, if you assume such a life-cycle of a universe, then biology tells you that you will have evolution: the dominant species will be particular stable crystals and those which loose on their edges most new and stable condensation seeds. You pioneered this by the idea that a universe with more black holes has more offspring (Smolin, 1997). However, the crystal concept shows intuitively how selection for a large and very stable crystal with lots of offspring is inherent. It leads then to a fine-tuned solution. This explains why our universe is then so special and fine-tuned, favoring lots of self-organizing processes including life, as the crystal and offspring basis for our universe is a high degree of self-organization to give rise to new offspring. Physics theoreticians know so much about the fundamental, all permeating basic concept of time (Smolin, 2013) to understand that this is beyond our everyday concept of "time". What you have in the end is a stable population of high ordered universes such as our one, another population of much less ordered and unstable crystals (maybe with less or more dimensions as in our universe

etc.) and the big ocean of string soup / chaotic spin-foam in which everything making up the crystals (or “universes”) is swimming.

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4. **Genetics and phenotype show that “naturalness” may be false**: There is no „naturalness“ in biology in that sense as physics theoreticians often claim that effects on a high level (e.g. molecules) are not influenced by effects on a low level (e.g. quantae). Gast (2018) presents current thought in physics in this direction. However, this is in biology completely wrong. Human genetics and genetics in general tell you exactly the opposite: Even a point mutation in the genetic code may change the whole phenotype (Mitjans et al., 2017). This explains much better, why favoring that the crystals replicate well by selection does select automatically also on all other levels for fine-tuning including that our planet has something maximally self-organizing such as life. Moreover, Dirac´s approach to correct for infinities was just a work-around to get correct results in quantum experiments. However, the real correction terms would consider ALL levels as we have to do in bioinformatics for disease predictions (Mitjans et al., 2017). Then the reader will see that in the limit the required formula (much beyond my capabilities) will get the vacuum energy right (currently wrong by 20 orders of magnitude too high) and straightens out a number of such similar conundrums (e.g. the hierarchy problem of Higgs boson mass).

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5. **Real is only one world, quantum trajectories are happening somewhere else, we only observe a clear genotype:** So how does then the crystallization really happen, taking the consideration into account that in biology quantum phenomena influence mutations and the observed mutation is then always clear, unique? Well, this means that coherence, the phenomenon that you have quantum states of long-term superposition, a basis for quantum computation, can happen only for short times, very soon decoherence dominates, a clear, well defined “particle-like” universe. This is again fairly well explained by my theory: The crystallization process means that everything becomes “particle-like”, a clear condensed 4D crystal with a very defined trajectory in time and space for all involved particles. This creates

entropy in the outside string soup / spin-foam and requires much more energy than when you crystallize at the same time all alternative trajectories in other world domains as different 4D crystals. In other words, I think that the crystallization process itself makes sure, that in each domain you only have clear, very defined 4D world trajectories for every observer. Long-term decoherent states would turn the crystal into the undefined string soup / chaotic spin foam and so the forces preventing long-term decoherence of the crystal are really strong. We have here only one real world. The other trajectories are possible, but happen in other worlds, parallel to ours, that crystallized probably at the same time from the same seed and are forming other crystal layers within the same crystal. This crystallization decoherence makes sure that in macroscopic observations we have time just as a normal dimension ("time reborn", another great book of Lee Smolin, 2013). "time" denotes here our usual time we can experience, as it is used in general relativity. The multi-world alternatives and the ever more possibilities as entropy increases are only visible for microscopic dimensions and for the small observation regions where coherence and entanglement is possible. This poses also a limit for quantum computers, probably they can only be built up in a modular way, individual units have very small boundaries and become too soon decoherent (Xin et al., 2019). Probably the Bohm guiding fields are correct for our world, our clear crystallized 4D trajectory. However, the quantum wave function of the non- collapsed state extends over all the other, non-observable universes, from which we are generally separated by the very high crystallization energy barrier, separating the different parallel planes of the crystal, each being one "real" universe with a clear state of its trajectory including all particle trajectories it contains. Hence, the alternative possibilities of results of the wave-function exist, we postulate and conjecture, however, they are in other "layers of the crystal" (parallel worlds). The crystal is very solid and a break-down of layers will only happen by extensive use of force (on the order of the formation energy). However, for small actions (smaller then Planck´s quantum h) the crystal is soft and you can sample and reach "next" or even "over-next" crystal layers and for minimalistic time-scales reach really far out. However, as this is only reaching-out and not changing the specific trajectories of your own crystal layer, we think according to this theory, you always stay in a defined future and trajectory.

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6. **DNA carries information in its structure setting the stage for life instead of chaos:** Similarly, the crystal structure from the interacting string field sets the stage for any order in the universe. A process of crystallization in an abstract way (the string or spin-foam interaction field, depending on the formalism of choice, see above and mathematical explanation in appendix) makes sure that we have the same laws everywhere, the same order. This is a problem for the Big bang theory, where just blowing up one quantum state is seen as guarantee to have the same laws everywhere. This is hard to believe and you have then the problem to have quantum fluctuations for large-scale structures arising. You have an even larger problem in Big Bang theory: Very limited information transport from anything before Big Bang. This forces the believe that everything has to stem exclusively from simple principles (completely wrong in my opinion for any biological structure, let alone the whole universe). Such a believe is best shown in the book “A new kind of science” by Steven Wolfram (2002) where a cellular automaton for all and everything does the trick. Instead, crystallization allows to transport much more information, for instance in the condensation nucleus which triggers expansion. In this seed the selection process for more and more self-organizing and life-favoring processes is taking part – replacing the unexplainable inflaton originally proposed by Linde long ago (Rosa and Ventura, 2019; Linde, 2017). Moreover, as also often seen in biology and ok for theoretical physicists, too, membranes may help in universe formation or interacting with it. Most well-known are the two membranes from Steinhard and Turock banging against each other (reviewed in Ijjas et al., 2013). However, in normal crystals, lots of things can make their way into it and influence the formation of the crystal. Similarly, crystal formation can take its natural time and hence, also avoids any information paradox in the first fractions of Big Bang why miraculously everything obeys the same laws, even parts which cannot be reached by light in the short time given. Finally, a structured crystal as the “genetic material” making sure that everywhere the laws of our local domain hold is something solid, proven to work. This is in stark contrast to rather esoteric suggestions from alternative theories of theoretical physics. The crystal unit cells as well as the overall features of the crystal (e.g. the right amount of irregularities and mixture of normal and dark matter explaining its large-scale structure; Dandekar, 1991) direct all processes the same way at any place which is part of the crystal (our domain). This is similar to DNA: Its structure and resulting information content directs all processes of life including your own, from cellular processes to consciousness.

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7. **Translation of these principles into a clear theory of the Universe:** Of course, nearly everything regarding mathematics or validation remains to be done, the general string interaction field / spin-foam interaction field has to be calculated and the crystallization force separating us from parallel worlds. Required is also the correction to Dirac´s formalism as well as the force expected for dark energy and the expected amount of dark matter in crystallization etc. – exactly the reason why I write to you for help and guidance.
   This paper is only biology inspiration, not more but also no less. It is of the same quality as Edgar Alan Poe´s "Eureka" (1848) with his new physics that pre-saged modern science anticipating black holes and the big crunch theory (Smooth and Davidson, 1994). Unfortunately, some of his assumed laws were completely wrong, but he was the first to spot the expansion of the universe, even before Edwin Hubble and Lemaitre by his poetic vision.

   A really speculative and crazy thought at the end:
   What about intelligent life? First of all, similar to enzyme catalysis, intelligence as a higher order process makes sure that something that can happen, happens much easier then without intelligent approaches to it. So if the statement of non-natureness of our universe is true, then also very high-scale processes such as intelligent life affect the lowest scale. In other words, man looks at hydrogen fusion, after the hydrogen bomb comes an artificial sun (Costley, 2019; Kates-Harbeck et al., 2019; Surrey, 2019). Next, there comes an artificial galaxy requiring understanding dark matter and finally a new crystal, the birth of the next universe! As this process happens with intelligent life much faster, our universe favors particularly the coming about of intelligent life on planets such as ours. And as all the parallel alternative trajectory universes very probably also exist in the crystal (as further crystallization layers arising at time of its Weiss domain growth in the spin-foam ocean), it helps the crystal already if at least in one of these parallel universes such intelligent life advances sufficiently to promote crystal formation, which favors again coming about of intelligent life in this new crystal and in most of its trajectory planes ("universes"). In my biology motivated theory, there is no accident that we are there and attempt to form a capable civilization or are even stopped soon by self-caused or other catastrophies: it is just the most speculative consequence of promoting crystal formation by allowing life to advance in at least one trajectory and one world contained in the crystal far enough so that a next crystal may form, helped by this intelligent process (we as mankind may never reach this level, nearly all

alternative trajectories and worlds with intelligent life may fail, however, one success in one of the trajectory universes is enough).

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Results, concluding remarks:

This theory replaces cosmological inflation by a much more plausible scenario of crystallization as observed in nature for minerals and creating order and highly sophisticated, ordered structures by increasing entropy in the water-like environment around as observed in protein folding. General relativity, in particularly having time as a clear time coordinate and a unique trajectory and arrow of time happens only inside the crystal, where particular unique 4D worlds crystallize together (in fundamental “time”; Smolin, 2013), separated by high energy barriers. This results from the energy-releasing crystallization process from just the right n-dimensional and next therefrom selected best 4-dimensional interacting, gravitation-like string fields /spin-loop-network promoting crystal growth from Weiss´ domains (e.g. Duerrschnabel et al., 2017) and making sure that decoherence occurs, with particle-like, defined behavior (“crystallization”). There is no proton decay observable as hint for an integrated field theory (Eichhorn and Wetterich, 2019): the proton as essential building block of our world has to be really stable (more then 10^{53} years) within the crystal. High energy experiments and the chaotic string soup / spin foam around are the realms of quantum theory, particle decay and multiple possibilities in coherent states and general chaos reside here.

A next step after this OPUS preprint to communicate these ideas in context of what is there and some general reflection would be a public article. With more confidence (and actual solid reasoning or mathematical language) a more ambitious paper and/or preprint on the physics archives (e.g. Hawking and Hertog, 2006; Susskind, 2003) may be attempted. The ultimate goal would be a top original paper in *Physical Review Letters* or at least *New Journal of Physics* (not in reach for me on my own).

The appendix only sort of sketches mathematical solutions and formulas required for this.

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Discussion

Sketches about Formalisms with literature pointers

References are above and in the following not always filled in with accurate papers, if self-evident anyway, but this will of course easily be doable in the next iteration step of this theory paper inspired by biology heuristics meeting physics and cosmology. Important are the formulas: Here I sketch in the moment only which formulas I want to show (this can be easily filled in) and where I think we could catch on new mathematics (sometimes a bit of luck, but worthwhile to study). I omit here further details, however, this is the really time-consuming part and it will work so much better with input from strong theoreticians in physics and particular in cosmology and quantum-loop theory (whereas I can only provide bioinformatics and some biophysics). However, I admit, this is the actual work after hammering out the concept and not in reach for me to do but I think that the community of theoretical physics should be gifted enough to achieve this if sufficiently convinced that my basic concept is right. My concept is at the very least an alternative fresh look at our current fundamental physics. Even disproving it may be a helpful next step to achieve here a new, comprehensive view and theory.

What I like a lot in my still rather heuristic suggestion is that we marry general relativity and quantum physics by focusing on how they do well together (in my view there the best approach is loop quantum gravity) but then add condensed matter physics, the high runner of today´s physics, to find the new integrated theory of the cosmos, quantum theory and resulting macroscopic reality (decoherence).
Example for a precedent:
The AdS/CFT correspondence appears also in solid state physics
https://arxiv.org/pdf/1612.07324.pdf (review by Sean A Hartnoll, field theoretician, physicist Andrew Lucas und Subir Sachdev solid state physicist). The huge advantage to have solid state physics involved is that theoretical statements become testable, for instance in crystals (new example: Chen et al., 2018; old example: Chuang et al., 1991)

It is already a nice achievement if the community uses my suggestions just as inspiration to join these three fundamental theories better with each other to get the new unified theory, this is what is in fact missing in my opinion. Hence, we could also turn all of this first outline into a more review-like paper if the mathematics becomes unsurmountable.

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1. Discussion: Proteins fold

Best is Ken A Dill´s seminal work on that matter, it is well documented starting from Christian Anfinsen´s work (noble laureate) that proteins fold by increasing the

entropy in the surrounding water. We can also cite some old papers of mine (Rainer König´s work; König and Dandekar, 2001), just for illustration that crystal formation of course can generate spontaneous order as the entropy outside, in the solvent, increases. I only claim here this happens also with the whole of our universe and its now highly ordered structure (our "domain" with matter, space and time) as outside the entropy in the chaotic string-soup or spin foam increases.

Some of Ken Dill´s seminar formulas (Dill, 1986) encapsulate entropy for the protein and for the surrounding water shell, just to make the statement clear

Generalized string interaction field / quantum spin-loop interaction field
(depending on formalism of choice, always extremely challenging to calculate).
However, as already Carlo Rovelli (2004) points out in his book on quantum gravity and you know as champion of the field, quantum-loop gravity should turn out to be the more natural and better treatable formalism here.

My idea to do find now the proper mathematics for this interaction field is simple:
We start from generalized n-dimensional quantum loops and show that only 4-dimensional quantum spin loops are easy stable and interact well and best.
There my hope is to show that lower dimensions do not yield a stable interaction potential and more dimensions simply do not meet sufficiently often.

Here is a surprising solid mathematical hint I came recently about to proof this:
The electro-weak unification according to the standard-model of Salam and Weinberg follows a U1 x SU2 x SU3 symmetry.
The extension of this to include gravity should be (assumed by many, but not yet really proven) then U1 x SU2 x SU3 x U4 (remember your inspired surfer and physicist Garret Lisi with the „elegant theory of everything".

The largest finite symmetry group is the E8 symmetry group, which contains all these symmetries and hence the general force field unifying all four basic forces U1 x SU2 x SU3 x U4 (and actually also corresponding to the E8 version of the ten dimensional string theory). So, the E8 symmetry seems to be the basic symmetry of our world, of the four forces and of all elementary particles. A good basis and candidate for the "theory of everything" (TOE).

Now in my theory this E8 symmetry group is the crystallization group of my crystal, the basis for our universe. So, something really abstract crystallizes!

However, then the question is rephrased: How do 0 to n-dimensional strings interact? Or, in quantum-spin loop theory, how would 0 to n-dimensional spin-foams be able to interact, is this not far too difficult to calculate and to solve generally?

Well, one solution pointer could be the consideration of hyper-complex numbers, so called octonions (you have real numbers, complex numbers with 2 describing terms, quaternions with four describing terms and octonions with eight describing terms)
With the latter you can of course also describe the E8 symmetry and some people follow this path, a TOE build on octonions (Wolchover, 2019).

However, regarding the generalized string-interaction potential, there is a nice proof that there are only these four types of numbers possible, higher hypercomplex numbers do not exist. This was already proven in 1898 by the "Kompositionssatz" of Adolf Hurwitz and there is a group theoretical proof by Benno Eckmann (1943) (Hurwitz, 1898 and the collected references below, i.e. compositional theorem; briefly, higher hypercomplex numbers would lead to divisions by zero).

So my conjecture would be that if 0 to n-dimensional quantum spin-loops do interact at all (so are not too chaotic to do this), then they can only do this in four ways: exactly as we have real numbers, complex numbers with 2 describing terms, quaternions with four describing terms and octonions with eight describing terms. The most complex are octonions allowing the richest seed structure for a crystal universe. As we are in a rather complex universe it has the richest structure, the octonions and the E8 structure. Higher complexity interaction potentials and resulting elementary cells of spin-loop interactions of n-dimensional spin foams are not possible: such interactions would lead to stability problems (divisions by zero, as proven by the Hurwitz compositional theorem above).

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2. Discussion: crystallization happens spontaneously

To make here the point of growth of a crystal with almost perfect growth but still a typical amount of misplaced holes and surplus bounds we again should cite formulas about crystal growth. In particular the Weiss domain growth during a magnetization process (see e.g. Gertsen physics text book; Meschede, 2015).

The inflation scenario is anyway in serious trouble after there were no perturbations visible 2016 in the BICEP/2 experiments and people such as Steinhard and Turock propose inflation-less scenarios like to membranes clanging against each other (obvious, many papers, e.g. Ijjas et al., 2013; Ade et al., 2018; Chen et al., 2019).

However, the point would be now from the 4D-string interaction field you get the threshold of interactions right to show that only when some of the abstract constants leading to a condensation nucleus are fulfilled, then you get Weiss domain growth. This is challenging, I admit.

Moreover, once you have such a first estimate it will be very interesting to look at this abstract crystal and its symmetry group and basic features: The hope would be that then the natural constants (c for velocity of light, h for Planck´s constant etc.) would come out from the interaction field.

As a first hint to study how this is possible you can set-up your model using exactly these constants of our world, i.e. h, c, G etc. (so called data-driven modelling in bioinformatics) and then check whether then the resulting interactions are favorable for good crystal growth. This is the center of the theory and showing this, you can book your ticket to Stockholm.

Inflaton wrong, crystal seed right: Moreover, one could also compare this first seed formation to the alternative scenario of an "inflaton":
Of course, the crystal seed should be quite tightly packed so that you have with the end of the Weiss domain growth of the spin-loop network of tightly interacting spin-loops a rather hot and compact small universe further rapidly but now linearly expanding, exactly as postulated also for the hypothetical decay of the inflaton.
However, the crystal seed is much more plausible:
There is no point-like start with infinities but rather strings interact tightly and start Weiss domain growth until a condensed crystal seed is created and then the forces of the outside soup are too strong to get an even bigger seed.

Agreement with observation: Actually, since the work of Ashthekar *et al.* (2006) we know that the Big Bang theory is wrong in its starting conditions: The paper shows that strings or quantum spin-loops resist further compactification, they can never be tighter then side by side, even if there is a "big crunch" of a whole universe. This paper actually disproves already the Big Bang singularity to have occurred in our universe.
Similarly, the BICEP/2 experiments (Ade et al., 2018) show that the start of the universe was far too soft to allow for the hypothetical inflaton. I would claim it was just condensation of strings to form a tight crystal seed.
Moreover, the calculations of Ashthekar *et al.* allow you to calculate the string repulsive potential (actually these authors calculated the quantum loop repulsive forces) and this again may give you important hints to calculate the specific attractive potential if they are not too tight compressed but form a tightly interacting crystal seed with E8 symmetry.

You need E8 symmetry to get a crystal seed to start with, but evolution operates on the best growing and most stable seeds, allowing for many different solutions:
It is important to note however (mathematical hint) that this is clearly one step better then directly try to get the natural constants from the octonions or the E8 symmetry as done in numerous efforts including the Lisi (2007) effort on the surprising simple theory of everything:

If the crystal theory is right, additional restrictions apply to favor crystal growth and Weiss domains. This definitely is an important help to figure out why the ratios of nature constants are as observed: different ratios would often deny the formation of a seed (there the constraint is the E8 symmetry, octonion formation; however, all E8-permitting solutions are allowed, these are an awful lot!) but very important is the subsequent growth of the seed in a surrounding quantum-spin-loop foam of "all sorts and chaotic" spin-loops. This growth is replacing inflation in my theory and it needs something like a magnetization of further "neighboring" quantum-loops from the "soup" such as Weiss domain growth in magnetic materials.
Hence, without my new theory on the crystal as start instead of a big bang you would try to get all accurate ratios of forces (e.g. between electromagnetism and strong nuclear force) just "by magic" by looking at the E8 symmetry or the mathematics of octonions. Instead, the crystal needs a seed of tightly interacting quantum-spin-loops to become solid and defined in the chaotic spin foam ocean. Hence, a basic E8 symmetry for the number of forces and symmetries is necessary as according to the Hurwitz theorem, otherwise n-dimensional strings or quantum-spin-loops do not interact. However, for the **subsequent growth of Weiss domains** and the long-term stability of the crystal many different solutions are possible. However, to have maximum offspring and stability of the crystal, it is advantageous to be particularly stable and this leads then as one of the best solutions to the rather fine-tuned ratios of forces and mass, charge and quantum force ratios of the three particle families observed: There are many more solutions possible (so in this theory futile to look for a unique solution from E8 symmetry), but really stable solutions are few, and the ratios we observe are rather fine-tuned and optimized for maximum stability of the crystal, but imply by this (so the theory) also rather stable suns, molecules and galaxies as well as further stabilization by self-organization.
Building on this, this universe allows then also stable macromolecules which are again self-organizing, and can have an evolution themselves for billions of years, leading to life and human consciousness if there is a stable sun nearby a planet Earth.

Regarding Galaxy formation, halo regions and dark matter there is a lot of literature around, the key point here is that there is no galaxy formation without dark matter (Kafle et al., 2014). And of course, again some formulas on this can be given to show this in physical detail. However, the heuristic of crystal formation provides here an interesting suggestion: If the crystal formation is true to nucleate our universe and its basic structure, then the mixture of dark matter and normal matter so critical for galaxy formation does not start at random but there should be some sort of elementary cell and fixed distribution at start for both types of matter, e.g. like in a sodium chloride salt crystal. You actually could test here different such starting models, look at the amount of galaxy formation you get starting from dwarf galaxies and check this aspect of the theory in this way (too low numbers of dwarf galaxies are actually the tricky, unsolved point in simulations such as Volker Springel´s millennium simulation, 2005, and later efforts).
Another point is that (see below) little irregularities in a crystal are natural. Hence large-scale structure formation in the universe is triggered naturally including higher density of mass but also always dark matter in close proximity to build the crystal unit cells from normal and dark matter, whereas for example inflation-scenarios go to

great pains to “explain” why then quantum fluctuations may become sufficiently large to trigger galaxy formation.
Mathematical hint: Of course, everybody will believe this theory much more, if we really can calculate the dimensions of a “unit cell” of this rather abstract crystal with many more fundamental entities contained and show that the dimensions really correspond to the distribution of halo regions dark matter concentrations (or at least form a seed that the distribution can become like observed now after billion years of expansion).

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3. Discussion: Nothing makes sense without considering evolution

This statement was made by famous geneticist Dobzhansky first (see Konashev, 2019) but relies for cosmology on the theory, pioneered by you, that the universe has offspring and can mutate (Smolin, 1997). That evolution really works, there is also selection necessary. Selecting for higher number of black holes (Smolin 1997) may increase probabilities of existence of new world seeds. However, there is no selection or real removal from a shared environment as in biological ecosystems (only collapse of many black holes e.g. into an active galactic nucleus or quasar). However, there is clear selection for crystals if they have not infinite stability: then they decay “after some time” but there is selection then for the more stable ones. Moreover, there is also a clear environment in this perspective, i.e. the chaotic spin-foam or string-soup the crystal is situated in.
Crystals do not exist forever, they decay again. This seems to agree with observation: the increasing expansion force by dark energy shows observational evidence (Huterer and Shafer, 2018) that also for our universe a big rip scenario is possible but, again fitting to my theory, the time horizon is in the distant future, around 70 Billion years (7×10^{10} years). So as suggested above, the crystal is selected to be pretty stable.

A strong achievement would be to show how strong the “tugging” of the chaotic string soup around the crystal would be, trying to take the crystal apart. Moreover, it would inspire confidence to show whether the pull could correspond to the currently estimated scalar field estimates for dark energy.

The end result is a first estimate on the stability of the "crystal universe", according to current estimates, a value around 70 billion years ($7 * 10^{10}$ years) would fit well to dark energy big rip scenarios (Huterer and Shafer, 2018).
I do not know how you feel about such scenarios, but for a biologist it is quite mindless or mind-boggling to come into existence out of the blue and being ripped apart in a not too distant future, whereas the thought, ok, you are part of a crystal and like everything in the world this has a limited life-time and will be created anew somewhere is simply much more comforting and meaningful. And after sometime there is evolution, survival and selection (well actually you shift an abstract equilibrium – i.e. in a more abstract and objective description you have an equilibrium of states shifted towards higher order and fine-tuned universes, no normal "passage of time" happens, there are no clocks and only a chaos soup or spin foam around)

What the formalism next needs, is an estimate how and under which conditions the crystal produces off-spring. Helpful is here to look at real crystals, e.g. salt, there lots of things such as dissociation constants etc. are known, but also the size of optimal condensation nuclei etc. . You can test all this in real experiments!
Moreover, look at the "cosmology in the laboratory" article on crystallization showing that you can test cosmology by lab experiments (Chuang et al., 1991). In this nice but old article the authors use their crystallization experiments only as a model to explore standard cosmology, they actually believe in big bang and mainstream cosmology and want to test this in their work from 1991.

In practice, you need an estimate of how probable a new condensation nucleus comes about and breaks of the crystal. Intuitive and interesting is to compare this process to the original nucleation process from the string soup and how much more probable the interaction start field becomes if there is a condensation nucleus to start with. Again, here is a lot known from real examples, for instance even condensation nuclei to stimulate meteorology cloud formation and rain and this can be compared to without these nuclei and the lower probability of cloud formation including its probability to dissolve (about 90% of the clouds dissolve again without yielding rain; interestingly this currently holds also for gas clouds and galaxy formation). You can thus use mathematical models already in place for cloud formation and rain, galaxy formation and similar condensation processes depend on seed nuclei to start with and compare this with observed values including expansion rate of the universe and large-scale surveys of galaxy formation.
In fact, this aspect makes it nicely possible to check whether additional factors support this theory such as galaxy distributions against standard big bang scenarios.

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4. Discussion: Genetics and phenotype show that "natureness" is nonsense in biology

Well, for the biological statement the OMIM databank should be ample evidence, the databank of "online inheritance in man". Even a point mutation can change the phenotype of an organism. We published two years ago a nice paper on a point mutation in a ncRNA leading to autism only in women (Mitjans et al., 2017). That is another neat example how the lowest level (the nucleotide sequence) affects the phenotype of a rather complex neuropsychiatric trait, autism, and this even exclusively in women, not in men (usually it is the other way round: There are more "Rainmen" as played by Dustin Hofmann around, there are far more autistic man then woman).

To show this in physics is again much tougher: There is Dirac´s seminal work on renormalization and then the next higher level of Weyl inequalities (so we should show there the formulas; Ruzhansky and Suragan, 2017). Now to show that the correction terms become realistic for vacuum energy by including "everything" (i.e. all higher energy levels) and not just the direct interaction plus higher quantum terms looks insurmountable difficult.

However, here my point would be that we have our crystal and already our interaction potential establishing elementary cells and condensation nuclei and Weiss domains. We actually only need to show that by step-wise increasing the size of the (pretty abstract) crystal, the infinities (ultra-red and ultra-violet in technical terms) slowly become less and for a sufficiently large crystal level off.
Thus you would have only to show a positive tendency from the elementary cell to a condensation nucleus (several cells tightly interacting) to a full crystal (orders of magnitudes bigger) that the vacuum energies get right and not by 10^{120} too high as the current state of affairs with the standard model (why currently wrong? Well, quantum electrodynamics and stochastic electrodynamics have to be consistent with Lorentz covariance principle and due to the magnitude of the Planck constant this leads to a rather large value of 10^{113} joules per cubic meter, also called the cosmological constant problem; Duplantier & Rivasseau 2003).
Moreover, comparing these potentials with the chaos of the n-dimensional spin-foam or "chaotic string soup" should give you an additional comparison for your work.

Keep in mind, by this you would have proven one aspect of "non-natureness" in physics (Gast, 2018), that the higher levels are required to get the energies right. This becomes an important hint for the speculation in point 6.

Thus, for the vacuum energy that at least looks not completely hopeless. For individual particle masses it is much more difficult (unless you could derive, see points above, from the crystal properties something as real and concrete as an individual particle mass, for instance regarding the proton, then you can start right away; currently the Higgs Boson gets too low mass, Gast 2018).

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5. Discussion: Real is only one world, quantum trajectories are happening somewhere else, we only observe a clear genotype.

5.1. Here my hope is that Prof. Johanna Erdmenger can help. In particular my surprising claim would be that the formalism describing decoherence of quantum systems (easy to cite, e.g. Bogdanov et al., 2019) has some basic similarity to our crystallization description and formulas.

5.2. An alternative would be, just to believe my suggestion, start from the decoherence formalism (describing how a multiple-particle system becomes decoherent by interacting with the rest – well usually only approximated) and then show and see that the arrow of time, so the increase of state representations in later time points, becomes non-observable, there is only a real, clear particle state observable in the next time point (e.g. after the measurement).

5.3. Bohm´s theory is an important alternative to textbook quantum theory, as a recent paper (Mahler et al., 2016) shows that Bohm´s theory seems in fact to be well compatible with observation. I am aware, there seem also to be quite convincing counter-papers, and it is too difficult to judge for me these counter arguments. However, a third mathematical approach would be to show that the Bohm guiding fields are of course never observed in our crystal universe, as our 4D trajectory of our whole universe is one frozen out possibility, the guiding field (or, in Kopenhagen text book interpretation the wave function) in fact samples over the other facets of the crystal, non-observable for us, separated by high energy barriers (close to the total “melting energy” of our crystal).

5.4. Similarly, one can from our crystal and its stability also derive an estimate for the time a coherent state may exist (because this would correspond to forming a bubble of purely, superposed wave functions, so a “bubble” of quantum foam) and which sizes are still compatible with the crystal and its stability whereas bigger sizes of “chaotic quantum-spin loop foam” would
a) need incredible amounts of energy
b) if they nevertheless occur they would destroy the crystal.
Interestingly, you can by these calculations on the crystal also derive a lower bound: which bubbles do not infer at all and this lower bound should then be an independent way and route of calculation to derive h, the quantum value of the uncertainty principle below which e.g. energy can be arbitrarily high for

corresponding shorter time points as long as the product is smaller than the quite small value for Planck´s quantum of action h (6.6 x 10^{-34} Js). This points in my interpretation of physics to a very stable crystal we live in, otherwise h would be higher (and everything would get more and more fuzzy and wave like)

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6. **Discussion: DNA carries information in its structure setting the stage for life instead of chaos**

Events at the lowest scale affect in biology easy processes at the highest scale, usually and generally. For example, the OMIM databank contains lots of SNP mutations (single nucleotides polymorphisms) that affect the phenotype (highest scale), the full individual, in this case a patient having a hereditary disease. So a mistake in one nucleotide of the fertilized egg translates into literally billions affected cells and an ill patient (may be for his whole life though the mutation took only one short hit of cosmic radiation). if the statement of non-natureness (Gast, 2018) of our universe is true also in physics, then also very high-scale processes such as intelligent life affect the lowest scale:

In other words, man looks at hydrogen fusion, after the hydrogen bomb comes an artificial sun, then an artificial galaxy requiring understanding dark matter and finally a new crystal, the birth of the next universe. As this process happens with intelligent life much better, our universe favors particularly the coming about of intelligent life on planets such as ours. And as all the parallel universes very probably also exist, it helps the crystal already if at least in one of these parallel universes such intelligent life advances sufficiently to promote crystal formation, which favors again coming about of intelligent life in this new universe.

We can show the Schrödinger equation for stability of molecules. However, what we really need is a Schrödinger equation for a whole enzyme (rarely solved). Usually, in molecular dynamics, you only use approximations (e.g. Hartree-Fock, Mahler et al., 2018); there is a host of molecular dynamics papers around (e.g. Zemojtel et al., 2004) and some even elucidate catalysis (Mahler et al., 2018).

The claim that intelligence is only some sort of catalysis is maybe best phrased in words, but of course there are master equations for DNA species around and I even tried in an OPUS preprint to go up level by level higher and higher (enzymes, protein networks, cells, individuals, civilization, up to an universe; Dandekar, 2007, 2008).

However, here the interesting point would be more to show that it is particular energy low for the crystallization of our 4D universe to have this happening with all alternative trajectories co-crystallizing at the same time. This would be no miracle for normal crystals, anything unsymmetrical simply needs much more energy to happen. This is another mathematical exercise suggested for you as definitely I am not able to do it: Comparison of these different crystals and their energies and showing that a

multiple-world trajectories frozen and crystallized at the same time is the most stable state with the lowest energy.

Nevertheless, showing this together with point 3, the offspring production, makes at least the statement plausible: Even if life or even intelligent life has low probability to achieve the technology jump to be able to create a seed for a new crystal, this already pays off, as it is sufficient to have success in one of the parallel worlds to create more crystal offspring, even if all other trajectories fail.

More derivations from the crystal basic properties how they favor creation of dark matter well-spaced for galaxy formation, and the derivation of favorable anthropocentric properties in addition to c and h (point 2) will of course help and round this up.

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7. Discussion: Translate these principles into a clear theory of the Universe:

--Actually, a first step could be a **more review-like paper**, such as done for the landscape universe by Susskind (2003), as nearly all the mathematics has still to be developed and only that will be “the beef” that a physicist will take it reasonable, and we can then give some first hints of this in the review. Moreover, I am deliberately stressing here the biology aspects of evolution and biology principles. However, of course, anybody who includes some type of selection process in his/her theory comes closer to the truth in my opinion (e.g. Carifio et al., 2018).

--Is **my theory economic**? This is a good counter-argument against multiple-world theories, in particular if every possibility exists (the Everett multiple-world scenario), the amount of multiple worlds becomes unreasonable high with every choice happening. Here the crystal theory (depending on its actual mathematical model formulation) can be rather economic:

If you look at a salt crystal (sodium chloride lattice) you see what this means: We have a compact crystal made from the ion lattice. One crystal, clear. However, in the crystal, on the lattice we have a very large number of trajectories on the lattice connections we can travel. Similarly, one may picture the defined macroscopic states of our world as the solid ions making up the lattice and the very large amount of

world trajectories in system states (corresponding here to a time-line for the world and its trajectory in time) as the different trajectories on the lattice you can travel. So the crystal theory is in fact really economic and is not incredible complex like "eternal inflation" or Everett multiple worlds.

--Why can there not sometimes be a pure state? The question asked by Stephen Hawking (and many others) "*why is there something and not nothing*?" is also a bit one-sided in my opinion. The quantum version of the question would be "Why should pure states not be possible, if everything is on average anyway a mixture, a boiling vacuum, a spin-foam?" And the answer would be: Yes, there are also clear states possible ("decoherence") but the scenario is somewhat special, requiring octonions, an E8 symmetry and crystal seed to start with. There are three essentially boring and too simple solutions corresponding to natural numbers, complex numbers and quaternions. Apart from this, you only get unstable quantum states, the boiling quantum spin-foam. And only with E8 the world becomes interesting with four forces and a number of quantum particle families. And a crystal is never perfect ("Wabi-Sabi"; Koren, 1994). Only this allows for galaxies and large scale structure, whereas inflation would blow out any large-scale structures.
--My theory has very high explanatory power: It explains dark energy (crystal dissolves at edges) and dark matter (the counter ion in the crystal) in an easy and intuitive way. It shows that General Relativity holds only within a condensed crystal, whereas quantum uncertainty is limited to small reach-out regions within the crystal (smaller or equal to one Planck quantum, as observed). However, the crystal swims in an ocean of chaotic quantum soup, and here only quantum theory holds.
However, what is much more important, with my concept there is now biology and sense in the universe: Life is important. All scales count. Man is not the result of an almost unbelievable explosion accident, but evolution holds everywhere and selects more and more stable crystal-worlds. Evolution fine-tunes for optimal self-organizing capabilities in the crystal, as this yields more offspring including life on small-scales within the crystal and augmenting order in the chaotic ocean, promoting crystals with best and highest number of offspring (the concept so well pioneered by you).

With more work and concrete results, also real Tables with observations and data become possible, a first sketch would look like:

Table 1: High explanatory value
dark energy, dark matter, …. (a lot, see above)…
calculation of h, vacuum energy calculation correct (and reasonable low results).
Weiss domains
fine-tuning for life well explained

Table 2: Observations supporting

We have too few perturbations at start that inflation could really be right and more problems with inflation and only comparatively weak alternative scenarios (Ijjas et al., 2018)
Galaxy distribution (best explained by not perfect crystal, vaccum fluctuation and inflation do not fit nicely)

Dark matter distribution (now in halo of galaxies and necessary to form them; but how do you get the lattice-like distribution of matter and dark matter in the first place when there are no galaxies but uniform gas after inflation? Answer is there was never inflation but rather a crystal formed with a lattice.

Value of h (see above: It should correspond to the "distance" between different leaves of condensed trajectories, so called worlds with a definite trajectory. So h would be a certain type of lattice constant and if you are below h then the crystal is not solid but "everything goes", no clear separation between states and trajectories)

Vacuum energy (should be correctly come out and not 120 orders of magnitude too big as in current standard model; above is explained how to achieve this)

E8 symmetry is basic (only then strings or quantum spin loops interacts richly in the quantum soup; Hurwitz theorem explains that there are only three simpler interactions but they do not yield a rich and full world with four forces).

E8 string theory (another indication that the idea with Hurwitz compositional theorem describes correctly how a world comes from interactions and can only crystallize in a world with E8 symmetry fitting observed particle distribution)

Mathematical consistency (the really tough part, but critical to be convincing)

Table 3: Testable predictions

-Consequences of a n-D string interaction field

-Drive from tugging at the crystal really explaining dark energy / fitting increased expansion?

-Lots of properties from real crystals

-Lots of properties from life.
In particular, early life and selection for selection for selection….etc.

Figures: Would describe variation of parameter values

Formulas: Will use quantum loop gravity and spin networks; they will, however, also consider terms from solid state physics and links such as the AdS/CFT correspondence.

References (only for this last paragraph; for the others see always end of paragraph)

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