

# To Emerge or Not To Emerge

## Reductive Freedom creates Life, Being and Death

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### Abstract

This article explains *strong emergence* in reductionist terms. Two laws are introduced which predict the structure of reality from general relativity to consciousness. The freedom law predicts (in a reducible way) how and when a new system, ‘life’, or even new ‘matter’, can emerge and where reducibility ends. Here *life* is defined *physically* as a flow-system of finite size that persists in time in its existence (and that provides ever easier access to the imposed currents that flow through it). The law of life, or Bejan's “constructal law”, predicts how this system or life will evolve or die. If it persists then it is either dead in the sense of being ‘bricked’, or it is alive in the sense that it persists in its “design” while being a process. The evolving structure entails and explains Ellis’ Evolving Block Universe. Mostly these “blocks” *have been* ‘alive’ at least *physically*. But there exists much more emergence than these blocks. As an illustration and elaboration these laws are applied to brain and consciousness, and to the unification of quantum mechanics and general relativity – to universal life, and to the life of the universe.

**Keywords:** emergence, freedom, life, consciousness, unification, causality

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·Readers familiar to Bejan’s “constructal law” can read a peer-reviewed paper by me on the same topic; see [1]. That article also contains more and different examples.

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# 1 Introduction to Everything

Many arguments have been given that prove *the existence* of emergence [2–6]. What lacks, I think, is a *causal* explanation of why a natural system or ‘*being*’ *must* emerge and evolve. The most general law predicting the direction in which flow-systems evolve is the “constructal law” discovered by Adrian Bejan [7, 8]. In this law the implicitly defined terms “life” and (in his later works) “freedom” play a prominent role [9]. Both “life” and “freedom” may seem strange terms to use in a physics article, so let me elaborate on these immediately.

## 1.1 Physical Life

In the constructal law Bejan implicitly defines *life* as a *flow-system of finite size that persists **and** evolves in time in its existence*. So “life” can refer to both animate and inanimate existences. A (prototypical) example is a meandering river. At some shape of a river the deposition and the taking away of sand will be such that the river stays in place. So the river *flows freely* but its shape or *design* remains roughly the same. The flow-system is *alive* because it flows *and* because it *persistent*. It can do so because of a given (reducible) *freedom*. A river does not delve energy, so it is not an example of that aspect of life – Armstrong calls such “liquid life” a “dissipative system” [10].

In physics *death* also plays an important role. For instance, new atoms are alive and come into existence in heavy stars. They are rather ‘dead’ or ‘bricked’ at lower temperatures. But not completely dead since chemical reactions are still possible. Our whole existence is or has been alive in this sense. Biological death is less relevant in this respect because what dies biologically generally dissolves, yet its DNA may have passed on to new life. Dissolving after death and being removed from reality is essential for the evolution of ‘sexual’ lifeforms because then, in their offspring, better life-versions will have more room and material to live.

## 1.2 Reductive Freedom

What I call “reductive freedom” is both a cause and a prerequisite of the constructal law. This freedom arises with a limitation of possibilities, and through creating a *persistence* regarding these limited possibilities – i.e. a lowering of entropy. It is also about interconnections – or “complexity” – that turn these possibilities into a ‘*system*’ or ‘*machine*.’ Reductive freedom need not be mechanical, but a mechanical and constructive definition of freedom will immediately show how and when freedom gives ‘birth’ to a new and free being which, by the way, itself need not work mechanical. This I formulate as a universal law which I call “the freedom law.” How and when this being will *stay* alive is predicted by the constructal law, which I will rephrase in ontological terms and then call it “the law of life.” These two laws form the constitution of reality.

My thinking started from a neural network design which I think has consciousness [11, 12]. Consciousness is clearly emergent. The reductive freedom of my and nature's neural designs makes it possible for thoughts, perception, feelings, and qualia to *live in* this neural network and thereby to form a new, conscious *being*. This easy to find *reductive freedom* proved to be fundamental to everything... 45

### 1.3 Terminology, Translation, and Ontology

Engineers think in terms of “systems.” Such systems are defined or distinguished by humans. Yet there also exist “*natural* systems” that arise spontaneously. Such systems I refer to as “beings” or “existences.” So a natural system distinguishes itself by distinguishing itself – through a natural process which I shall describe and explain. Typically natural systems are *flow systems*. I experience “a *being*” (Dutch: “zijn”, German: “Sein”) as something that is flowing or living. I use the term “being” in this sense. But a being is also an entity or a whole. In English I refer to this as “an *existence*” or “*persistence*” (Dutch: “zijnde”, German: “Seiendes”). 50 55

Since existences or persistences both *have* a being and exist or live inside *another* being, I speak of either a *subverse* or *subbeing* in, or a *superverse* or *superbeing* outside of an existence. Earlier I used the terms “*intrabeing*” or “*intraverse*,” and “*extrabeing*” or “*extraverse*”, but “subverse” and “superverse” are more clear and to the point terms. 60

As the mathematician and philosopher René Thom said: “Prédire n'est pas expliquer” (“To predict is not to understand”) [13, 14]. In theories we express *possibilities* or *freedom* (=ontological discourse) as *laws* or *mathematical constructs* (=epistemological discourse). Laws are predictive. But to understand things we have to “get into the skin of things” and be able to empathize with entities of the external world [14, p.126]. Things have to *live* inside us. For that to happen it helps me to formulate things ontologically. Once you realize what physical life and reductive freedom are, the laws about them force themselves upon you. 65 70

## 2 Predicting the Birth of Free Beings

The *freedom law predicts* that

for a new being or natural system to come into existence, i.e., to emerge, it must do so because of reductive freedom. 75

In earlier versions of this article I formulated this as that

a natural system, life, or *being* can only emerge out of reductive freedom.

The freedom law is about the “strongest” *emergence* [15].<sup>1</sup> The Latin “*natura*” denotes the continual birth (or emergence) of what *is* [16, 7’22’], from (relatively) fixed freedoms or possibilities which are equally called the “nature” of something.

When and how a *being* or system *persistent* in its existence, i.e., *stays* alive, is predicted by another law, the *law of life*, which is a rephrasing of Bejan’s constructal law – about which in a moment: [7]

For a finite existence to *persist* (in time), thus to *live*, it must (keep trying to [17])<sup>2</sup> *evolve freely* in such a way that it can handle what it encounters more easily.

This law entails a *definition* of life and a *prediction* of how this will stay alive. The freedom law and the law of life together could be called *the* “natural law.”

Since persistent structures are *stable* they are quite common for the simple reason that they tend to remain. Dead structures may be even more stable. Dead biological beings dissolve, but many others get more or less *bricked*.

## 2.1 Reductive Freedom – How to create Irreducibility

Take a look at Figure 1. With the eye of a reductionist one would think to see that the smallest particles ultimately are causative for the behavior of the whole. Yet I claim that in the end there often arises a structure in which these smallest particles are *subdued*, just like with parts of a *mechanism*. All the gears in a clock start turning when you turn just one of them. *With that, all the atoms and quarks in all those gears are moved*. So the gray particles together can more or less form a mechanism or something otherwise *persistent*, being the pink circle.<sup>3</sup> This mechanism or *persistence* makes its parts or particles *unfree*. They are subdued to the evolving superverse or extraverse (i.e. the ‘new’ mechanism or persistence) that will control and *determine them*, i.e. *top-down causation*. For instance, a micro-controller may provide an XOR-function and through using that any software can control the micro-controller. Likewise an atom provides chemical and mechanical possibilities to its surroundings.<sup>4</sup>

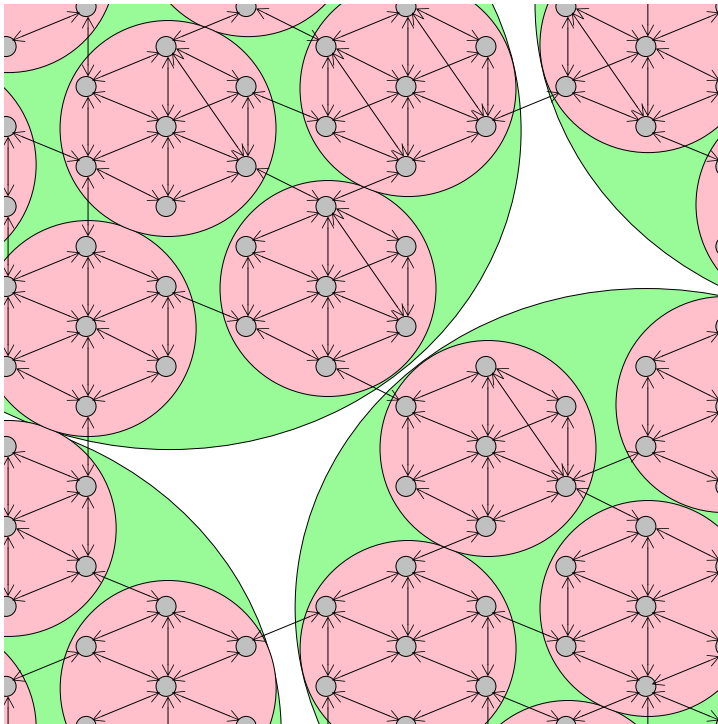
So the parts of the mechanism or persistence can be forced to behave in a certain way, usually involving feedback-loops and sometimes through fixating something. Then the mechanism or persistence and its superverse or extraverse *as a whole* becomes *free of being completely determined by its parts*. This I call *reductive freedom* because hereby reductionism – i.e. bottom-up causation – ends. It ends through the construction of the smaller, lower and more subversal or intraversal particles themselves – thus in a way that a reductionist expects; I will not address other possibilities in this text; for that see [17]. This freedom itself may be reducible, but this reduction will only prove how top-down causation will (partly) determine its state! Ultimately the parts of the

<sup>1</sup>Chalmers thinks strong emergence is rare, but that is absolutely and totally incorrect. See [1] for more examples.

<sup>2</sup>In [17] I propose this little adjustment to the constructal law.

<sup>3</sup>Physicists may recognize this persistence as *gauge invariance* and as not breaking *symmetry*.

<sup>4</sup>Mathematically this is a well defined form of *symmetry breaking*. Mathematically this also creates new and (partly) independent *dimensions*. These can be calculated on independently of the underlying, invariant dimensions.



**Fig. 1** Freedom created by smaller particles (the gray circles) forming ‘mechanisms’ (pink circles) that accept input from outside and that provide output to the outside. Green circles represent a next (super- or extra-)level. (*This is an illustration, not a model!*)

mechanism or persistence are restricted both by the structure or system that they form together (its sub- or intraverse) and the structure that is around it (its super- or extraverse).

Thus, although the pink circle as a mechanism or persistence is largely (but not completely) caused by forces and particles in its subverse, it also constitutes or *emerges as* a new *existence* in its (thereby created) superverse – with probably more complex and more information-rich behavior than its constituting particles. We experience this existence to be a ‘*particle*’ or ‘*matter*’ – or sometimes a *miracle* – *if, as seen from its superverse*, its subverse becomes *unknowable*, i.e., a ‘black box,’ because of near-absolute freedom or otherwise – this is why “subverse” and “superverse” are better terms than “intraverse” and “extraverse.” Together the pink circles often form a new subverse or intraverse for another, higher level being again. It is common to see the gray circles as “*lower*” level and the pink circles as “*higher*” level.

If the reductive freedom of the pink circles would be absolute then in the ‘pink’ superverse (that is in a green circle) the *inside* of the pink circles would be absent, not relevant, and *not causative*. Thus its content is *irreducible*. The pink circle is like a black box that behaves in a (more or less) *given* way. Ellis speaks of this as the “multiple realizability of higher level functions” [6]. This

behavior or ‘givenness’ *is* the created reductive freedom, i.e., its *possibilities*. The extraverse *depends on* reductive freedom but is *not determined by* it – Polanyi uses the same words regarding mind and brain [3]. When, in our mental world, a subverse does ‘break into’ higher levels, i.e., when its reductive freedom is not absolute, we experience that as a quale [18], for example as pain or craving.

Remark that *complexity* is not the key. Consciousness needs complexity because it is a consciousness *of something*. So it must be able to represent the complexity of something in itself. The hypothetical emergence of the universe in the quantum realm, which I will present in a moment, is an example of a, although huge, not so complex system.

In Figure 1 it is as if all gray circles become part of pink circles. This is not realistic. In our world one carbon atom is part of a human being and another is part of a mouse. A sub- or intraverse and a super- or extraverse is *always* a sub-, intra-, super-, and extraverse *of something*. I shall explain how the encompassing circles in Figure 1 are not themselves the extraverses, but the extraverses do *live* in these because of the given freedom. Figure 1 is an illustration, not a model.

To summarize: The state of (reductively) free beings is not (or at least not fully) determined by the parts or ‘particles’ that they consist of, but *by the state of other mechanisms around it*. So we have a *given* (reductive) freedom and a *restricting* context or “boundary condition” [3]. Ellis speaks of “context” too [6]. Thus freedom is not only a limitation in possibilities, in the sense of lowering *entropy* and creating *persistence*, it is also about interconnections – or “complexity” – that turn them into a ‘*machine*’ or *being* with a certain *morphogenesis* and *evolution*.

## 2.2 Relative Freedom

What makes this text somewhat cumbersome to write and read is that less absolute freedom can also create a somewhat independent being. Polanyi speaks of this as that “the control exercised by the boundary conditions of a system can be reduced gradually to a vanishing point,” which leads to a “continuous emergence of irreducible principles within the origin of life” [3, 4].

Any non-linear causality will quickly cause some form of reductive freedom. Ellis speaks of this as “causal slack” which for him has to do with the non-continuity and probabilistic nature of quantum mechanisms [6]. So reductive freedom is abundant and fundamental.

Any decrease in entropy will increase reductive freedom, and conversely any increase in entropy will decrease reductive freedom. If reductive freedom and entropy were measurable quantities then maybe  $\frac{\text{reductive freedom}}{\text{entropy}}$  would be constant.

Without mathematics clear boundaries are more easy to write about. Ellis is a mathematician, yet he proposes the model of the Evolving Block Universe which has clear boundaries between emerging blocks. These blocks and their top-down causality are, of course, evident. As I will explain in Section

3.2 these blocks emerge from partially ‘bricked’ or ‘dead’ physical ‘life.’ Less clear boundaries one finds, for instance, in the content of neural networks and consciousness. 180

Because of non-linearities existing everywhere, life usually implies that the freedom it makes use of is limited or held in check by *feedback loops*. Everywhere in biology [19], our brain [11, 12], electronics, society, our economy and the relation between earth and weather one finds feedback loops. Exceptions only exist in ‘living-dead’ human creations such as software and mechanical constructions, but also in ‘bricked’ natural existences. Furthermore, input into freedom-giving entities often implies *modulating* these feedback loops. Therefore the functions describing them are usually more or less sigmoid. This creates partly recursive freedom easily and abundantly. But I will leave that to mathematicians and biologists – non-mathematicians may want to read Armstrong [10]. 185 190

### 3 Predicting Life and Death of Beings

Reductive freedom usually causes a new *living* being, i.e., a superverse or extraverse, to *emerge*. At a ‘higher’ level this, together with others, again forms a new (sub or intra-)being, i.e., a sub- or intraverse. All these may *die* in a flash. The ones staying alive will do so by following Adrian Bejan’s brilliantly conceived constructal law: 195

“For a finite-size system to persist in time (to live), it must evolve [freely] in such a way that it provides easier access to the imposed currents that flow through it” [7]. 200

In later works Bejan added the term “freely” to this law [9]. I rephrase this as “the law of life.”

*For a finite existence to persist (in time), thus to live, it must [(keep trying to [17])] evolve freely in such a way that it can handle what it encounters more easily,*

This law entails a definition of life and it *predicts* how this life *persists* or, as Schrödinger puts it, how it does “‘keep going’ under similar circumstances” [2]. It also unifies more than 2700 years old philosophical issues regarding what changes and what remains. 205

#### 3.1 Definition of Life – Free Flow and Persistence

Using terms of Bejan 210

“*life*” is defined as a *flow-system of finite size that persists in time in its existence* (and that provides ever easier access to the imposed currents that flow through it) [7].

Bejan’s prototypical example of such life (or being) is a meandering river [9]. At some shape of a river the deposition and the taking away of sand will be such that the river stays in place. So the river *flows freely*, but its shape or *design* remains roughly the same. The flow-system is *alive* because it flows *and* because it *persists*, because of freedom. There may be *evolution*, for example 215

when conditions change, but the system is more persistent than adaptive. Any  
220 too adaptive system *necessarily* will *morph* until being more *persistent*, even  
if it means *death*.

Instead of a “(flow)system,” or even a *natural* system, (i.e., epistemological  
constructs) I prefer to speak (ontologically) of a real “*being*” (Dutch: “Zijn”,  
German: “Sein”) that through a *self-created* and *finite* form becomes an *exis-*  
225 *tence*. (Dutch: “Zijnde”, German: “Seiendes”). The *being* is what is streaming  
and what is continuously changing. But *as an existence* (or “design”) this  
being hardly changes. So my definition is:

*Life is the* (in time) *persisting and freely evolving being of a* (finite) *existence* (that  
can handle what it encounters ever more easily).

230 Here “in time” and “finite” are self-evident. Being alive itself causes its own  
persistence, by definition. And this persistence will be the reductive freedom  
again (!!!) of a ‘higher’ being or superverse.

3.2 Recovering from Death

The aforementioned death need not mean ‘forever dead.’ If death means that  
235 what *was* alive *dissolves* then it is forever dead. If it means that it gets ‘bricked’  
or *fixated* then it may come to life again when conditions change. Think of  
viruses that come to life in biological cells, and of nuclear reactions that are  
only possible when heat and pressure are enormous. Reactions that *can* brick  
ultimately *will* brick – conform Murphy’s law [20] – and that creates the ‘*fixed*’  
240 levels.

| level | ‘Bricked’ Structure      | Intraverse                | Extraverse/‘Bricks’ |
|-------|--------------------------|---------------------------|---------------------|
| 8b    | Ecosystems               | Species Interdependence   | Biomes              |
| 8a    | Populations              | Competition, Food chain   | Ecosystems          |
| 7     | Organisms and Animals    | Physiological functioning | Populations         |
| 6b    | Limbs and Organs         | Organism homeostasis      | Organisms           |
| 6a    | Tissues                  | Growth, Maintenance       | Limbs and Organs    |
| 5b    | Cells                    | Growth, Specialization    | Tissues             |
| 5a    | Organelles               | Cell homeostasis          | Cells               |
| 4c    | Macro Molecules          | Folding, Binding, DNA     | Proteins            |
| 4b    | Building-block Molecules | Combine to Polymers       | RNA/DNA             |
| 4a    | Molecules                | Chemical Binding          | Materials           |
| 3     | Atoms                    | Atomic Binding            | Molecules           |
| 2     | Nucleons and Nuclei      | Nuclear Binding           | Atoms               |
| 1     | Quarks and Electrons     | Fundamental Forces        | Nucleons/Nuclei     |

**Table 1** Hierarchical nature of living and death existences (adapted from Ellis [21])

Bricked existences usually are not completely bricked. Think of atoms and  
DNA. They can still perform chemical reactions. Most blocks of Ellis’ Evolv-  
ing Block Universe model are based on such ‘bricks’ – see Table 1. Regarding  
biological life this ‘brickedness’ in the end is hard-coded in DNA. Our bodies  
245 and possibilities are a kind of dead too. We cannot grow wings if we want to.  
Our bodies are kind of ‘living bricks’ forming a population.

Outside of these blocks there is much more life, but it is difficult to distinguish clear levels here. Try, for instance, to add consciousness into Table 1. Or think of a heap with organic waste. These will certainly evolve emergent structures, but not uniform ones.

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### 3.3 Law of Life

As said the constructal law may also be called “the law of life.” It describes a necessity regarding life. The freedom law *predicts* the *birth* of a superverse, i.e., a new *being*. The law of life predicts *how* and *if* this being will *stay* alive or die. It is debatable what to do with ‘living dead’ variants such as human made software. I think a program as a whole can be seen as a recursive thing but it cannot evolve without us. Regarding biological life DNA changes and evolves by chance and selection in its extra-being. So (evidently) the law of life applies both to a species as a whole and to a subject or an exemplar. Both are persistent and both evolve during *their* existence. The essence is that a biological cell provides *freedom* to the DNA to do its thing and that this DNA can *evolve* phylogenetically in a pool of biologically living beings.

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Regarding biological life it may seem more difficult to see what is ‘software’ and what is ‘hardware’ because they are, so to say, made out of the same material. But reductive freedom is *always* created within a subverse or intraverse. For instance, in a biological organ, such as our hart or liver, its cells are also ‘forced’ to behave ‘as needed,’ and this will influence its growth, form, and so on ‘top-down’; through sporting your muscles, and even your heart, will grow.

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### 3.4 Free Beings ad Infinitum

A new, free being, superverse, or extraverse<sup>5</sup> coming into existence is not something that consists of ‘new’ matter. The essence is that its parts or particle are not *fully* determined by *their* matter, parts, or particles, opposed to what a reductionist expects. It is determined recursively in the (thereby) emerging superverse or extraverse even though it also consists of ‘states’ in its subverse or intraverse. The ‘new,’ *free being* is a construction with *possibilities* that are, more or less, taken care of by its subverse, and the subverses of their subverses, etc., but *only as possibilities* or freedom. So *this* freedom is *designed, created, determined*, or has *arisen* in the subverse, sometimes mechanically and sometimes following the law of life. This may give rise to again new, living beings or superverses, and so on, ad infinitum.

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### 3.5 Absent Subverse or Intraverse

The sub- or intraverse gives freedom, yet from inside its super- or extraverse this seems to be the opposite. It does not ‘feel’ to be free because from within its superverse ‘one’ cannot see how it is free from inference from (lower level) subverses. From within the superverse ‘one’ can only see that ‘one’s’

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<sup>5</sup>In earlier versions of this article I equaled a “new, free being” with “matter,” but now I think this only leads to confusion. Maybe ‘substance’ and ‘superstance’ are good terms?

constituents behave in a certain, thus ‘unfree’ way. But they *behave*, i.e., they are not completely ‘bricked,’ and this behavior is their freedom. If the freedom is absolute then the subverse is not accessible from within the superverse. For example, your thoughts and perceptions live in your brain without having knowledge of brains or neurons. This proves the ontological status of the superverse as a truly *existing* being. Your mind ‘copies’ its surroundings by using its senses, imagination and body. Its content consists subjectively of these thoughts and perceptions, and *not* of neural activation patterns. Schrödinger puts it as follows:

“(i) My body functions as a pure mechanism according to the Laws of Nature. (ii) Yet I know, by incontrovertible direct experience, that I am directing its motions, of which I foresee the effects, that may be fateful and all-important, in which case I feel and take full responsibility for them. The only possible inference from these two facts is, I think, that I [...] am the person, if any, who controls the ‘motion of the atoms’ according to the Laws of Nature,”

from which he also questions whether we are God – not Gods [2, Epilogue]. So if quantum laws permit the leap in time then Schrödinger will have been the first to understand my laws and theory:-)

If I can show the universe to be an superverse too then this is even more proof, since we certainly experience the universe to *exist*.

### 3.6 Part and Whole, Meaning and Content

The ink droplets on this page together form letters. Are these letters the *content of the ink droplets*? Then the form is the content!? In our culture we perceive of content as something that is ‘inside’ a form or such like. Then a page can have content, but ink does not. But regarding emergence this is the other way around. Content creates its form, both subversally and superversally. A superverse can be the determining *content* of its subverses. An emergentist might then say that a superverse “supervenes” on its subverses [4].

The other way round we could call the mass of gray circles in Figure 1 an *exostructure* and then call the gray circles inside a pink circle an *endostructure*. This has nothing to do with emergence, but the distinction does have value when describing “blocks” or “levels” of emergence in as far as they exist. Regarding Ellis’ Evolving Block Structure a “block” is such an exostructure. Its endostructure then consist of the blocks below it, as “fields of possibilities.” This is descriptive, not explanatory. In a truly emergent and free being, exostructure, endostructure, and sub- or intraverse all ‘*disappear*.’ Subverse and superverse always belong to *some existence* and not to a “block” or exostructure as a whole, even if an exostructure in the end encompasses the whole universe. Physicists do not like places where entropy lowers and where things get more unique:-) That is the field of an engineer.

## 4 The Freedom Law

For a new being or natural system to come into existence, i.e., to emerge, it must do so because of reductive freedom.

Put in one sentence and without defining the term “reductive freedom” beforehand, the *freedom law* states that

a new, free (super)-being can only come into *existence* when a being, thereby becoming its subbeing or *subverse*, forms and *determines possibilities*, i.e., (*reductive freedom*), which, and the content or use of which, this subversal being does not *completely determine itself*.

This “not determining” is the reductive freedom, and this usually is or has been an active but persistent *process*.

The freedom-law entails a definition of freedom and a prediction that a being or natural (flow)system *can emerge*, and most often will emerge.<sup>6</sup> The *emerging* being forms (at least partly) its own ‘universe’ with its *own laws and rules*.

This *being* as a whole, thus as an *existence*, is a new *substance* – or a ‘superstance’ – for again higher level superverses. If this being persists then it is *alive* or *dead*, where *life* is defined as the in time *persisting* and *evolving* being of a finite *existence*. This implies that it may (partly) *die* too. Dead existences prove to be very important since they can be very stable and thus persistent, though not evolving. Molecules, atoms, and their subverse, for example, have physically died, but were ones more alive in heavy stars, and at the start of the big bang.

The freedom law predicts when a new being or a new ‘universe’ can arise. When the law of life cannot be applied, then this life will *die*. Because of the (mathematical and logical) necessity, I think these are not only physical, but also *universal laws*.

If this superverse, as ‘new’ life, does not die, or if it dies only partly, or if it gets ‘bricked’ in the right way, then it is and must *necessarily* be (at least partly) a separate, ‘new,’ independent and free being, with its own time and space, *with its own dimensions*, and *with its own possibilities, rules, or laws*, conform Polanyi and conform Anderson [3–5]. Using my laws it is in any concrete example (in principle) completely clear what happens both super- or extraversally and sub- or intraversally, except that we cannot fully understand subverses that form the basis of our universe.

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<sup>6</sup>Sometimes possibilities are not (immediately) ‘used’ and thus only have a ‘potential’ to be used. For *those* possibilities my freedom law does not *immediately* hold. (This said, if not even one of its possibilities is connected to another *being*, then it would *not exist*. This is a somewhat bland argument. If mass and energy could disappear, by becoming as it were ‘imperceptible’ to the universe, then the law of conservation of mass and energy would be broken. But knowledge in our mind often is disconnected and it is a real revelation when they get connected again, e.g. by understanding my natural laws.) Regarding emergence, i.e., as seen from the superverse, we only see *used* possibilities. This said, *potential possibilities* are very interesting, for instance as energy-carriers or energy-users, or as *hope*. Remark further that a new (super)being or superverse may sometimes immediately become a ‘brick,’ without ever having been alive.

## 4.1 Examples – Brains and Software

A metaphor and in part an example is the hardware of a computer, providing possibilities to software running in it, without fully determining it. A computer is *made* to give *to the software*, and only to the software, the *ability* to *determine* what that computer does. This software is, of course, laid down in hardware. In that sense it runs in its subverse. For instance, from the perspective of the software it is not reducible how the computer realizes an XOR-function – or even what a computer looks like. For us, humans, both the computer and the XOR-function are reducible because we stand outside of them and both computer and software are (usually) not alive, i.e., the functions describing its working are (often) not recursive – computers and software are not alive in the sense that they do not evolve naturally.<sup>7</sup>

Biological cells are somewhat like computers. They work by following a software program that is written in DNA. These biological ‘computers’ can even reproduce themselves following such principles.

A more clear, *evolutionary* example is our brain making thinking possible, also without fully determining it. Its content, that is thoughts, perceptions, and (even) qualia, are alive, I claim [12]. Not all neural networks have such living content, but our brain does.

## 4.2 Extraversal Explosion and Enclosure

So the essence for understanding the law of freedom is that a sub- or intraverse creates reductive freedom in the form of new ‘material’ or persistences. These substances then interact with each other and behave in a *determined* way. Thereby they (again) form a new ‘universe,’ which I call a *being* or *natural* system, with *its own possibilities, rules, and laws*. Next, this being may again be part of a subverse of a higher-level superverse, et cetera, i.e., an ‘explosion’ of superservers enclosing their subverses.

Thus ‘counter-reductionistically’ wholes determine parts. This is called “downward” or “top-down causation” [4]. Wholes do this by forcing subversal freedom or possibilities in a certain direction, thus *determining* a subversal ‘state.’ Whether this has other consequences in the subverse is another matter. In our body, for instance, it often does have subversal consequences. Think of stress, enjoyment, and the placebo-effect because of thoughts we have. As Ellis puts it: “Top down causation [...] means having causal power over lower levels, channeling causal effectiveness at those levels” [22].

Entities creating freedom need not work mechanically. They must only be somewhat predictable or repeatable. If there is freedom then the life of a being must at least tend to *start*. So people behaving habitually will create a social structure which has a life of its own. This living social structure will influence the ‘states’ of the people forming it. That may influence the habits

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<sup>7</sup>Yet Bejan correctly sees them as alive because, at a higher level, engineers, society, and reality are part of the development and evolution of computers and software.

of individuals, evolving everything, etc. Corning points out that when free entities differ from each other, forms of *synergy* may arise [23].

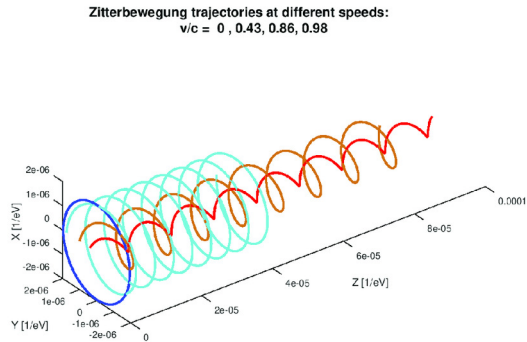
## 5 A Relativistic Universe from Quantum Freedom

My knowledge regarding physics largely comes from Wikipedia and such like. Yet I have a nice theory that applies the freedom law and the law of life to quantum mechanics and general relativity. This works different than in aforementioned examples, so it is an illustration we cannot miss. Let us not call it a theory but scientific fiction, to be improved by physicists. In it the universe that arises from quantum mechanics conforms to the theory of general relativity. Further more, it explains the *rebirths* of the universe through “big bangs.”

The quantum mechanical intraverse provides certain possibilities that are limiting but not completely determining, in other words: they give freedom. These create a living structure, being the universe, and from inside this structure, where we are, things look rather different. I will give a very compact version here, just to illustrate the laws of freedom and life. Whether my fiction is correct or not, any theory can be improved with my idea of freedom and the coming into existence of new beings *because that is the structure of reality*.

### 5.1 Lattice, Mass, Density and Frequency

Imagine the quantum world as a 3-dimensional ‘lattice’ or ‘ball pit’ that can vibrate in a complex way. Therein the motion of what we perceive as matter is the movement of a wave. The lattice consists of elastic spheres or holes that can vibrate and shrink when being a mass, that can be crushed also when not



**Fig. 2** A particle as a rotating wave and having a certain speed; dark blue = zerospeed, red =  $0.98 \times$  speed of light. Both a higher wave-frequency and a non-zero speed of the wave shrink the wave's diameter and thereby raise its quantum density and its ‘worldly’ superversal weight. (Image by Giorgio Vassallo [24].)

being a mass, that can pass their vibration when touching each other, and that stick to each other in some way.

The essence now is this: the *mass* of a (quark- or sub-quark-size) ‘particle’ is determined by *frequency* and *size*. View such a particle as a *rotating* wave, not as a propagating wave [24], i.e., as some quantum thing rotating at the speed of light, whereby its frequency is the number of rotations per second. *Higher* frequencies *shrink* the ‘wave/particle’ in size. A ‘wave/particle’ that is more *heavy* in our world is *smaller* in the quantum world. So quantum-mass is a value that specifies the interrelated mass-frequency, mass-amplitude-or-size and quantum-lattice-density.

At higher speeds the wavelength of a particle becomes shorter too, thus its size shrinks, and in its super- or extraverse (our universe) its weight rises. If a mass would move with the speed of light then its size would become zero; see Figure 2.

‘Normally’ mass-frequencies throughout the quantum universe are in harmony. It takes ‘effort’ to deviate from harmonious frequencies. Only during violent events such as a big bang masses can change.

## 5.2 From Quantum Gravity to Gravity – from Mass to Weight

*How come* a particle with mass ‘also’ has *weight*? What is mass? What is weight? If it would be possible, increasing a particle’s mass would shrink the quantum lattice locally, because more mass means a smaller quantum size. The total bending increases with every mass encountered. The bending and shrinking progresses outside of a mass by deforming cells such that their circumference and, thereby, their mass, remains equal, but their volume shrinks – this explains gravitational waves and double-slit inference patterns of a single particle. I visualize the lattice as being rubber-like. Lattice elements get smaller but also stretched and somewhat cone-shaped toward a mass, thereby ‘*squeezing*’ or ‘*pushing*’ lighter-weight, thus *qua quantum-size* larger masses (including ‘empty’ ‘non’-masses), away, like with a squeeze pouch. Heavier, thus smaller-*size* masses, on the other hand, are being ‘pulled’ or ‘sucked’ in. This ‘squeezing and sucking’ is *quantum ‘gravity’* without gravity, and this we experience as *weight*.

In our universe, thus super- or extraversally, the shrinking of the lattice does not change any distance or size because measurement-sticks and space shrink equally. What we experience is mass having weight (!), a gravity that is a warped version of quantum gravity, and centrifugal force (!). Seen from the quantum sub- or intraverse, higher mass means smaller but more particles per volume unit. Seen from its superverse it means: intrinsically more heavy particles. See how our universe, that arises out of this quantum subverse as a free superverse, can *control* quantum processes *in as far as these give the superverse this freedom*, for instance using gravity and all its consequences.

## 5.3 Gravity Waves, Maximum Density, Black Holes and the Big Bang

Suppose a gravity wave is a temporal, rhythmic *change* or *modulation* of the mass(-frequency) of ‘particles’ or ‘lattice elements,’ which is transferred to neighboring ‘particles.’ The ongoing lowering and raising of mass(-frequency) defines the gravity wave’s *form* and *frequenc(y)ies*. The gravity wave goes with the speed of light from ‘particle’ to ‘particle’ in the lattice, not (much) influenced by the shrinking of it.<sup>8</sup>

Since quantum elements have a smallest possible, Planck length size, there must also be a *maximum particle mass* and thus a *maximum quantum density*. Above this density the quantum-lattice must form a black hole with most mass residing at its *surface*, conform Bekenstein [25]. Thus with relatively little mass inside. The raster elements at the border are the one's smaller in size and are, thereby, more densely packed. In the middle the larger size and more lightweight elements come to reside, and these are also stretched. Most mass is pulled outward and is ‘condensed,’ perhaps by a stiffening lattice that stretches a sphere around the middle of the black hole. Due to relativistic effects the inside of a black hole *as seen from within the superverse* is *relatively* small. The outside superversally is like a hologram, giving reality to the mathematical holographic principle of Van’t Hooft [26][27, 16’25”].

When mass is added to a black hole, then a gravity wave or -pulse sets in, somehow consuming mass ( $E = mc^2$ ), and *lowering* the density *inside* the black hole. When two black holes collide it will be a Big Bang. In a single flash, particle masses lower, their sizes enlarge, and a gravity wave sets in. When the inside of a black hole, such as (!) our universe, expands, the mass of particles inside can rise again, with the particles restructuring themselves and creating new matter. The black hole as a whole does not expand much because maximum mass can never be overridden. Maximum density is found at a sphere at some distance around the center of the black hole. The more heavy a black hole is, the bigger the radius of the sphere is where this density is maximal. Relativistic effects, however, make the border of the *universe* thick again, so superversally its inside will hardly be empty. In time black holes inside and outside the universe will merge again and the whole process will repeat itself – without the universe ever “collapsing.” The universe is *living forever* at a very large time- and space-scale.

## 5.4 Ontology of Quantum Subverses

For the universe to be a free super- or extraverse we have to point out what its freedoms are. Does the universe introduce any *new* freedom? Possibilities in the universe seem only to be changed. Part of the reason for this, I think,

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<sup>8</sup>A gravitational wave may generate an electromagnetic wave when charged particles are ‘shaken.’ The other way around an electromagnetic wave will generate (an unmeasurable small) gravitational wave. I think electromagnetism is a phenomenon in which the motions of electrons distort spacetime locally too. I think that *all* elementary forces, including electromagnetism, are, in the end caused or propagated by deformations of space because I do not believe in telepathy, not even at quantum scale.

is that the quantum subverse shown is not the whole exostructure. Shown is only the (recursive) ‘machine’ that I call a subverse. This subverse contains the freedom-giving parts. About the rest of the quantum mechanical world I know nothing! Maybe this subverse is the complete quantum mechanical world? I have no idea.

More essentially, we have to see our universe as something that *lives in* the quantum world. Through this life, due to gravity, celestial bodies form and orbit around each other, and this then changes the quantum world. So the superverse lives in a subverse that has subdued itself. The reductionist thinks the subverse is determining, yet it (mostly) is the ever differentiating superverse that determines the subverse.

## 5.5 Discussion: Superposition and Reductionism

Maybe what is in “superposition” in the superverse is a *possibility* in the subverse. Think of two entangled particles that, according to current mathematical models, both ‘decide’ on their “spin” when one of them is measured. Maybe these mathematical models are too reductionist? Maybe they can be adapted using the idea of emergence? Top-down causality is evident here, but is this at the time of measurement or at the time of creation of the entanglement?

## 6 Mind and Brain

To understand the ontological status of sub- or intraverses and super- or extraverses let us look at an example of which we understand both its superverse and its subverse somewhat – and which was the reason for me to want to understand all this. Neural activation patterns in our brain represent our thoughts and perception. Here a state of mind is also a state in its neural machinery. The former consists of thoughts and perceptions, the latter consists, to put it simply, of electrical activation patterns of neurons (and their memory, but let’s ignore that). The latter is difficult to interpret, but it is not completely impossible to get to know a brain this way and to map brain-states to states of mind. Brain-states and mind each seem to involve completely different realms. One is described using *states* existing in subversal ‘material,’ being neural activation patterns. The other is described using superversal ‘material,’ being (lower or higher level) thoughts and perceptions. We can understand both our mind and the activity of our brains as seen in a brain-scanner, and we know from experience that both are real and that both exist. Showing the *correlation* between the two is another way to prove the relation between consciousness and neural machines, as I tried in [11], but that is not a *causal* explanation. The existence of reductive freedom and the accompanying freedom law do provide a causal explanation. Now we can see how both brain and mind are part of the same, really existing structure of being, in which neural content is *causative because of* reductive freedom created in the brain’s neural network.

Many mathematical studies regarding neural networks study both the network and its contents, but with implicit reductionist thinking and without

seeing this content as being a new, living and causative realm. They keep calculating on neurons instead of on its content and the content of this content, et cetera.

Our consciousness, I claim, is a hierarchy of beings –qua hardware of about seven layers at least– of which we do not fully know its subverses. Consciously we mostly experience the most superversal being, which is controlled by hardware-based attention. Each subverse is served by, or build ‘on top of,’ other subverses, and so on six times at least. Just *below* the top we have a preconsciousness of which we understand its existence as intuition or as part of our feeling. The other layers we only get to know somewhat through psychological tricks and tests, and through brain injuries.

## 6.1 Consciousness and Subversal Patterns

I hope the reader can imagine now that, if you would want to try to reduce what is happening in a being, ever lower into subverses of subverses, you would see *ever more complex patterns* of (states of) processes. ‘Mechanisms’ or existences are built up out of smaller, *free* ‘mechanisms’ or existences, and they are (at least partly) controlled *top-down* from out of *their* superverses. Since there is reductive freedom ‘between’ each ‘layer of being,’ none of these subversal beings is *fully* causational. To the contrary, the superverses are *made to be* causational and hold on to this while being alive, or by partly being bricked in a ‘lively’ way. Superverses are only less causational if there is (non-free) subversal input into them, such as instincts or attention influencing thought and perception.

A reductionist might complain that each term or input into a superverse can be formulated in subversal terms. Yes, of course. Freedom arises in this subverse –ultimately in Figure 1 the connections are between the gray circles. Yet what a complexity arises out of such thinking! For instance, instead of “I see a squirrel,” I would have to name the state of a trillion neural synapses. But that is not even the point. Even if that would be possible *in principle*, then still the superversal state is free (from reduction) and independent (from what its constituents might ‘want’) *in principle*. Thus *prediction* from out of the subverse, i.e., reduction, is impossible:

Reductive freedom makes prediction from out of a subverse impossible.

Our consciousness, I claim, is a multi-layered, temporal structure of superverses created out of each other, or in other words of subverses created inside each other [12]. Consciousness is also a product of our hardware-based *attention*. The attention-mechanism is hardware-wise connected most superversally, thus in the ‘highest’ neural layer. It selects only five *mental beings* maximally. This is how you experience your consciousness –except when attention dissolves in a near-death experience and such like, which I thus consider to be a prove of my theory. More subversally (thus in ‘lower’ neural layers) ever more complex neural activation patterns arise. These consist of other beings, which

are not ‘fully’ part of your consciousness. But consciousness would not be possible without them – and they may have a ‘(discontinuous) consciousness’ of their own. If parts of your subversal network start to rule, for instance induced by fear, then you will be in a psychosis. Reductive freedom is mandatory for sanity.

Remark that both our consciousness and reality are structures of subverses in subverses. Our consciousness is well adapted to the structure of reality. Language is less so. It is difficult to arrive at a correct, not estranging theory.

## 6.2 Metaverses and Truth

To make this article recursive:-) let us take language and truth as an example. Language runs in us as an exemplar or specimen of a species – much like how a virus may use us. Language speaks (or should speak) *us*, not itself. Language makes the existence or being possible of truth and representation. Truth arises with the possibility of lie and nonsense. It is speaking without lying and without uttering nonsense. Each truth is a set of laws, facts and possibilities. Truths take on a life of their own by being copied, imitated and supplemented. Truths live in us as exemplars of a species, with great variety and with enormous possibilities of mixing and evolution through exchange and testing of truths – if we are not totalitarian [12].

Special of truths, and also of consciousness, is that these are subverses mirroring other things or even other subverses. Thus they are *metaverses*. In a metaverse *copies* – or ‘translations’ – of other things *live*.

## 7 Conclusion – Freedom, Life and Death

We have two laws that together predict the structure of reality and of our being. The freedom law explains *what* a being and freedom *is*, including artificial beings, and how they are born. The constructal law or the law of life explains *how* living existences and their beings *stay alive* from *freedom* of flowing in *any* being. Together these laws explain the *nature* of something.

Reality consists as a hierarchy or tree of beings. There is an abundance of life. Extensive freedom started with biological life. Humans add technical forms of freedom and language to these.

But not all life survives. Often systems have “attractors” or “local minima” that make them get stuck. Thus much life dies immediately. Special about the mammal brain is that it tries to prevent this. Yet because of language and truth humans tend to end up stuck in fixed thoughts, escaping the shame and delight that would arise when transcending one’s view [12]. Without irritation or seduction we have to push each other out of these again and again, conform Lévinas, who was a great inspiration to me [28]. The structure of beings inside beings is fundamentally relativistic. You cannot fully understand any other being from within your own being, whether it is another human being or your own brain, or sublayers within your own brain.

## Statements and Declarations

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