A Brain-like Computer Made of Time Crystal: Could a Metric of Prime Alone Replace a User and Alleviate Programming Forever?

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Abstract Big data or data overflow problem is due to century-old wrong information theory practiced even today that believes every single event that has happened, is happening, and will happen in the universe could be recreated as sum of simple events. We say, events are connected by geometric shapes, e.g., eight points of a cube represent eight events; to integrate events, either one places new geometric shapes inside any of the eight points, or consider entire cube as a single point located in a new giant geometric shape. Brain has no algorithm running, how does it make decision? Making a decision by building a scientific theory means predicting future from a given set of events; here, we propose to do that by using a pattern of all possible choices a given set of events could be grouped. This pattern is like space–time metric of astrophysics. When we convert any event into a 3D topological shape changing with time, those shapes are fed into this pattern of event-groups namely, phase prime metric. The output is another changing shape that links all possible unknown patterns that could happen in future; so, without any algorithm we can analyze big data and run a robot. We reject Turing's machine. For

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frequency fractal computing using time crystal, information is not "bit," but a unique time crystal, which is life-like. These crystals holding geometric shape self-assemble to create a clocking topology of phase. To convert information into a 3D geometric structure it follows our phase prime metric. Phase structure changes continuously, sometimes it is manifested as dynamics of mass, spin foam, string, tube etc. Thus, time crystal based brain-like computer of makes a decision using phase prime metric.

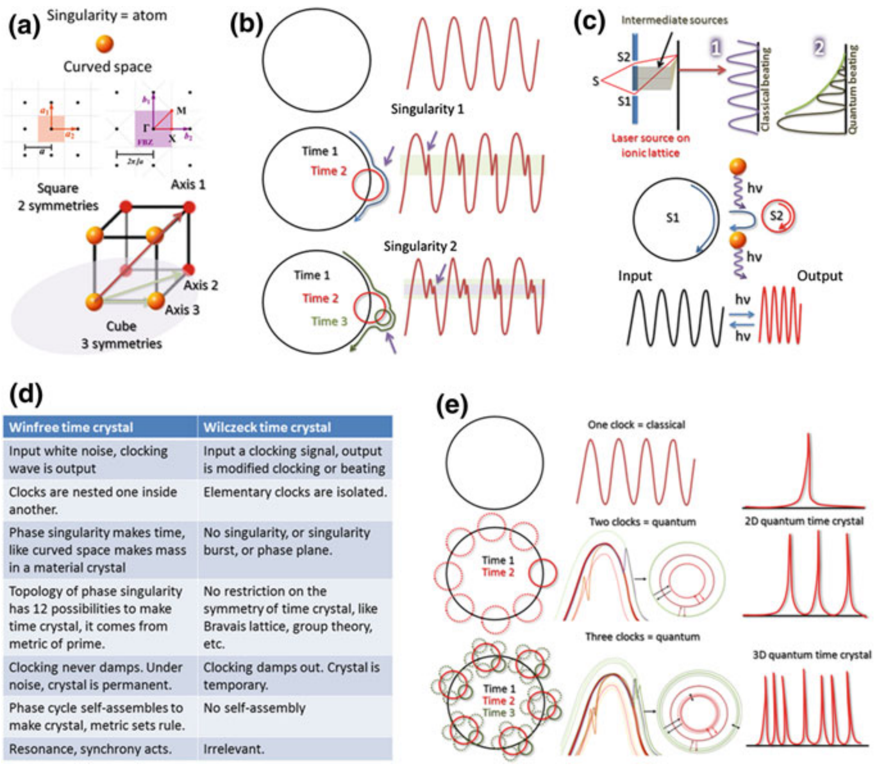
Keywords Singularity · Fractal clock · Time crystal · Bloch sphere
Turing machine · Phase prime metric · Geometric phase · Phase shift
Self-assembly · Quantum computing · Topology · Resonance · Biological clock
Geometric musical language · Fractal information theory · Big data
Artificial Brain · Harmonics · Hilbert space · Hypercomputing
Fractal · Fourth circuit element · Artificial intelligence · Morphogenesis

1 Introduction

Historical perspective: Spatial non-linearity is easy to detect, and it is a curved path. However, a temporal non-linearity is tuning the velocity of light and or maximum velocity governing the clocks in a system faster and slower, without physically moving an object from a single point [93]. Measuring and estimating a nonlinear time are crucial, but, historically, the research on the experimental detection of topology of a nonlinear time flow is scarce. Using such nonlinear time, one can speed up computing [23, 51, 63, 106]. Closed time-like loop proposes a nonlinear time that came in the 1930s [25, 111, 114], but lost in history, because a true quantum clock cannot run in a fixed direction and maintain a fixed diameter like a classical clock [1]. In contrast, the smallest time of a fractal clock has a clock inside, so a piece of time remains undefined, and we get singularity everywhere [77, 107]. Singularity is undefined, not useful at all, so does a fractal clock. One idea to use a fractal clock (clock inside a clock inside a clock…) was to run many self-similar (fractal) tapes side by side like a tree [60, 96]. Recently, we proposed a complement to this concept, placing Turing tapes in every single cell of a Turing tape [6, 52]. Until recently, fractal clock devices did not exist in reality, because, even, how to physically plot discrete "time" slices into a single structure was not known. Here we propose that Winfree's concept of "time crystal" [116] could be used [108] to build a structure of phase, where discrete "time" slices could exist. We have discovered such a 3D phase structure in the resonant vibrations of proteins [103–105] and also mimicked that in the fractal superstructures of a synthesized organic "time crystal" material [12]. The singularity that Feynman eschewed in his renormalization (Feynman 1948) [33] is an essential part of this 3D phase structure. We started from Bloch sphere and modified it to construct our experimentally derived 3D phase structure since it would clearly show the difference between classical, quantum and fractal information theories. In quantum, Bloch spheres hold no geometric shapes. Here in FIT, singularity points are corners of geometric shapes. To self-assemble clocking Bloch spheres that hold new geometric shapes, a corner or singularity point splits (fractal information theory, FIT), [6, 5]. This split enables one dimensionless point to hold another geometric shape inside. This constitutive physical process is analogous to inserting a Turing tape inside every single cell of a Turing tape.

However, simply finding the fundamental information as 3D phase structure is not enough. We need to find how to naturally self-assemble these modified clocking Bloch spheres. By analyzing experimentally derived 3D phase structure of proteins, neurons, brain, organic molecular machine, supramolecule, electronic clocks and circuits, we found a way to morph the natural events using a phase prime metric [42, 62, 100, 117]. ***A phase prime metric is a plot (C-n) of the number of ways (say C) n number of nodes of a standing wave could combine. Every point C in this plot represents all possible ways n random events could have happened together; each point C also represents a single event***. This metric is physically realized by tuning the topology of capacitive elements in an insulator and thus editing its geometric phase [73, 81, 82, 94, 95]. Then, instead of a user, the phase prime metric governs the decision-making without an algorithm. For any given random set of events (event = clocking Bloch sphere holding a geometric shape as described above), phase prime metric integrates topologies of these Bloch spheres; as n ∞, elementary geometries combine as discrete points to make bigger geometric shapes drawn in a cycle or clock. A geometric musical language (GML) is recently introduced [6] to track the morphing of topology by the phase prime metric. Note that 3D phase structure is a new type of "time crystal" that we propose to integrate all information as topology in a single-phase structure.

What is a time crystal (movement without energy! no)? From any given point in a spatial crystal, by moving toward any direction, one would get different kinds of arrangement of atoms. Figure 1a shows that by rotating 360°, one should find at least two distinct spatial symmetries. One cannot imagine a space in a set of time intervals, as one cannot state a "direction." If the phase oscillates one full swing 360°, it is equivalent to the concept of all directions in a spatial crystal. On the circular 360° path, if at least once, the cycle hosts another small loop that shifts the rate of phase change, then one gets two time symmetries (Fig. 1b). A system point moving along the phase cycle perimeter would experience two different rates of time flow [58, 91]. The large phase cycle which constitutes a "time" is called the host time cycle, and on its path the local phase cycle is called guest time cycle. This guest–host phase assembly is called a time crystal [116]. Phase shift is fundamental to both space and time, and it is abundant in nature [38]. Therefore, information structure, if it is a 3D phase sphere, could represent all existing physical parameters comprehensively.



Winfree time crystal	Wilczeck time crystal
Input white noise, clocking wave is output	Input a clocking signal, output is modified clocking or beating
Clocks are nested one inside another.	Elementary clocks are isolated.
Phase singularity makes time, like curved space makes mass in a material crystal	No singularity, or singularity burst, or phase plane.
Topology of phase singularity has 12 possibilities to make time crystal, it comes from metric of prime.	No restriction on the symmetry of time crystal, like Bravais lattice, group theory, etc.
Clocking never damps. Under noise, crystal is permanent.	Clocking damps out. Crystal is temporary.
Phase cycle self-assembles to make crystal, metric sets rule.	No self-assembly
Resonance, synchrony acts.	Irrelevant.

Fig. 1 **a** Spatial crystal. Square has two axes where mass distribution is different. Cube has three such axes. **b** Classical time crystal formation by Winfree. Input is white noise. Top row shows a clock and its output. Sinusoidal output wave deforms, as one new clock adds (middle row). Bottom row shows third clock added. **c** Wilczeck time crystal. S1 and S2 are coherent sources (input is LASER light). quantum beating is tagged as time crystal. **d** Difference between Winfree and Wilczeck time crystals. **e** Quantum version of panel a. Three rows have an additional column of Fourier transform of output (intensity vs. frequency). Nested clock resides all over the perimeter at a time. So, superposed clocks are dotted

Frank Wilczeck's version of time crystal contradicts Winfree's version: Frank Wilczeck revived the lost time crystal of 1977 in 2012 [108]. There is no guest–host phase cycle in Frank's version, i.e., the guest's singularity is absent. The follow-up works have surprisingly rejected the concept of singularity. An external energy input signal oscillates the diameter of a given time cycle by beating as shown in Fig. 1c. After a while, the original cycle returns [44, 119, 121]. This is like the orbital transition of an electron in a molecule. Such evidences neither support classical nor quantum time crystals. Temporal oscillation of diameter of a phase cycle is found in multiple systems. Periodicity in quantum ground state alone is not enough evidence to justify a time crystal. Therein, two different time symmetries do not coexist. If we detect one, citing uncertainty, it violates the basic definition of a time crystal. Both time symmetries should coexist, with or without entanglement [37]; the uncertainty that we need in quantum would be in the phase path. Now, change in phase path is not much investigated in the history of quantum; it requires understanding of topology when one fuses multiple Hilbert spaces. Frank's version therefore has not two, but one phase cycle; it contradicts the definition of a crystal. Frank Wilczeck's proposal is also tagged "impossible" [26]. See Fig. 1d for comparison between our version of time crystal and Wilczeck's version. Our time crystal is an advanced from that developed in the Winfree era, we bypass the current sensation of time crystal, suspecting that it needs serious corrections on singularity. Figures 1b, e show the possible outputs of a Winfree class time crystal.

What is a singularity? A singularity is a gap in the phase space, where the phase structure of a typical biomaterial is undefined. At these conditions, a system resonantly vibrates, emits or absorbs signal of a particular frequency. Singularity points are corners of geometric shapes in the phase structure. A system point passes through the corners one by one, which we depict as the running of a clock, signals burst.

2 Here Are Twelve Properties of a Time Crystal that Advances the Winfree's Original Concept

(1) Clocks in a neural system self-assemble [7] to modulate time. For this purpose, a need for three clocks is observed in some biosystems [20]. One needs to add at least three interlaced phase cycles to make a time crystal that sustains at least one time symmetry breaking while interacting with its environment. The central clock or phase cycle remains protected by the other two terminal clocks serving as input and output interface with the environment. The slowest clock acts as a host phase cycle. It runs the system point of its guest central phase cycle, which acts as a host to its guest, the fastest clock. The central cycle regulates the two rates of time flows, in its guest–host system (Fig. 1b for classical, 1e for quantum). The central clock interacts with its host and or guest phase cycles without interacting with the environment. (2) In a network of three clocks, if stopping any one of the three guests or host phase cycle stops the other one, then it is a quantum time crystal. If the rest two clocks stop simultaneously, then it is not a time crystal at all; it is like day-to-day watch. Therefore, quantum time crystals claimed thus far would require major revisits. The central clock (phase cycle = clock) [91] survives even if the environment edits the two boundary clocks [97], i.e., slower and the faster ones. In such a three-layered clock, a time crystal turns naturally fault tolerant, i.e., breaking of time symmetry is uninterrupted. If the entanglement breaks, quantum time crystal converts to a classical time crystal (Fig. 1c). (3) We generalize Winfree's concept of singularity. The number of singularity points on the primary phase cycle of a host is the number of guest clocks [8]. It is the number of different time flows experienced by a system point as it moves 360°. Each clock can have its own system point and

can grow its own phase cycle structure or time crystal inside by making a new guest–host system. It can connect with neighboring time crystals or phase cycles as guests of a larger phase cycles. This is self-assembly of time crystals side by side [60, 96] or one inside another [52]. See Fig. 2a. (4) The relative locations of the system points estimate the initial phase differences among different clocks. It significantly changes the output measurement of the time crystal. To re-assemble the disintegrated parts of a time crystal, reviving the initial phase difference between clocks is essential. Such phase reset is abundant in biology [21, 27]; thus, biological systems have a memory to remember the phase gaps of various clocks. (5) When a time crystal has only two clocks, a 2D plane is sufficient to represent. If there are three clocks, then 2D phase cycles orient as a 3D sphere. Since three singularity points ensure holding a triangular geometric shape, this is a clocking Bloch sphere (Fig. 2b). The time crystal becomes information storage and processing device (Fig. 2c). (6) A spatial crystal appears different, from different directions. Its response remains the same as it is determined by the lattice symmetry. For a time crystal, different rotational directions of a system point on the phase cycle measure

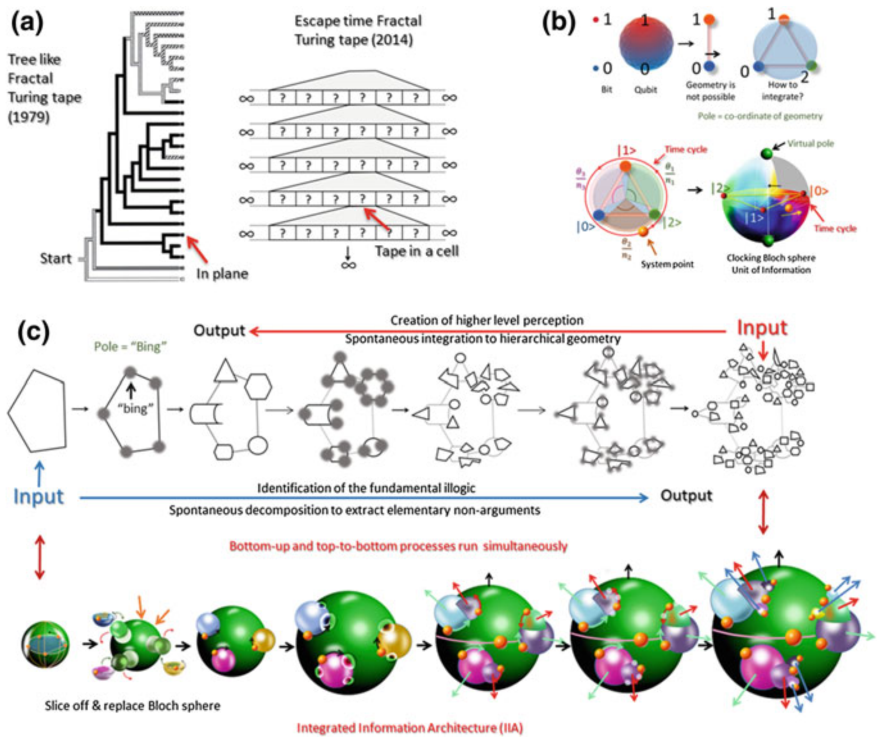


Fig. 2 **a** Two types of fractal wiring of Turing tapes. **b** A transition from bit to qubit (top left) to clocking Bloch sphere holding a geometric shape (bottom right). **c** Top row shows decomposition of a pentagon. Corner points are singularities. Each point holds a geometric shape inside. The bottom row shows the corresponding time crystals

different responses. It depends on three parameters: first, the relative phase difference between the clocks, second, the relative location of the clocks, and third, the relative diameter of the clocks. Follow vectors in Fig. 2c to see three situations. (7) The repetitive patterns of densely connected phase cycles are denoted as a "mass" in a 3D phase structure, when observers' time crystal cannot resolve the distinct clocks in the 3D phase architecture depicted as time crystal. Then, the relative perimeters of the longest phase cycles of the observer and that of the object or event being measured is "space." Thus, a "clock" made of a path whose points are phase values, the path wires discrete events, using an assembly of clocks one gets a circuit representation of mass, space and time [92, 97]. (8) The structure of a time crystal is determined by the topology of oscillators. Instead of breaking symmetry of a spatial lattice structure that generates the resonance frequencies, we need to study the spontaneous breaking of time symmetry. All singularity points may remain intact that is no change would be observed the resonance frequency band, yet, it is possible that time crystal is changing its symmetry. The relative phase path between frequencies is changing. To make a crystal, one has to fit many phase cycles inside a bigger phase cycle; such a nesting of phase is meticulously designed in biology [22]. (9) As described above, the singularity points residing on a phase cycle represent a geometric shape. A small perturbation to a system by applying a noise of selective frequency range reveals the singularity points, just like a noise reveals fermi level [74]. Perturbation creates a ripple of phase shifts [75]. The relative rotations of the phase cycles are restricted by the topological constraints. The topology of phase response curve reveals the variables and the constraints (Kawato and Tsuzuki 1978). The desired 1D, 2D and a 3D time crystal structures form [53, 55, 57]. The formation could be linked to the pattern of primes (Fig. 3a–i). (10) A time crystal is an artwork of singularity points connected by phase; not a single point in it is real. There is no time, space or mass; it is a network of phase [58]. Phase shift is the only event in the information processing, caused either by changing input frequency [39] or by intensity of light pulse [40]. Time crystal represents any information as topology and every topology or geometric shape is a single point or corner point in its higher topology. (11) The appearance of time crystal depends on three parameters: first, the observer's phase detection resolution, second, the relative phase between the observer and the time crystal, and third, the orientation of the observer. (12) The time crystal dynamics strictly depends on the topology of singularity. Neither classical nor quantum mechanics addresses the issue of singularity, so we have proposed a new fractal mechanics that makes a journey into the singularity [6]. Note that a waveform is represented by a system point moving on a circle (Fig. 1a). Using elementary math, we can calculate the number of ways to arrange a given number of waveforms or nodes of a standing wave. Just like there is Bravais lattice, strictly allowed lattice points for spatial symmetry; similarly, for time symmetry breaking, a pattern composition of choices of waveform restricts and regulates the transformation. In a classically static resonance band, one could measure quantum fluctuation of phase paths. In a random fluctuation of phase path of quantum, one could find topology of phase structure following fractal mechanics.

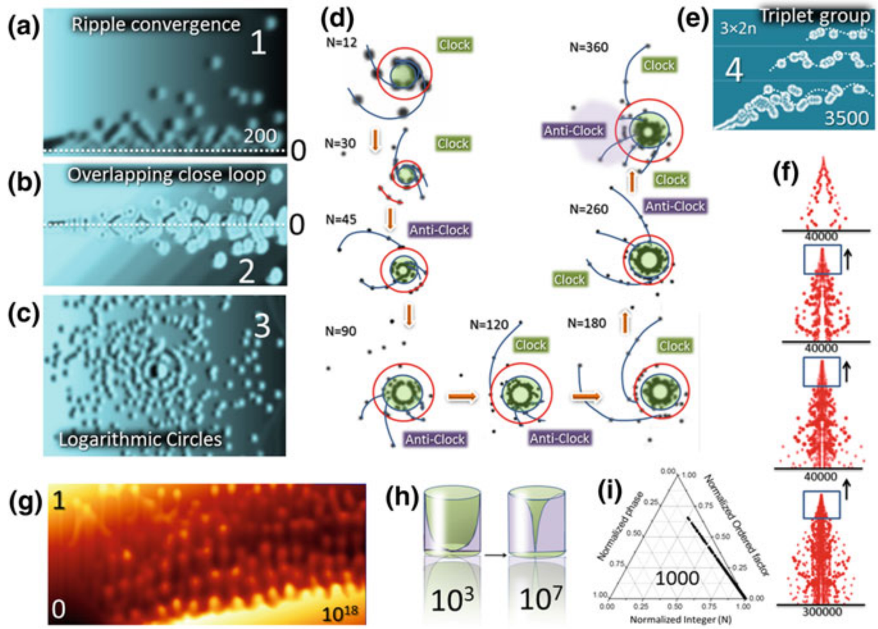


Fig. 3 Twelve phase prime metrics. Vertical axis always represents ordered factor or OF of a number *N*. **a** First metric, $N = 200$, one damping ripple of ordered factor is shown. Several such ripples form and damp as *N* increases. **b** Second metric, OF/2 versus *N* plot shows vertical parallel lines along with connecting shapes. **c** Third metric, polar plot of OF, for $N = 10^9$, period $N = 360$. New cycle begins at 361 and then again at 721, etc. Here, all OF points are connected by line. We get a gap. These gaps make circles. **d** Fourth, fifth and sixth metrics are derived for $N < 360$. For a given *N*, (<360), $1 - N$ numbers are multiplied to reach 360 and thus complete a polar loop. Radius of circle is OF. Then, we see three events to unfold. (1) Alternate creation of 3 clockwise and 3 anticlockwise spirals. (2) At a time only a few spirals are active, the rest sinks inside a circle. (3) A pair of active incomplete circles regulate the formation of spirals. This circle is the activity zone of the metric. **e** Seventh metric. If only those *N* which are products of 3 and 2 are plotted, we find OF-N metric which shows layers of nearly constant distinct oscillating lines. It is the sign of triplet groups governing the metric. **f** Eighth and ninth metrics. If only those *N*, whose OF > *N* are plotted, we find a unique pair of metric. The first one is a central core with a unique pattern. The second one is a triplet. **g** When convergent ripples of primes are plotted similar to panel a, we get a new network of waveform. This is tenth metric. **h** The slopes of OF with *N* increase to 90°, as *N* increases to 10^7. This is two imaginary transformation of discrete OF points into a 3D prolate shape. **i** The triangular plot of *N*, their phase and OF makes a linear line, suggesting that phase is quantized in phase prime metric

Ten biological relevances to a Winfree time crystal obtained via experimental studies of biomaterials: Winfree detected spontaneous emergence of singularity in a biological clock [2, 3]. An automated creation of a guest clock in the phase perimeter of a host clock prompted him to connect the emergence of life with the formation of a time crystal. A time crystal holds two or more distinct rates of time flow in an orderly fashion. It means the system can hold and execute an event.

(1) **The "signal burst or bing" is not important; silence or phase between the "bings" is important**: Detecting a time crystal has a clear route. Find if the resonance frequencies of a material remain the same. Then, check if the phase associated with each resonance peak changes with time. It means the materials dielectric property that regulates the resonance remains unchanged. The geometric parameter of the material edits the phase to run the clocks. For microtubule, it is length [103, 104]. By varying it, one finds a change in the intensity and phase of the peaks, but not the resonance frequency values [56]. ***The ratios of phases for the resonance frequencies determine the geometric shape stored in a microtubule. Similarly, one can determine the geometric information stored in the particular conformations of protein's and their complexes (see Fig. 4a)***. Currently, we are working on inventing a time

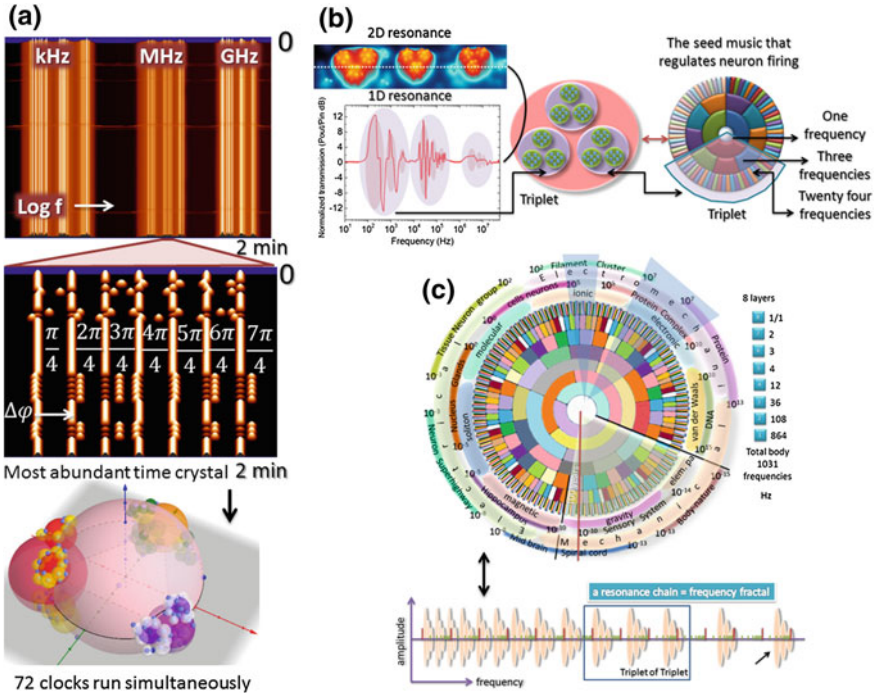


Fig. 4 **a** Top, resonance frequencies of a microtubule plotted in the Log scale continuously recorded for 2 min. Neighboring microtubules are continuously pumped with white noise. No change in resonance frequency is observed. During same time, phase difference between 8 peaks in the MHz domain shows significant shifts with the wireless energy transfer. Using these data, its equivalent time crystal made of 72 clocks is created in the bottom layer. **b** 1D resonance band of a hippocampal rat neuron, measured using coaxial atom probe. 1D resonance means electric field applied in one direction. 2D resonance means electric field applied in two perpendicular directions. Using a line, it is shown that 1D resonance is a single line in the 2D plot. To the right, triplet of triplet of octave made of 72 frequencies is shown using 2D resonance domain and nested frequency data. **c** Triplet of triplet made of 72 frequencies are shown for 12 bands. If one moves one inside another, it finds 12 bands; it is like a resonance chain where only three bands are visible. One has to go 12 times one inside another to access entire resonance chain

crystal pen that will read the 3D information structure as time crystal directly from nature.

(2) **Nesting of clocks was missing in the concept of time crystal**: The existence of time crystals was verified in the elementary life forms, for decades, experimentally. However, the nesting of clocks was never proposed or investigated. Winfree's idea of a singular singularity had to be generalized and we do that. A time crystal of a virus vibrates as a single clock. Inside, each plane of lattice oscillates in period; those are clocks inside clocks. Inside a plane, each group of atoms vibrates like a clock. The crystal acts like a clock inside a clock inside a clock [107]. The network has several layers within as the clocks are also clocked [45]. Such fractal clocking in the biomaterials is a recent discovery [52, 56]. In Fig. 4a, we are showing the resonance band of microtubule. Figure 4b shows that the phase is flipping spontaneously. In Fig. 4c, we demonstrate the corresponding time crystal. However, fractal clocking was reported in the ion channels long back [83].

(3) **Ten geometric resonance properties of biomaterials**: Recently, the resonance frequencies and their associated phases of various biomaterials were measured (Fig. 4a, b) [56, 103–105]. It shows that the emergence of frequencies is not random. They follow unique geometric relationship between them. Here are some features. (a) Various carriers interfere to resonate with the biomaterial cavities. Thus, make their distinct band of resonance frequencies. The experiments show that the distribution of frequencies is grouped as a triplet of triplet as shown in Fig. 4a. It means apparently there are three bands, but if one looks within one band, it finds three more sub-bands (Fig. 4a, top, notice the kHz, MHz and GHz bands). (b) Each region of all nine sub-bands contains one to eight peaks inside; this makes biomaterials E1 to E8 class systems. Biomaterials increases layered sub-bands, but no instance is reported to have more than eight peaks at the lowest level. (c) Figure 4b (bottom) shows the time crystal of a triplet of triplet band; it has 72 clocks embedded in the phase spheres. The diameters of the experimentally measured Bloch spheres remain the same. Only, their relative positions change, and on the 3D spheres, they are visible, distinctly. (d) Resonance frequencies are always associated with the quantized phases. A shift from quantization in a particular peak's phase value is the information (Fig. 4b, middle panel) [5]. (e) As one moves from higher to the lower frequency range, the scale-free power distribution of the frequency band is observed (Fig. 4c) [52, 56]. The intensity of the resonance peaks increases by orders of magnitude. (f) The amount of material is irrelevant. The geometric parameters, length, width, pitch and lattice parameters regulate the self-similarity of arranging the resonance frequencies. (g) Each frequency corresponds to a singularity point [85]. The value of frequency relates to the circle diameter. The frequencies of the resonance peaks would remain static, but not their phase. Using the phase, one can put system points at an accurate location on the host phase cycle's perimeter. This step secures the relative Bloch sphere positions. Thus, biomaterials are mathematically precise devices. (h) The time crystal remains

intact if the fundamental geometric parameters remain constant. Then, it is possible to change the system points and regulate the relative phase or phase shift [76]. The same time crystal would then store different information. This is interesting, because an experimental measurement of detecting resonance frequencies or phase associated with a peak would never show the information. We need to measure specifically the phase shift to see that a biomaterial is processing information. In the eukaryotic cells of the entire kingdom, microtubule rapidly changes its length (dynamic instability), sometimes its diameters (6–19 protofilaments) and then its pitch to morph its shape in incredible ways. Thus, it carries out key tasks of a living life form by editing its topology. (i) Sometimes, it is necessary to add or deduct some clocks or resonance frequencies. Then, the structure would change its typically associated symmetry so that particular singularity points disappear (all phase values get defined) or new singularity point appears. Subtracting or adding a singularity point means destroying the link or creating a link with several layers of geometries hidden within. (j) Number of oscillators or the number of devices has no relation to the number of clocks; it is not even related to the lattice symmetries. The number of lattice symmetries adopted by microtubule is the number of resonance peaks for a microtubule, not the number of clocks. Often, spatial symmetry breaking is associated directly with the time symmetry. ***A composition of lattice symmetries together defines a clock if they all undergo phase transitions as a group***. In the assembly of clocks, only eight dynamic symmetries repeat [103–105]. We have proposed our own fourth circuit element Hinductor for artificially demonstrating biological time crystals and the potential of singularities (Fig. 5a–c; Sahu et al. US patent 9019685B2).

(4) **Magnetic beating of beats**: Electrical beating occurs when two electromagnetic signals of very close frequencies interfere. Biological materials known for producing low magnetic fields (10^{-10} T) could generate beating locally in the lattice. Then, the beat signals could interfere again if the smaller lattice domain is part of a larger structure. Beating of beats could beat again, and such layered structures are rich in biology. Thus, one observes that beating signals cover entire electromagnetic or magnetic frequency domain (Fig. 5d) [5, 69]. Such a hierarchical network of beating requires simultaneous switching off the topological constraints at all level to destroy signaling. Thus, all signals survive together at ambient conditions (Fig. 5e).

(5) **Harvesting thermal, electrical and electromagnetic noise**: Time crystals in biomaterials reveal its unique phase relationship in the presence of a noise (Betz and Chance 1965a); we used noise trick inspired by biology to read the time crystals. Thermal noise compensation is rich in biology [28]; clocks neutralize the thermal noise [30, 50, 65]. Thermal pulses could even activate the biological clocks [46]. The origin of electrical ionic activity is attributed to oscillatory potentials in biology [29]. Even the electromagnetic pulses of light edit the biological clocks [47]. However, ordered signals affect the infrared photon absorption in biosystems. Signal inhibits the noise conversion to resonance-induced interference. It affects the nested beating described above

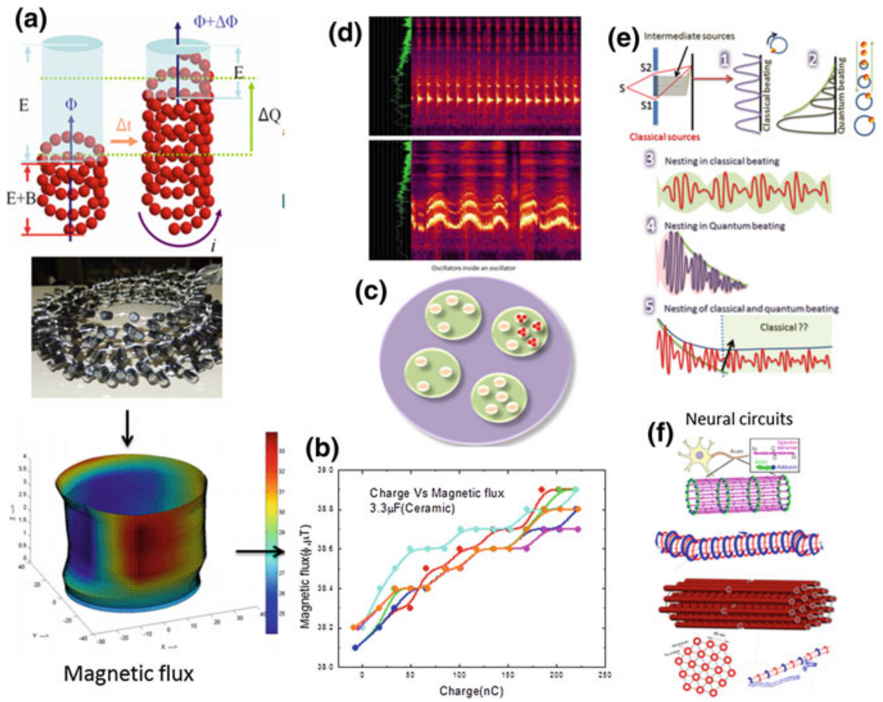


Fig. 5 **a** Fourth circuit element Hinductor not memristor (US patent 9019685B2). Charge stores to generate magnetic flux (top). An analogue made of capacitors (middle). Magnetic field distribution on its surface (bottom). **b** A oscillatory or nearly linear relationship between charge storage and the generation of magnetic flux. **c** Hinductor elements are kept without wiring inside vibrating membranes to create a composition of vibrations. **d** Classical beating (top) and quantum beating (bottom) inside a microtubule (experimental measurement). **e** Quantum and classical beating measurement setup used to detect Wilczeck's time crystal. The concept of fractal beating where classical and quantum beating is nested explained. **f** Ordered architectures inside a neuron, beta-spectrin-actin assembly (STORM data), microtubule bundle are being constructed in NIMS, Japan using Hinductor, the fourth circuit element

(Sahu et al. US patent 9019685B2). Among all frequency domains, biosystems absorb most in the infrared domain.

(6) **Harvesting singularity to self-assemble clocks: Learning, communication, all forms of information processing in neuron occur via time crystals**: Energy transmission is studied following a unique biological route, bottom up. Protein ↔ microfilaments ↔ bundle inside neurons (branches) ↔ bundles of neurons in a cortical column (Fig. 5f). It suggests that a neuron edits the phase of a transmission signal by modifying the neural branches [5, 56, 71]. The effort changes the stored geometric structure of the neurons time crystal, surprisingly, those we claimed it explicitly in 2016, and some old results were very near to it [32]. Neuron may take two steps. If a neuron builds a new branch, it creates a new clock. Else, it locally modifies an existing branch.

That edits the phase of an old clock. Thus, a change in the structure does not mean the creation of a new clock or singularity. Neurons communicate by clocking ionic pulses [61], but the evidence of wavelike communication is also there [68] apart from Ghosh et al's work in 2016. After the creation of a new branch, the system spontaneously investigates two factors: first, whether the phase modification is required in the new clock, and second, whether the new clock is integrated into a suitable location in the existing time crystal.
Similar to neuron, protein, microfilament and neurofilaments, assemblies inside the neural branches and cortical column edit their own time crystals [89]. The modified time crystals continuously edit their physical structure [113]. Greater neural pattern in size often dominates in the higher-level (slower) clocks in the time crystal [118]. Following magnetic beating of beats, all forms of vibrations are topologically connected in the brain. Electromagnetically this would have never been possible, as the electromagnetic signal damps in the cell fluids. Consequently, the proposal that a brain is a single resonance chain (Fig. 4c) [19, 56] is a primitive one, we modify our previous claims a bit and add that brain is a time crystal, and resonance chain is a limited view ignoring the topology of phase.

(7) **A nonlinear correspondence between spatial and temporal assemblies of crystals**: Even a tubulin protein molecule is a time crystal. It self-assembles into another time crystal, microtubule. Then, microtubules self-assemble into a bundle to build the core structure of a neuron, e.g., an axon. Neurons respond as time crystal (Fig. 4b) [32], a bundle of neurons forms a cortical column that is also a time crystal. The bundle of cortical columns also acts as a time crystal. A secondary structure of protein ~2–5-pm to 1-mm cortical column, spatial journey is about 10^7 orders. However, the temporal scale regulation is from picoseconds to seconds, 10^{12} orders [52]. The parameter that regulates the phase relation of various resonance peaks is geometric. Tubulin's each of the eight conformations holds a particular set of geometry. Similarly, microtubule's different length, lattices hold suitable symmetries. Neuron's branches edit their own symmetries spontaneously. The cortical columns length and symmetries of neuron locations edit their own symmetries. In association with the spatial symmetries, the phase relationship changes together causing a ripple effect in the temporal symmetries. We repeat that the resonance frequencies remain nearly unchanged, yet ***10^7 order time crystal gets changed by 10^{12} spatial scale changes. We cannot isolate particular part of a time crystal and suggest that information is being processed here. To hold memory, various clocks only use the phase space, together; thus information is stored everywhere simultaneously***.

(8) **Interacting with the living cells and proteins in their own language**: The biological structures sense a phase connected time crystal network better than conventional sensors. A sensor absorbs the existence of a signal burst. Biomaterials senses not just phase links between several such bursts, but exactly the pattern following which those links change with time. We did

perform a nice experiment with the neurons. 7–8-day-old neurons were given a specific set of frequencies as time crystal, wirelessly. The suitable neuron responded. No searching is required for searching a suitable time crystal. Electric or electromagnetic signaling faces the effect of a physical boundary of a material. However, magnetic beating of beats do not face boundary; it integrates by a phase map with everything within a magnetic shield. So, communication does not happen like we see it in electrical or electromagnetic case. It was predicted in 2014, as a spontaneous reply [52]. Moreover, it was possible to encode geometric shapes in a neuron. Talking to neurons is possible in its own language (geometric musical language, GML) [6]. Even treating misfolding of proteins is possible by twisting the time crystals [105].

(9) **Clocking integration of resonances: Various kinds of resonances are not isolated events**: A list of published resonance frequencies and our experiments show that the ratios between different frequencies are not integers. Even they are not harmonic. They are anharmonic [56, 87]. The ratio of magnetic resonance frequencies is the golden ratio (phi ~ 1.61). If the fundamental frequency is $f_{o,}$ then the other sets of frequencies would be $f_o, \varnothing f_o, \varnothing^2 f_o, \varnothing^3 f_o \ldots \varnothing^n f_o$. The electromagnetic resonance frequencies occur at the ratio of pi; $f_o, \pi f_o, \pi^2 f_o, \pi^3 f_o \ldots \pi^n f_o$,. While mechanical resonances occur at ratios of $e, f_o, ef_o, e^2 f_o, e^3 f_o \ldots e^n f_o$. All three resonances are related by a quadratic relationship e^2 + phi^2 = pi^2. By following this equation, the biomaterials ensure an integration of electromagnetic and magnetic resonances delivers a regularized mechanical change in the system. There is a clocking integration even between three different kinds of resonances. It also justifies our fractal information theory, FIT, where we incorporate all topologies in a circle or topology. Nature makes it using the fundamental constants.

(10) **Clocking Bloch sphere holds the geometric locations of singularities**: Our experiments confirmed that the proteins clock like a time crystal, though similar claims were made in the 1970s. At that time, technology was not that advanced to provide a direct evidence. To be a time crystal, any system's resonance frequencies should change their phase as if three clocks are part of one phase cycle. A single system point while completing a full rotation 360° would find that all constituent clocks do not delay it, or let it finish full rotation early. Thus, one has to check if the change of phases of clocking frequencies is quantized. If yes, it is probably a time crystal. Six proteins associated with the neuron firing showed time crystal features: Tubulin, beta-spectrin, actin, ankyrin, clathrin and SNARE complex. Clocking of phase appears to be a universal property of proteins. During clocking, they hold specific geometric shapes (Fig. 6a). We repeat that a clocking Bloch sphere holding the geometric shapes made of singularity points was proposed as the basic information structure of nature in FIT (Fig. 2b, c) [6].

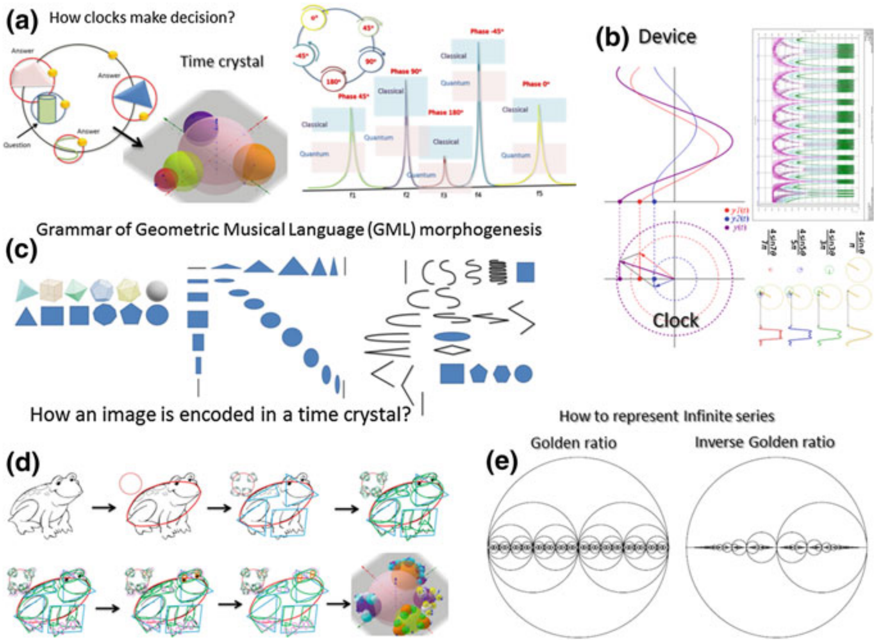


Fig. 6 **a** Geometric decision-making by a clock. This is fundamental operation of a frequency fractal computer. The time crystal representation of this decision-making unit is shown to its right. Reading a resonance band data to construct a time crystal is shown in its right. **b** Clock is a circle, but its output is sinusoidal. If more than three clocks nest, it turns to a binary pulse. **c** Inside a circle, the 1D–2D–3D geometric transformation happened due to the relative rotations of the clocks is listed. **d** In eighth step, a frog is converted into a time crystal. **e** GML and FIT work together by converting all data as part of infinite series: two examples, how to write, golden ratio and its inverse

3 Three Advanced Features of Time Crystal Suitable for Information Processing

1. **Creating a larger singularity or fill in the blanks inside a singularity**: Singularity points of a Bloch spheres bursts in a sequence, clockwise or anti-clockwise to hold the geometric shapes listed in Fig. 6b, c. These singularity points burst signals by harvesting noise in the biomaterials [79]. Singularity bursts of the biomaterials are discussed in detail [4]; however, we think a lot of research needs to be done in the near future on noise. The pattern of noise could play important roles in regulating temporal symmetries. The new fractal information theory (FIT) [6] has also analyzed the information integration. There are two ways to self-assemble multiple time crystals (Fig. 2a): first, inserting multiple time crystals inside a singularity point in a suitable topology, and second, looping time crystals with its neighbors by creating a new clock, i.e., bringing neighbors into a single framework. Figure 2c shows the growth of the

time crystals, how a starting Bloch sphere is sliced and new Bloch spheres are added. Bloch sphere expands/contracts to process information [6].

2. **At least three geometric parameters collectively regulate the phase of nested clocks in the time crystal**: There are four geometric parameters of a dielectric resonator. They are length, width, pitch of helical or other kinds of periodicity and the lattice parameters, which regulates the 12 singularity points in its 3D phase architecture. Two geometric parameters cannot be changed simultaneously. Our study on the fourth circuit elements has shown that if two geometric parameters are varied simultaneously, then singularity points encompass almost entire phase sphere. One has to underpin one of the four parameters that does not terminate major singularity points and causes minimum changes in the clocking time or phase. Say, it is length. Then, by varying the length, one could choose the right geometric shape. One has to write in the material or time crystal a desired phase. This neutral parameter edits structure. Thus, spatial and temporal crystals have to change synchronously to edit 12 singularity points while processing information.
3. **A time crystal is naturally a seed of astronomical number of events**: Creation or deletion of new clocks in the time crystal changes the 3D network of geometric shapes embedded in the phase structure. Simultaneously several clocks run in the crystal to hold the geometric information in multiple layers. The motion of system points in the time crystal links various geometric shapes as shown in Fig. 6d. To an observer, some shapes appear at specific intervals, while the rest of the geometric shapes appear simultaneously. Our time crystal is an advanced form of Winfree's time crystal; it holds clocking geometric shape which is equivalent of an event, not a static data or facts. The time crystals interact with the environment and morph perpetually, like biological systems [36]. The nature never stops changing. Interfacing clocks of time crystals never fully stabilize into a concrete phase structure. Therefore, a standalone time crystal is not a solid, but jelly, wherein, correlated geometric shapes construct an interactive matrix. Its phase flips, resembling a jelly. If nature triggers any of the elements or clock, it ripples the entire matrix. All associated time crystals get coordinated (Fig. 7a–d; Ghosh et al. 2013) [52, 54, 56]. We repeat, when all these processes go on, if one measures resonance frequencies would notice nothing. Time crystals do not need to be programmed to suitably linking with new clocking Bloch spheres. Only feasible compositions allowed mathematically are automatically embedded in the phase prime metric, which guides integration of newcomers. Phase connected 3D network of geometries cannot be linearized into a sequence of tasks. Therefore, it emulates nature as is like a universal sensor. In most cases, the 3D clocking geometry could be accessed in astronomical ways. Even if one twists input in an incredibly large number of ways, yet the structure would sync reliably. In a time crystal of 10 clocks, each clock with 8 possible connecting routes can coexist with 10^8 ways.

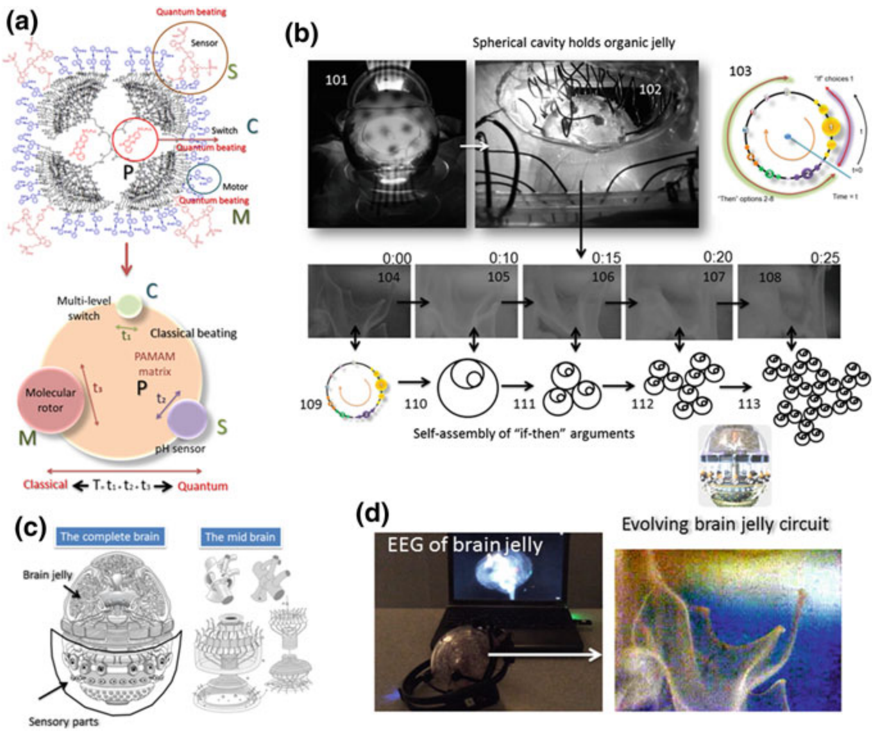


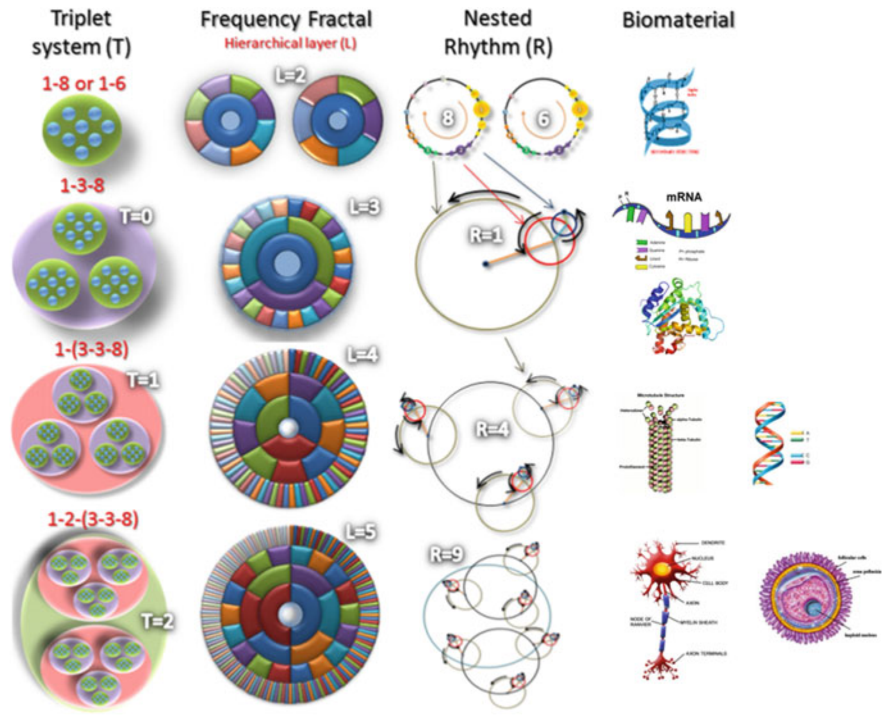
Fig. 7 **a** Elementary organic supramolecular structure used to build the brain jelly. Its time crystal representation is shown below. **b** Experimental images how a set of unit organic time crystals self-assemble to form a neural network like jelly to mimic brain-like activity. **c** An artificial organic brain designed and being developed in NIMS, Japan, for its operation. **d** EEG of organic brain jelly-based time crystal mimics human brain

4 The Necessity of a Universal Metric that Regulates Spontaneous Self-assembly of Time Metric

Nature is rich in time crystals. It has already optimized them by working for several billions of years. We have listed resonance frequency wheel and its corresponding 2D phase cycle network in Table 1a, b. The wheel represents how frequencies assemble together to form nodes in a dielectric resonator. While the 2D phase cycles are part of time crystals, it is the skeleton of information, because topological or geometric shapes made of singularity points are not shown. The entire table has been created expanding the gridding of triplet of triplet symmetry, for simplicity. Doublet of doublet, doublet of triplet, triplet of pentate, all compositions are there. Self-similarity of various time crystals hints for a metric of finite patterns. That metric gives rise to all possible symmetries found in nature. The geometric similarity between resonance frequencies demands for an invisible resonance chain

Table 1 (a) First part and (b) second part of the table showing step-by-step evolution of computers or decision-makers starting from a single time crystal

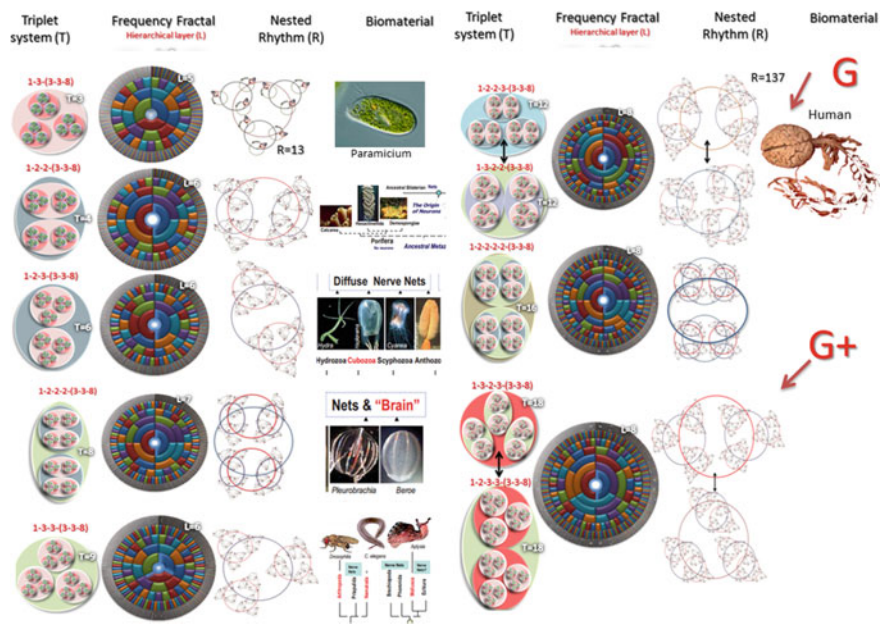
(a)



(continued)

Table 1 (continued)

(b)



First column shows 2D resonance domain, second column shows equivalent frequency wheel, and third column is a slice of time crystals showing simplified operation. Fourth column shows the equivalent biomaterial targeted to mimic

[52]. The phase quantization is not possible without a universal rule governing the shape of dielectric resonators. A hidden universal metric governs the basic structures of the time crystals. ***We have calculated the pattern by finding the number of ways a given number of nodes could combine successively until we reach prime number of compositions***. It varies non-linearly as the integer grows from zero to infinity. Then, we have calculated how this pattern would look like under various constraints, like n phases that make 360°; then, we find clockwise and anticlockwise rotation, etc. (Fig. 3). We can normalize the number of choices to one, to find self-similar ripples in the number systems. If one event represents one point, and each event is a topology, the pattern suggests a common non-repeating routes or metric as their singular origin. Events occurring in nature are not random. Random events integrate from one singular metric. That metric is closely related to the vibrations of dielectric resonators [73, 81, 82, 94, 95].

Research in the last decade to address the problem of computing: Historically, there was always an effort to "go beyond Turing" [34]. It started by von Neumann to build non-von-Neumann machines. It continued with Turing with an attempt to building non-Turing machines; one class is hypercomputing [109]. Feynman proposed to "replace all physical laws with changing patterns" in 1962 [101, 102]. It continued with a series of works to make it nature inspired [99]. Quantum mechanical coupling was applied to non-sequential computing in the atomic scale. In 2008, 16 molecular clocks were placed around a single molecular clock [12]. Then, the central molecule was tweaked to process 4.2 million 16-bit choices of the nanowheel. Comparatively, a sequential process could provide only in a structure that violates the Turing system. One could see online video of this time crystal. In 2010, Feynman's suggestion (1962) that patterns compute is true was tested. Two physical events were emulated using quantum properties of molecular clocks [15–17]: First, the evolution of cancer cells, and second, diffusion of electrons on a grid of molecules. The result was obvious. Cellular automaton works as a Turing machine [101, 102]. Two events were emulated, but if there are more events, one required a new hardware. Then, scaling up was impossible. The quest for a universal system ranged from neural network [13–15]. It would require a new hardware every time one tries to emulate a new natural phenomenon. All efforts failed.

A dielectric engineer would consider that everything in this universe is made of dielectric resonators [73, 81, 82, 94, 95]. For this worldview, one can calculate the geometric correlation between the resonance frequencies ranging from the Planks scale to the largest dimension of the universe. A unique pattern of primes is found holding all possible solutions to all possible dielectric resonator networks. This mathematically derived pattern is the phase prime metric (Fig. 3). It was historically used by many researchers to claim that it connects everything in the universe [64, 110]. If true, a hardware inspired by this phase prime metric should absorb the information in nature. During absorption, it will not destroy the 3D integration of events. Then, a small fraction would extrapolate into total information [66]. Thus, analyze events that have not yet happened by using the metric of primes. Simply put, "phase prime metric" would hack nature, copy and paste it in the hardware. Therein, one would see nature, the way it unfolds.

The phase prime metric hardware (non-computer) would not require codes. We plan to eventually optimize the phase prime metric that let the events happening to nature sitting inside our non-computer. It tells beforehand a gross overview of what might have happened or could happen in the future (Quantum computing claims partially) [120]. Then, the phase prime metric is an alternative to a computer programmer; it is an user. The intellect of artificial intelligence is the aptitude of the person who wrote the code. Alternately, a meticulous information structure of any event could be configured from the phase prime metric. Different patterns of a metric act in coherence to frame an event. This key set of compositions is required to simulate or emulate the event. Once the metric codes are read, the event is reliably recreated. Free will and unpredictability are there in nature. However, it is not random [84]. A generic operator "phase prime metric" puts an intricate geometric detail of the event in nature. One reads an event's phase–signal relationship as fractal seed (a few geometric shapes written in a network of clocks, Fig. 6d). Then, one writes that in the metric structure.

What is a phase prime metric: Say in the beginning nature is given only one quanta to create the universe and only allowed to decrease the wavelength of a single quanta, by splitting it one by one, dividing one into two quanta, then each one into three and so on. Now, the nature's approach would be top down spatially, from the largest boundary of the universe spatially making a journey to the plank scale. Simultaneously, mapping the shortest to the longest time is possible. Together, the journey would look like Fig. 2c. A standing waveform is part of a clock (sin or cos wave = a circle with a rotating system point), and it occupies a space, so it is an unified way to map both space and time. A given number of nodes of a waveform are combined until it reaches prime number of nodes. Then, in a particular way, both time and space are integrated. Therefore, one gets a composition of frequencies. The number of the composition *C* is plotted as a function of a number of quanta *n*. A group of primes determines *C* compositions. *C*-*n* plot shows geometric correlations of different choices [42, 62, 100, 117]. *C*-*n* geometric pattern is called a phase prime metric. Twelve distinct ways one could connect the dots or events in the phase prime metric (Fig. 3). Therefore, there are 12 sub-metrics, or 12 geometric patterns, one top of another. If 12 special methods are adopted, each pattern is seen.

Historically, phase prime metric connects the smallest dimension known to us to the largest dimension at the extreme end, or a single event to the all possible events, or fastest time to the longest time possible. Spatial interpretation is easy to understand, through all three interpretations that are equivalent. Choose a length as the starting half-waveform, and start calculating its ordered factor (OF) and/or divisors following protocols developed for centuries. This is one of the simplest known mathematical problems taught to kids. OF can have many interpretations too. All possible superposition for a given number of waveform is OF. All possible ways one could combine an event is OF. All possible ways a space could be mapped is OF and so on. But one should connect the nearest neighbors in the OF plot for $N = 1$ to infinity, to learn how network of events could be a single event represented as a single point would combine and evolve with space or time or mass. The beauty of phase prime metric is that once a point is defined, its integration topology is revealed. If it is time, then the past and the future is also evident. The number of composition varies non-linearly with the *N* number of waveform as shown in Fig. 3a–c, e, g. The origin of non-linearity is the irregular occurrence primes as evident in Fig. 1g. For the prime number of waveform, there is no harmonics, hence no superposition. Recently, fractal metric is suggested to replace space–time metric [90]. Phase prime metric shows phase fractal (Fig. 3d), triplet grouping fractal (Fig. 3f), phase quantization (Fig. 3i), organized selection of clock and anticlock spin (Fig. 3d), circular traps at logarithmic space (Fig. 3c), saturation of patterns for 1 = 1 million (Fig. 3h).

Advance from the existing fractal space–time metric [90]: The established route of fractal space–time adds a physical reason of connecting the neighbors [4]. First, one has to divide the number of superposition ($\pm h/2$) count. It inherently considers that the there is a Bloch sphere whose diameter is h and $\pm h/2$ are two of its poles. As the number of superposition increases, one gets larger spheres. It is known that the Hilbert space is infinite in size irrespective of the Bloch sphere diameter. A Hilbert space connects various pathways between the poles. The composition of superposition estimates the energy of a dielectric. It also measures the number of degenerate states of a system. Connecting the neighboring compositions means connecting the neighboring real poles. It transitions between different energy packets. A Bloch sphere also represents a particular symmetry. A closed loop drawn by connecting the points is a set of symmetries. This set forms an energetically coupled group. This is strictly how a material is defined. "A set of symmetry" defines a lattice, a dielectric, a real structure. However, a 2D loop in the phase prime metric does not tell us how its corresponding object looks like.

Derivation of wiring of clocks from phase prime metric: For this reason, one rotates the *XY* plane 360° along the *X*-axis ($X = n$ or number, $Y = C$). When one connects the $\pm h/2$ points, using an imaginary line, a 1D line makes a 2D surface. However, when one rotates the *XY* plane, an infinite number of the same imaginary lines in the 2D surface roll. Thus, one gets a 3D structure, teardrop to ellipsoid, vortex to spiral and dumbbell disk to nephroid. As noted above, each $\pm C/2$ points form a Bloch sphere. As the 2D surface rotates around the *X*-axis, the real points of the Bloch sphere rotate with the same angular speed. Multiple geometries overlap in the metric. A pair of teardrops of different sizes overlap or a teardrop overlaps with an ellipsoid. Then, the rotating speeds of the real points of the two shapes are different. If more than a threshold, then it satisfies the condition of singularity. Thus, as one connects the *C* coordinates, it is applying geometric algebra that creates a hyperspace. The process generates naturally abundant symmetries and dynamics from the pattern of primes. A slice of phase prime metric designs a universal sensor. Phase prime metric inspired sensors would capture the natural events more efficiently.

Imaginary lines are phase paths connecting the singularity points. Once a singularity point is formed, it triggers a cascade effect. Singularity acts like a glue. It embeds various time crystals inside or connects side by side [60, 96] to the surface of the Bloch sphere. Singularity points are undefined functions. There are layers of geometric shapes inside a singularity point. Several clocking spheres pour in and embed in the host sphere. Thus, the Bloch spheres expand as it integrates information as shown in Figure lb. This is fractal information theory (FIT) (Fig. 2c) [6].

Now, we explain geometric musical language so that the "fractal seed" is understood properly.

The fundamentals of a geometric musical language (GML): Many small circles written as pixels on a big circle act as a clock. If one zooms any phase cycle or clock, similar tiny phase cycles or clocks are found inside. This is how several clocks reside inside a clock, while the side-by-side assembly of the clocks forms when such circles are drawn one top of another. All the circles of a time ring oscillate continuously. During oscillation, it increases its diameter together coherently (in phase) and decreases to a single point. That single point is also one pixel or the smallest phase cycle [91]. Say, one of the many connected pixels starts oscillating in a different phase, for a certain time. Then, returns to the same phase like its neighbor. This happens with all the pixels one by one in a sequence. Then, an external observer sees as if a point is moving on a circle, or a clock is born. Two such points hold an angle that enables encoding a geometric shape. For example, by shifting the position of points, one can encode triangles of any shape. Similarly, by using four points one can encode a rectangle or square and so on (Fig. 6a–c). Every pixel in a phase cycle is another phase cycle or clock [58]. When clocks change locations, it is not a crystal, but a jelly. The jelly absorbs, writes and erases the time rings or clocks to sync with its environment [14, 57].

How a decision is made by Geometric musical language (GML): Self-assembled geometric shapes represent all sensory signals. Geometric shapes can integrate two ways: side by side and one inside another. The corner points of a geometric shapes break, and then, one inserts a geometric shape in it. Thus, geometries grow side by side and one inside another. It is not a 2D structure. The integrated geometric shapes are best represented in a clocking Bloch sphere (Fig. 6d). When it integrates, information bubbles of Bloch spheres would grow [6]. When a time ring holds more than one geometric shape, any of them could represent a query and the other an answer. Therefore, when the clock runs, the decision is made for a query (Fig. 6a). The existing 3D assembly of Bloch sphere adds new sets of nested clocks or bubbles with its surface [112]. During addition, it even undergoes a phase transition just like an organic supramolecule [53, 55, 57]. The rule for phase transition is same, "symmetry breaking." Here the 3D oriented structure of phase cycles is an alternative to program or algorithm. When synchronized clocks run together, every time, synchrony selects a new wiring [88]. To an external query, all the associated clocks run. All issues related to a query are played out by the clocks. Since entire Bloch sphere architecture is one single structure, no choice is left out.

Experiments that enabled us to construct geometric musical language (GML): Pumping a time crystal holding geometric shape is the route to test a geometric musical language. The resonance frequency band and associated phases need to be written in an antenna to pump. If one plays time crystal music to a microtubule, it responds a crystal. Similarly, by synthesizing the organic jelly a neural network like supramolecular structure was built (Fig. 7a, b) [53, 55, 57]. That brain jelly is poured in a fractal dielectric, designed similar to a brain. The organic jelly made device of time clocks morphs the EEG features of a human brain (Fig. 7d). Clock like crystallization of materials is unique in nature [31].

How the phase prime metric hardware is designed and built: The philosophy is that all information in nature is an event, like a single point, which has inside a geometric shape with its corners made of sub-events. Following that philosophy, one has to convert a stream of all sensory signals (visual, auditory, etc.) into a time crystal. There are several self-similar geometric shapes of the time crystal. Phase prime metric-based filter shrinks the size of a time crystal network. The shrunk time crystal is called a fractal seed. The decision-making core is 3D time crystal architecture. First, one should pump such a fractal seed into it. The fractal seed expands by phase prime metric and morphs into an information architecture (Fig. 2c). During morphogenesis, fractal structure formation is common in biology [35]. Most dense parts of a time crystal network are blacked out as if these are pieces of mass. We repeat that phase shift models space, time and mass as network of clocks mimicking biological rhythms [49]. If these "masses" are replaced with clocks, phase lines with wire, one gets a circuit. This circuit vibrates like the time crystal. Building a circuit from the phase prime metric requires ten steps. We discussed it below in a separate section. The experimental prototype of the non-computer is a device whose vibration is similar to the phase prime metric. There are various ways to do it. A suitable organic jelly [53, 55, 57] is being developed for over a decade (design in Fig. 5f, result Fig. 7). Now, a suitable fourth circuit element is found (Sahu et al. US patent 9019685B2). It could be assembled to clock like a phase prime metric. If a white electrical noise is applied to this hardware, then the clocking waveforms superimpose. It delivers a resonance frequency pattern like that of the phase prime metric. With the current technology, it is not possible to realize circuitry with intricate details of phase prime metric. It is primitive, but at least a hope for the future. Moreover, no one requires a new accurate high-resolution computing. The existing Turing based computers are ultimate in doing that.

Prototype under construction in NIMS, Japan: A global platform is under construction [10] (JP-5,187,804-"a vertical parallel processor"). In the current prototype, a slice of $N = 1000$ is cut from phase prime metric. Find its equivalent clocking circuit. Depending on the number of integer in the metric, define its class. For example, $N = 1000$ means a thousand class hardware; if $N = 10^{12}$, then it is a conscious class or G class (see Table 1b, G and G+). A G class means a superposition of a pair of time crystals generated by a single hardware (classified). However, a global triplet of triplet fractal pattern emerges in the phase prime metric. If that seed pattern is plotted in a circle to address the phase quantization, it makes a wheel for 360° phase. This is noted as frequency fractal (Fig. 4c). Frequency wheel classifies the non-computing ability in the hardware. It also accounts for a transition from artificial intelligence to natural intelligence.

Determination of wiring between clocks from a phase prime metric: There is an upper and a lower time limit of an integer representing a decision-making non-computer. Non-computer core architecture is a fractal network of clocks or clocking Bloch spheres holding the geometric shapes. Mathematically, it is an assembly of a large number of distinct ΔN slices of the phase prime metric. To cut a ΔN slice of metric, start at $N = 0$; end at a certain N value. All clocks are wired following ten steps noted below. A metric prime hardware could be realized in various ways. We repeat every point in the phase prime metric of Fig. 3 is an event that contains many points forming a geometric shape inside. One could start from any simple event to begin with and find events inside, continuously, building a topological network.

(1) **Select a set of *N*, e.g., {1, 3, 7, 45, 32, 734, 1500, 3800}**: A set of n values is selected on the phase prime metric that forms a closed loop. The phase relationships of N Bloch spheres plotted in a circle. Together, n components try to cover a phase space of 360° (see Fig. 3). The plot reveals the value of quantized phase. The resultant parameters of spiral dynamics become evident as in biosystems [24]. In the set of n, some engage in clocking; others are found as not participating in the periodic vibration. They remain outside the spiral or vortex dynamics that integrates a set of N.

(2) **Identify different slices are components, to make individual loop of geometric structures**: All distinct slices of a phase prime metric have their own time crystal or phase space structure. A slice means a set of values n in ΔN; it has its own factors, own sub-metric. The network of time crystal reveals hidden geometric structure. The layered geometric structures match for all N time crystals and those hidden self-similarities group subsets of N. Therefore, even before the phase prime metric starts convergence to primes, as a drive to integrate the discrete time crystals into a singular one, a preliminary grouping is made.

(3) **Initial phase gap between the clocks is important**: Initial phase relationships between different clocks can change the output projection of time crystal dramatically. Initial starting points define temporal change of phase or dynamics. Temporal recording of resonance peaks reveals how the time gap or phase gap between clocks changes with time (dynamics). For a given slice of metric ΔN, the dimensional ratios of the n geometric shapes located at n points on the metric are noted (Figs. 4a and 6a). Junctions of clocks locate system points; direction of rotation is selected to neutralize vector sum of 3D structure. The system points and their phase gaps determine the angle between clock planes.

(4) **Fractal network of clocks, side by side and one inside another**: When a set of N integers is spotted in the phase prime metric, the integration begins. Say two integers of set N are 32 and 56; they make individual time crystals by following phase prime metric. At the same time, their products ($N1 \times N2$, $N1/N2$, $N1 + N2$, $N1 - N2$) will be the new members in the phase prime metric; expansion of set numbers will be plenty to find a closed pattern in the phase prime metric. The gaps will be filled by repeated elementary primes. The repeat of primes repeats a particular geometric shape to build a large structure. These repetitions cause self-similar patterns in an architecture; there is essentially no universal fractal in the phase prime metric.

(5) **3D geometry optimization of clock location**: Since one has to build a wireless network of clocks, the physical location of the clocks in a 3D network is important. Wireless projection of constituent time crystals all around, by 360° solid angle, selects whatever time crystals reside in its path. A 3D network appears as a sphere to an external probe or we state "3D projection of a time crystal." So, the clocks along a line screen each other's information, thus creating an erroneous signal to an observer. Note that in case of conventional electromagnetic signaling by an antenna and a receiver, the energy degrades largely with the distance. However, for magnetic beating in a noise activated phase coupled matrix of time crystals, there is no single point source of energy and no fixed destination. Thus, size of the phase network is irrelevant to an observer, which also becomes a part of it. Geometric locations govern the phase relationships of the integrated clocks. Locally in the 3D architecture of the computer core, a group of clocks shifts their coordinates. Thus, locally, the system shifts from one metric to another.

(6) **Vibrations at all time scales in all spatial scales maintain speeds**: Clock speed is regulated by delay time and fixed everywhere in the metric hardware. Only one, the fastest clock alone is used to integrate the phase or delay to create all possible "times" for operation. For that purpose, it is imperative that every clock senses all neighbors once hardwired. This is a critical technological challenge. All the clocks communicate wirelessly in a hardware following magnetic beating of beats explained earlier. The localized beating during synchrony should converge on the particular locations of the clocks, so that phase shifts do not occur. Phase shift with the motion of the system point is key to reliable processing of topological information. The speed of a system point along the perimeter of phase cycle changes if it falls into the singularity domain and recovers it afterward. This falling into singularity is crucial for editing geometric memory.

(7) **Thermal and electrical noise as the source of energy**: Wireless communication is the key to achieve "one-to-many and many-to-one" communication [12, 13]. The 12 singularities detected in the biomaterials 3D phase space link magnetic field with the stored charge. This relation is historic because in the last 800 years all theories of electromagnetism have endorsed that a current must flow. But this phase space activates by noise and only noise; no current flows into modulate magnetic flux with charge. For that reason, clocks are wired, but make sure that em noise splits into electric and magnetic parts, but no current flows, but only white noise (Sahu et al. US patent 9019685B2). Thus, a clock in a phase cycle is free for neighbors; no wiring is essential.

(8) **Testing the 12 metric compatibility, building a grammar of limiting changes allowed**: First, the clocks are wired as suggested by the phase prime metric. Provisions are kept so that input time crystal modifies the coordinates of the clocks. Specific input time crystal selects one of 12 distinct patterns of phase prime metrics (Fig. 3). It is crucial task to find the right trigger. A delicate choice of the clock coordinates eventually allows a few metric to dominate. We are currently adding several new aspects of the phase prime metric. Newer and more insightful metric features are being revealed.

(9) **Geometric shapes synchronization is a test of unity (oneness)**: The non-computer has two parts: First, converting all sensory signals into a set of topology, and second, integration of topology. However, at both parts the geometric shapes spontaneously store and synchronize the clocks. Circuits modify; filters, amplifiers and vibrating membranes are added to process geometric musical language [6]. The whole device is just one single clock holding plenty of clocks inside. The non-computer core has one device, only one geometric shape for all sensory memory.

(10) **Non-disruptive Interaction between the four modules**: Finally, the wiring is edited to enable the device as a filter, resonator, inverse of resonance and clocking geometry writer. Once these four qualities are optimized, a true hardware of metric of primes is made. It is tested for image processing, hierarchical perception to find the mismatch in the wiring. A particular test is repeated in all directions of the 3D network of clocks.

Four essential modules of the phase prime metric hardware: A diffusing function connects the dots (composition, h) to show a superposition of 12 different sub-metrics inside one phase prime metric. Following ten rules described above, four modules are made, as a core decision-maker [52]. They are sensor to sense the environment. Initiator filters and makes instant decisions. Processor stores the learned situations. Regulator filters the learning parts and evolves entire architecture. The four hardware modules operate independently in the non-computer core. Together, they have a purpose. It increases the length or number of integers in the slice of operational phase prime metric.

5 The Operational Mechanisms of the Non-computer

Viewing a decision-making in terms of time crystal concept: All are time crystals that vibrate like metric of primes. The same hardware is used differently to get different functionalities.

First, sensor acquires data from its environment. As the signals fall in, due to resonance, associated clocks are spontaneously activated. Thus, the phase prime metric based sensory network transforms even a binary stream of pulses into a 3D network of clocks, instantly. The sensor network builds an architecture of input time crystal, irrespective of nature of sensory signal.

Second, an initiator acts like bipolarity filter. In one way, it shrinks the size of an input time crystal. Output becomes a small fractal seed. If the input is sent through the reverse direction, phase prime metric fills the missing gaps. It inflates the time crystal, to its original form, sometime much larger. Output time crystal contains situations not yet happened, i.e., futuristic dynamics.

Third, all parts of a processor are always active. As time crystals arrive from initiator, synchronization begins. Entire phase prime metric from the smallest to the largest time scale syncs simultaneously. All the matching time crystals amplify the signal.

Fourth, a regulator synchronizes with the time crystals missing in the processor part. It activates the new missing clocks inside. The mismatched yet essential clocks find suitable location in the Processor. They are later absorbed there as a part of learning.

Viewing a decision-making in terms of geometric musical language: Corners of a geometric shape are made of singularities. When the clocks run, at the singularity points one hears “bing” [85]. The time gap between a pair of “bings” tells us the phase gap. The ratios of the phases hold the geometric parameters. This is the rule of composing music too, note geometric musical language [4]. Therefore, to feel like a triangle one can combine three ringing bells with an alarm clock (Fig. 6a). The alarm rings the bells after certain intervals. In this way, using a simple circuit one can realize an analog of clock-based geometric memory. This kind of decision-making or non-computing does not distinguish between question and answer (Fig. 6a). Both get the same status. Various geometries self-assemble as clocks in the phase cycle. It increases the complexity of decision-making. It is preferred to assemble the nanosecond clocks alone in the entire circuit. Fast clocks are coupled to deliver clocking at all time scales. Picoseconds clocks make a seconds clock. Singularity is a key to this non-computing. However, a separate hardware provision is not required to realize that. An external sensor could lock on any part of the hardware. Due to two limiting time resolutions of the sensor, the fastest clock and the slowest clock are selected naturally. Thus, a decision-making fixes the end of computing before even it begins synchronization.

6 How Phase Prime Metric Replaces the User and Enables Self-programming

Circuit-based Turing computers have human as the key component for its efficiency. Non-computer relies on the phase prime metric to fill the gap and expand the time metric it gets from nature. Discrete clocks link. If some clocks are missing, they are created. Constructing a higher-level clock is the only drive of a non-computing core. A drive to make slower clocks gets everything done, spontaneously.

7 The Use of the Pattern of Primes in Integrating the Time Crystals Has Ten Major Advantages

(1) **Retrieving the lost data and transmitting a fraction**: Sometimes, a hardware damage loses information. One has to place the remaining part in user's time crystal network. The pattern of phase prime metric integrates the available crystals, thus recreating the missing network [17]. For this reason, there is no need to communicate full information. If a fractal seed is sent, it evolves uniquely, more profoundly in the receiver. The morphing of a fractal seed retrieves total information. See Fig. 6e; an entire infinite series could be retrieved from any part of hardware.

(2) **Drive to integrate discrete time crystals is similar to programming**: The metric acts as an operator on the input matrix of clocks. It links any form of time crystals with slower clocks. The phase prime metric has two drives. Make slower clocks to integrate, and expand its phase prime metric implementation. No hardware can implement a phase prime metric with intricate details. A continuous drive to improve metric makes nominal mistakes in reconstructing the perception of logic.

(3) **Provide key information to change wiring**: Unlike other space–time metrics, the phase prime metric does not depend on user's guess. It determines the detailed structural features like an origami [57]. The time crystals dynamics

are mapped accurately. The time of symmetry breaking and the states post-phase transition are also determined. Thus, the phase prime metric provides the software solutions, like a fusion of a user and computer. The essential hardware modifications required for an input time crystal to store and evolve are also delivered.

(4) **Higher-level perception is naturally embedded**: A phase prime metric hardware has embedded self-similarity. As a result, it does not count "bits," but a pattern of time. Slower clocks integrate the faster clocks in a scale-free manner [43]. In its own time scale, clocks are arranged symmetrically. It enables fractal clocking. It means during a one-second operation, one could dip down into the picosecond scale, process and return with a solution before the one-second clock "ticks." Fast running time crystals are never left alone. In a widely varied time scale, only a few clocks need to "tick" to make a decision.

(5) **Computing location, start, end and halting are decided early**: The construction and editing of the time crystal continue forever. During synchronization, the transformation (morphing) peaks, but do not die out [17]. The effective length of the metric is infinite due to a closed loop [63]. It also drives to increase metric length. This has several advantages; no instruction is needed to start and halt. Halting is a significant problem only when the end is not fixed [86]. This is a case of Turing computer. Here, computing is all about entering inside a singularity, so the start and the end are fixed before the journey begins. The metric activation reaches a maximum and then naturally reduces the editing of the time crystals. Thus, a near halt is reached.

(6) **Non-reductionist approach: no choice is ever rejected**: The phase prime metric reads the events in nature, so the concept of input is none. A phase prime metric hardware includes an observer, an external user and all environmental participants. It integrates into a virtual unified universe. There is never a rejection or reduction in choices or even a probabilistic select. The only effort is to en-loop the isolated loops. Non-reductionism ensures junction-free hardware (no heating).

(7) **Quantum-like speedup without entanglement**: Due to the fractal nature of the phase prime metric, it performs a search without searching. A physical wiring destroys the phase modulation. So, the hardware uses a wireless communication [70]. Spontaneous reply requires only 12 layered clocks to find 10^{12} number of clocks. At every layer, one enters inside a faster clock. Hence, time to solve a problem is the smallest time possible in the layer where the question was asked [52]. Note that 10^{12} oscillators make 99% of all patterns in nature (10^7 almost covers all, Fig. 3h). So it is the maximum number of clocks used in a layer. Quantum computing also provides this speed [23, 51, 63, 106]. However, if entanglement needs to be broken, repeatedly, which is often requisite, then the advantage of speed disappears in quantum [72]. Alternate routes can speed up [80].

(8) **Directional memory delivers a virtually infinite capacity**: The same 3D structure of a time crystal emits a different burst of signals to different directions at any given time. The observer can chose infinite locations around the structure to get a new solution. Therefore, the memory capacity and the distinct solution generation ability are astronomical. It has nothing to do with the number of oscillators.

(9) **Universal language is fundamentally embedded in the phase prime metric**: The geometric musical language (GML) in combination with the phase prime metric can build a virtual language of patterns of any system. They need only a temporal evolution of resonance signal data to build a network of phase. It suggests interacting with any system whose language is unknown. No rules or information about the intelligence of the system is required.

(10) **Harnessing singularity is not possible with the existing mechanics**: Due to the fractal clocking behavior, there are singularities at every location on the phase prime metric [78]. The differential calculus needs to be replaced by a conformal algebra to simulate the wiring (Fig. 6e). If one enters a singularity domain, it finds no self-similarity. The phase prime metric ensures a non-repeating experience continuously [18]. One needs to make a journey to the singularity domain blindly following a phase prime metric. Thus, both classical and quantum mechanics are not useful here. Bridging the singularity safeguarded quantum. Here, it is prohibited. One has to enter inside a singularity and collect available self-similar clocking factors. This finding holds the key dynamics of a phase prime metric. It explores pure topological factors for developing an effective mechanics [4, 67] (Kawato and Tsuzuki 1978).

8 When One Does Requires a Truly Bioinspired Computer?

Biological clocks are well known in the brain. It extends from circadian rhythms to the single neurons. The connecting protocol and the route that connects the rhythms are unknown. Currently, rhythmic activities are linked as a chemical process associated with proteins and enzymes. Clocking in the protein like nanoscale biomaterials does not terminate at the neuron level, as it was believed thus far. The rhythmic or clocking reaches deep down to the few atomic groups. Triplet of triplet resonance band connects the peta Hertz (femto seconds) to the nano Hertz (twelve years) frequency scales [52, 56]. The resonance pattern looks similar to the pattern of primes derived from the resonance of the dielectric resonators. There are many carriers. All carriers resonate with different dielectric resonators [73, 81, 82, 94, 95]. Yet, the frequencies constitute a singular pattern.

Ten situations when one should use this non-computer: The objective is to develop a science for non-computing to make decisions where the Turing computing fails. Here we note ten circumstances where non-computing is essential.

(i) Information is not sufficient or organized to frame logic. (ii) No time is available to find the rules for structuring logic, i.e., the urge for an instant reply. (iii) Rejection of choices is not advisable. The rejected choices could take over the lead anytime as the dominant player. (iv) Database is too big to structure it into a format solvable by a futuristic quantum computer. It requires to "search" without searching, i.e., spontaneous reply. (v) The decision-making devices of the future cannot carry a giant megawatt power supply continuously. Thermal and electrical noises are the only energy sources. (vi) We encounter a system that uses an unknown language, cannot be understood at all. (vii) Learning the real parameters using which a system configures its response. Complete rejection of black box approach, to unraveling the true dynamics. (viii) A large number of parameters are being born, disappear, change and redefine itself with a truly random, chaotic fashion, when even the variable parameters could not be identified. (ix) Undefinable factors govern a situation. A factor has several sub-factors. In addition, each of those has several sub-sub-factors. Thus, the logical statements inside logic inside logic perpetuate into an endless network [59]. (x) Computing is always a reduction in choices, but in morphing, it is just the opposite. There is a continuous increment of choices and that defines non-computing. Output is more than input.

9 What Is Non-computing? Definition of a Non-computer [4]

(a) The number of choice and quantity of information increase during a decision-making instead of reduction. (b) No finite statement is found; all statements are fractal, not overlapped [98]. (c) There is no sequence of events; it is always event inside an event, i.e., a fractal thread. (d) No measurement happens here; superposed possibilities coexist as a distinct state. The observer becomes an integral part of the morphing. (e) All decisions are logically circular. Nothing exists without a closed loop. (f) There are no data or fact as the decision. It is always a shape changing geometry; the habit of looking at numbers for solutions is unfound here. (g) All solutions are incomplete. They are extended from the beginning to end of the hardware structure. (h) Halting is never there; decision-making never stops. (i) A decision-making happens in the phase network. Mostly, the signals remain the same, only the phase changes. So literally an observer detects no ongoing computation; still, a decision is made. (j) There is no question and answer or argument, only situations. An intractable Clique problem is solved bypassing its criticality [48, 52]. (k) The user or observer does not write instruction. Instead "metric prime is the programmer, it replaces the user." (l) There is no input. User does not search inside the hardware. Using a geometric grammar, it searches its environment.

10 Critical Challenges and the Weaknesses of a Non-computer

(i) A non-computer is not precisely accurate. It gives a global idea or perspective. A non-computer is like a life form, good at those kinds of problems that it solves most. If given, different kinds of problems, a shadow of past analytic protocols are reflected. (ii) Speed, makes no sense, the total time of decision-making are fixed. Decision-making cannot end in principle. An observer captures a solution based on its own time resolution. (iii) Blindly it trusts the metric prime as an encoder of all dynamics in the universe instead of a human user. This is as conventional computers trust that all events could be sequentialized. (iv) All ten deliverables of non-computing are abstract (see below). (v) Instead of signal, the phase or silence between a pair of signals holds the key information. A 3D network of silence is the unit of information, not bits. Hence, particular clocks work [9–11, 15], but a switch alone fails. (vi) Wiring does not work; one-to-many and many-to-one communication is required [16, 17]. Hardware needs a wireless communication and a fractal network with a null screening effect [70]. (vii) Non-computing never stops; it slows down at synchrony. Therefore, there is no static output. The answer depends on the time when the question is asked. Depending on the observer location, the solution changes significantly. (viii) In the conventional computer, noise disrupts the system. Here, noise is fed to activate the synchrony. But a signal affects the decision-making largely, i.e., signal affects negatively. (ix) Addition of resource has no value. It is not number of elements, but the distinct sets of vibrations that make a powerful non-computer. (x) The solution has to be taken from all over the fractal hardware. There is no output and input location.

What is this non-computer going to deliver? The following ten features are not common to a computer. The problem, scope of application and the user protocol are different.

(1) It does not have any software program (no algorithm). (2) It runs by white noise; more randomness in noise is preferred. It uses an ultra-low power; only to manage re-wiring, non-computing does not require power in principle, as there is no reduction, no collapse and no junction. (3) It expands the input information using phase prime metric and hacks nature to predict a gross future. (4) It runs 24-7 as it evolves its wiring by itself for learning, a computation never stops, and “halt” is set by observer. (5) It never performs a search yet finds what it seeks (search without searching). It never acquires a true input; it has all possible input elements already inside as part of the geometric musical language (GML). So, it reads them outside; thenceforth, a spontaneous reply is its operational key. (6) It follows geometric clocking language or principles of composing music to process information. It is hypothesized as a natural language. (7) It has the singular unified homogeneous fractal hardware for doing all tasks of decision-making, learning changes them in their own way, and all tasks are performed by metric prime architecture. (8) The non-computer is made of one element only, clocks. It considers only parameter phase, emulate mass, space and time to process information. Thus, it explores

singularity and uses fractal mechanics [4], nothing to do with classical or quantum computing. It belongs to a non-Turing class. (9) It shrinks massive information into a small geometric clocking seed. It follows a unique superposition of 12 sub-metrics; each sub-metric represents a set of unique geometric patterns. (10) No wiring is involved; a wireless connection to process geometry at all the time scales is allowed in the hardware simultaneously.

11 A Comparative Study Between Time Crystal Computing and the Artificial Intelligence

Linearization of events is not accurate: Artificial intelligence has thus far considered that all events could be expressed as a sum of a series of elementary sub-events. Here the events are not linearly connected. They are intricately connected by phase. It means, if an event has several parts, their intricate relationships are neither in series nor in parallel. A temporal 3D wiring of sub-events is a reality. When one tries to draw the connections, 3D phase wiring should remain intact; one cannot draw it on a 2D surface. Every corner of this geometric wiring of events is important. A corner holds a unique geometric structure inside that is also a 3D network of sub-events. A singular change in this worldview changes everything in the Turing information theory. Consequently, the whole research field of artificial intelligence is redefined.

Why this little change does affects so much? Here, all events are considered as a 3D wiring of sub-events. Then immediately all events turn unpredictable, just like quantum [41]. Say, one is looking into a complicated 3D network. It would appear differently from different directions. Now, the second problem is even more serious. Every event has a 3D network of sub-events inside. It means there is an infinite journey for any observer who wants to find out the basic event that gives rise to all other events. This is a disruptive idea. One could immediately notice that an "event" becomes an undefined function. The third immediate effect is that an observer has to limit its sensing time width between limits. It is not like cutting a tape; it is cutting a 3D rock. If the lower limit is cut, even after cutting the rock appears as the same. Thus, an observer recreates an event: first, by finding a suitable orientation around the 3D event architecture, second, by locating itself where in the infinite journey, it would fit, and finally, to sense it, cutting off the event architecture based on observer's own time limits.

Feynman's singularity bridge [33] (Feynman 1948): This worldview breaks the fundamentals of the information science that has been successful for over a century. The reasons are the following. First, the observer dilemma is that already it is putting its bias into the system by choosing when to see, wherefrom to see, how much to see in the output. Then, the observer should not make a black box to fit nature blindly. Second, quantum fails to probe singularity. When one considers events located inside an event are located inside another event, in an infinite network of events, then it takes us back to the quantum deadlock of the 1930s. Then, Feynman bypassed the singularity to save the quantum deadlock [4]. Bridging singularity saved them. However, the journey they avoided is what makes the nature beautiful. One should not bypass, but explore it [85]. Third, logic and the fitting tools of AI are blamed to be a product of human imagination for creating the abstract black box. This is far beyond reality, only to fit certain observations. Then, one should not avoid singularity, do not use an "educated guess."

The phase prime metric is an explorer of singularity: From this metric, one can build intricate details of an event's 3D architecture and avoid black box. This metric which is derived from experiment with the proteins is to hack nature. It is to replace the "free will of a programmer" from the current structure of the artificial intelligence and information processing. This metric is not a black box, but a starting point of mapping a 3D network of events. Events pours in as time crystals, since each event's time crystal is a set of integer, one finds the exact location of the event where it locks with the metric. Then the missing links are bridged, all associated numbers of 12 sub patterns are activated in the metric, so, we finally get a new set of numbers as output or decision of the information processing. This number set represents the output time crystal. If input time crystal changes with time, output geometric shape changes too. We observe morphogenesis of a geometric shape. If one knows how nature processes information, then the any form of artificial intelligence is irrelevant. Now, a geometric musical language, wherein the letters are a few geometric shapes, is invented. Using this language, a non-computer could search outside. It does not have to wait to get an input. This approach is just opposite to a computer. Understanding the true nature of an event is to replace the black box with something real, closer to nature. It is not the ultimate. Non-computing is a primitive yet significant step to mark the beginning of replacing artificial intelligence with a natural intelligence.

Ten features that constitute our frequency fractal computer distinct [AjoChhand—A = Advanced, J = Junction-free, O = Organic, C = Computer, via, H = Hierarchical (higher level), and H = Heuristic (without programming), N = Nanobrain, D = Development]:

(i) Search a massive database without searching (spontaneous reply). (ii) Multiple nested clocks one inside another enable "a virtual instant decision-making." (iii) No programming is required as "cycles self-assemble/disassembly for better sync at all possible time scales simultaneously." (iv) "Phase space" keeps "volume intact" as required resources only increase phase density not a real space. (v) Perpetual spontaneous editing of slower time cycles (creation/destruction/defragmentation) "prepare for unknown" = higher-level learning. (vi) We introduce "fractal resolution," a complex signal's lowest and fastest time scale signals that are absorbed. Simultaneously, and during expansion, the fractal seed delivers full output, from a seed of information (drastic shrinking of data). (vii) The superposition of simultaneously operating million paths assembles into a sphere enables "extreme parallelism." In quantum, only one Bloch sphere represents all qubits, with increasing numbers we move to higher dimensions, here we build a network of spheres, wherein inside the singularity points which are corners of geometric shapes, more spheres reside, finally, its an infinite network of spheres, within and above. (viii) Time cycle is memory, rotation along the cycle is processing, there are same events, “no transport needed between memory and processing units,” no wiring. (ix) No logic gate and no reduction in choices, which ensures that “speed” is irrelevant. (x) All sensory information is converted to one geometric language that allows “perception;” a yellow color could have a taste. Perception is not a programming as wrongly perceived.

12 Future of Fractal Computing

(1) **Musiceuticals (musical + pharmaceuticals)**: Vibrations could rectify the misfolding or unfolding of proteins (Sahu et al. 2015) or activate new age chemical bots [57]. (2) **Increased human sense bandwidth**: Phase prime metric restricts the time bandwidth of a brain-like computer. By harnessing the phase prime metric, mathematically, human ++ intelligence could be developed. (3) **Halt aging-related processes significantly**: Editing age requires a true phase prime metric hardware to feed cells with real vibrational data. The hardware would correct the clocking errors in the age-related proteins and complexes. (4) **Understanding of the language of natural events like the beating of earth’s magnetic field and every life form**: Geometric musical language (GML) is a universal language. It could be scaled up to replace the fitting with black box, equations, to a group of patterns explaining fundamental physics theories (Feynman 1962) [101, 102]. (5) **Developing a truly dynamic model where we cannot find any logic**, e.g., earthquake, weather change, the evolution of a virus, aging, side effects of drugs, dynamics of gaseous clouds. A non-computing hardware learns higher-level rules. Thenceforth, it bridges the missing links in the information architecture and spontaneously simulates the future instantly. It can morph events much better than the previous cellular automaton-based architectures [16, 101, 102]. (6) **Science of human behavior, society, economics, etc**: The psychological behaviors, emotions and other non-defined parameters would be geometrically defined [115]. One would get a geometric pattern of clocks from the human responses. (7) **Simulate beyond limit or knowledge**: Once built, a phase prime metric hardware needs very little gross information about any event. Then, from that little information, it generates dynamics at time scales that it has never encountered in the past. (8) **Noise would replace signal and enter into the era of ultra-low power**: Earlier, scaling up was like adding more resources, faster speed, more power, etc. Now, it is all about how one could make a device that captures a much longer slice of phase prime metric. (9) **Predict and simulate’ million year evolution in’ a finite time (the science of evolution)**: Currently, there is no tool to estimate evolution because this is a slow process. Non-computer, by using geometric musical language and the phase prime metric, could project a far more reliable picture of the future. (10) **Machines of nature**: The phase prime metric, by intimately interacting with nature, can design scientifically life-like machines; it could be an architect.

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Glossary

Biomaterial Material collected from Biological living species.

Bloch sphere Quantum mechanics is a dynamics of system points active between classical states. So, the system points can acquire a large number of solutions, we keep a pair of classical states at the pair of poles of a sphere, while the actual solutions are located on the surface of the sphere. These solutions are phase points, and the sphere is called Bloch sphere.

Fractal clock Normal clocks are circular, and a system point moves around it. Quantum clock has an additional geometric phase counter, but a fractal clock has infinite chains of clocks; so it is not just a counter, it represents a changing topology.

Fractal computing Undefined phase space of singularity domains in a system is harnessed to apply phase prime metric suggested integration of vibration. This way of integrating and extrapolating events to the future is fractal computing.

Fractal tape A tape whose every single cell contains a tape inside. One version of such a tape is a circular ring with finite cells.

Geometric algebra A study of mathematics to fuse geometry and algebra. It is not just algebra of geometric shapes; it is also finding the hidden geometries in the algebra.

Hierarchical perception A hierarchical perception is made of two kinds of information feeding each other. Symmetries that integrate a set of discrete information created by unique different definition of information are hierarchical information. When both lower level and higher level information are about cognitive ability, it is hierarchical perception.

Image processing A method for identifying the geometric shapes hidden in an image using algorithm.

Information theory Information could be any finite state with a significance, the method to process the states such that the significance of information content is properly justified.

Microtubule A nanowire made of a hollow tubulin protein cylinder with a dimension of 20 nm to 30 nm, and inner core is a solid water cylinder. It is found in every Eukaryote cells, say, all animal, plant, protista, and fungi cells have these nanowires, whose primary objective is to run primary cell events. Most part of a microtubule is water.

Neuron It is a non-dividing cell whose membranes or cell skins have highly evolved over the years to pass electric current.

Phase prime metric A pattern of all possible choices a given number of events could be grouped.

Protein Protein is a long chain polymer which folds with water such that is forms various elementary geometric shapes called secondary structures. It is the building block of life.

Quantum computing Harnessing the phase path between two classical states, classical computing speed is increased enormously. This is called quantum computing.

Resonance Periodic oscillation has a frequency. If a system is triggered with an external signal with the same frequency at which the system naturally oscillates, then several vibrational modes canalize energy into one; thus, one observes a surge in the energy of oscillation of a particular mode.

Singularity It is a point in a set of system points, linked with all other points in a set via well-defined dynamics, so it is accessed, but does not deliver a defined value. At singularity, the function representing the dynamics that links the events becomes non-differentiable. One reason for this to happen is the fractal nature of subset points around a given singularity point.

Synchrony More than one oscillators match in one or more oscillation parameters.

Time crystal Singularity of a space is measured as mass, so we get a spatial crystal when there is a space, and 360° rotation around a point in space one finds more than one singularity points or mass. Similarly, singularity of phase is measured as time; in a 360° variation of phase if one encounters a pair of such phase singularities, it is a time crystal. Just like one point of mass cannot create a crystal, one point of phase singularity cannot create a time crystal.

Topology Geometric shapes could acquire various symmetries or an order in its arrangement. Ordering in geometric shapes follows certain properties, topology is its study.

Turing tape A tape that encodes any information as a sequence of unified simple information in its cells.

Universal language A method of expression of information following which all possible information could be encoded and processed.

Wireless communication Electromagnetic packet of energy could travel without a medium. Using this property, one could send signal from one point to another.

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