tattvamasyādivākyena svātmā hi pratipāditaḥ/
neti neti śrutirbrūyādanṛtaṁ pāñcabhautikam // Abadhuta Gita

If we argumentatively state to correlate "Who am I" with every single object of this body and the universe, then we continue to get "not this" and "not this," eventually what that is left is the innermost conscious being that defines "me."

9 Brain Jelly to Humanoid Avatar—Fractal Reaction Kinetics, Fractal Condensation, and Programmable Matter for Primes

9.1 NEUROMORPHIC DEVICES ARE NOT ALONE—17 BIOMORPHIC DEVICES SING TOGETHER

Culturing 3D human brain architecture would soon grow exponentially (Pasca, 2018). By now we have learned that brain jelly is a mathematician who plays with primes to find a similar set of primes in an apparently different integer (Reddy et al., 2018). A problem is a lack of symmetry in the geometry of the time crystal that is applied to it and the solution is to find what geometric changes need to be carried out to regenerate the symmetry. Brain jelly identifies the lack of symmetry and checks memory whether it has already got those pieces of geometric shapes as clocks in its memory bank, if not it assembles the missing pieces and sends it to the questioner and or tries to acquire those pieces. Thus, a brain jelly not only simulates the future, but it can also carry out an intelligent conversation, and provide an intelligent solution to the problem. Say, one kid writes $2 \times 5 \times 3 \times 7$, now, like an obedient student; brain jelly would synthesis the associated organic product and then, if in its memory any structure was created before containing this group would start vibrating, self-assembly would trigger. Not just that, 2×5, $2 \times 5 \times 3$, $5 \times 3 \times 7$, all possible compositions would find neighbors and the integers which have a similar number of compositions of a set of primes would come together to self-assemble. It is unique, because the number of compositions is important not the primes used, $2 \times 3 \times 7$ and $41 \times 37 \times 47$ would be similar. Thus, synthesis of a material analog of a phase prime metric (PPM) (see Chapter 3 for details) continues spontaneously in the brain jelly (Strogatz, 2003), until there is a saturation. Coiling and supercoiling of vortex or helical filaments in oscillatory media is brain jelly's key bet (Rousseau et al., 1998), it is not electronics, a superior version of claytronics (Goldstein et al., 2009). A brain jelly would evolve materials as evolutionary computing (Eiben and Smith, 2015). It would be read by imaging the optical or magnetic vortices emitted by brain jelly.

One of the prime questions then arises how does a brain jelly carry out an intelligent conversation. When input information enters into the brain jelly as a time crystal, the data acquisition system in the sensor system acts in a pro-active manner, not like reading a stream of bits. The brain jelly inspired sensors have to build a time crystal, hence, instead of a bit as a function of time they acquire 10 different types of data (see geometric musical language (GML) in Chapter 3). We repeat that brain jelly sensor acquires a geometric shape made of singularity points, the clock speed or the rate by which system point changes the phase, the duration of silence or phase, the rotational direction of the system point, the noise tolerance that tells the diameter of the clock, how many distinct channels are there and if there are inter-channel signal pattern, the imaginary layer interaction, the relative amplitudes of different clocks as intensity ratios and the ratio of frequencies as the ratio of primes. These 10 classes of information were always there in natural interactions, time crystal-based FIT, the new information theory enables acquiring information content that was never taken into account. Nonlinearly coupled Hamiltonians of a large number of *H* devices, they sync and desync to grow dynamically and to deliver thinking for a brain jelly (Gupta et al., 2017).

However, there is an important query that the time crystal sensor makes, after acquiring the 10 types of row data for the time crystal. These four queries are to build a linguistic structure. First, what is the slowest clock in a compounded wave stream, that would be the host clock, in linguistic terms, the slowest clock is the subject who does the job. Second, what is the fastest clock, since that would tell linguistically, how the job is done. Third, the clock that is very sensitive to perturbation is the condition when the job is done, in a linguistic term that is a predicate, and finally the fourth clock that is least sensitive to perturbation is the answer to the query, what. The four-layer linguistic query is structured as a quaternion tensor, the data of the time crystal may be a dodecanion or 12D tensor, but, each dodecanion tensor is packed in a quaternion tensor as soon as brain jelly acting as a sensor acquires a data. During entire processing in the brain jelly, below the quaternion, the structure of information is never broken.

Magnetic field projected self-assembly: a key to synthesize a PPM in brain jelly: Brain jelly is a gel like liquid made of a spiral nanowire, that is a fourth-circuit element Hinductor, *H*. As said earlier, *H* builds the magnetic vortices and projects that field all around as a function of stored charge, it senses the cavity around it, builds a 3D distribution of potential centers. It requires 17 key components to build a brain-jelly-based humanoid avatar (Figure 9.1). To trigger a PPM synthesis, one has to pump a signal at a particular phase, repeatedly to an assembly of uniquely arranged oscillators, then they would activate complex vibrations and synthesis of materials following PPM (Lewis et al., 1987). Simplest geometric code is a triangle, three frequency quasi-periodicity could appear like chaos (Linsay and Cumming, 1989). Therefore, we could mechanically shake, trigger electromagnetic signal, or even pump magnetic pulses in a liquid solution of *H* nanowire or its gel. Magnetic field pattern in the projected vortices of *H* from a few new *H* devices. This assembly is like a nest that builds the future cage to hold more *H* nanowires, and as soon as the cage is filled with *H* devices, the output vortex creates the next version of the field distribution. So, once a seed pattern is written in the solution of *H* as a nucleus of gel formation, it triggers continuous self-assembly of the *H* devices. We convert input data into a universal time crystal using time crystal analyzer (TCA, Chapter 3), a software module. From time crystal, one could estimate the possible pattern of *H* devices, a seed of *H* devices that nucleates in the liquid and triggers spontaneous gel formation. Form a seed we see live the self-assembly of *H* devices into a giant structure. In a conventional self-assembly process say a tiny seed of ZnO crystal grows into a giant structure we see the repetition of the same 1D, 2D, or 3D lattice, over and over again. We may call crystal a fractal, but that self-similarity is not the case here. Here in the new kind of self-assembly, the seed structure is not cooked by the natural material property. Therefore, the geometry of seed structure is not restricted by the lattice limits found in nature. Possibilities are infinite. To write a time crystal input, we create nodes and antinodes in the cavity filled with the brain jelly, which is a special liquid of organic ligand molecules. As the time crystal of the information input builds H, first it sets the geometric parameters of the elements to be synthesized, i.e., length, pitch, diameter, and lattice of element-assembly. The instructions are written as vortices of field distribution in the liquid. Then the *H* devices come to the vicinity as the float in the liquid and build the seed lattice. The seed starts growing following the projected path set by magnetic field vortices generated by *H* device and thus follow the PPM as described in Chapter 3. The growth continues beyond input as PPM takes the control. The final saturated structure projects magnetic field distribution as the futuristic dynamics of the

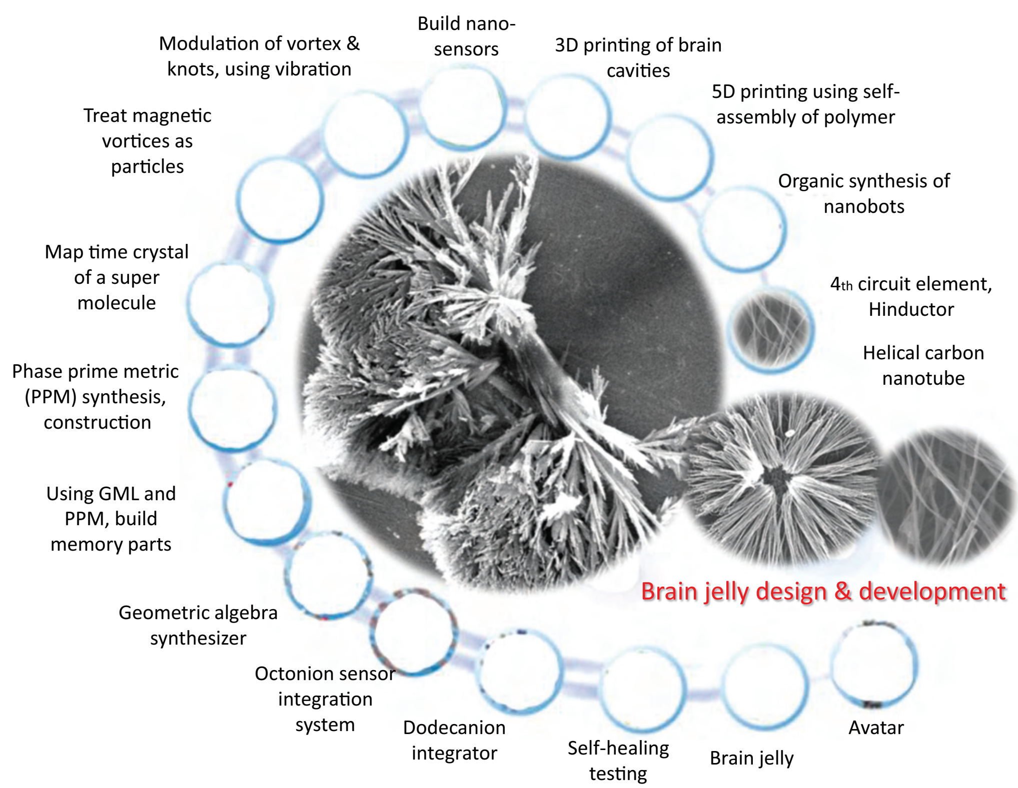


FIGURE 9.1 Brain jelly synthesis process is described step-by-step. The first step is the synthesis of a fourth-circuit element Hinductor and the last step is to build a humanoid avatar. Inside the spiral pathway, a few Scanning Electron Micrograph (SEM) images are captured for the growth of brain jelly.

input information, that structure is analogous to an algorithm. If we want to read output, simply pump electromagnetic signals of different frequencies and 3D temporal dynamics of output magnetic vortices would contain a series of solutions. Thus, brain jelly works. The question is why we don't see a repetition of the same input lattice as a fractal? The reason is that the magnetic field projection follows the same method as we multiply primes to create an integer space in the number system. Pattern of primes evolve in the integer space, so is the output of brain jelly. Field projected self-assembly is different from thermodynamic lattice self-assembly that we see around us every day.

Frequency fractal hardware = brain jelly: Frequency fractal is a fractal that may or may not look like a fractal, but it's all kinds of resonant oscillations for wide ranges of activated cavities and dielectric materials filled with wide ranges of carriers are measured as a function of time, then one may find self-similarity. The groups of frequencies form higher periodically oscillating groups, ratio of bandwidths of groups follow the pattern of primes across the entire frequency range. Dissimilarity is governed by pattern of primes, this is called frequency fractal. Computing hardware that would implement a fractal machine would follow the geometric language of primes, where 15 primes and 15 geometric shapes would rewrite any information content as events in the universe. The hardware does not care how a system's materials are arranged, but it cares about the geometric arrangement of clocks, for the time being in this book the exploration is limited to 11 imaginary layers, i.e., algebra of dodecanion, a 12D tensor. Information is an 11D time crystal presented as a quaternion, octonion or dodecanion, the time crystals are synthesized by manufacturing vortex atoms made of magnetic, electric, ionic, mechanical ripples. The unique material is named as brain jelly.

The historical background for the soft truly autonomous robotics: When engineers cut objects into pieces and then reassemble them into the desired product, it is subtractive engineering. When added liquids, jelly, or diluted materials are crafted into a pattern, which solidifies into a desired product, it is additive engineering (4D printing Eujin et al., 2017). For example, recently resin was pumped with electromagnetic fields to convert the desired part of an entire solution in a 3D object. Apart from fusion of materials (Li et al., 2018) some researchers are trying fractal condensation to grow and evolve all parts of an object at a time, continuously, just like a human body or brain grows from a single cell. Synthesis of a product spans over a vast length and time scales simultaneously (Rabitz, 2012). Recently multi-level evolution is being explored (Howard et al., 2019) in an effort to use existing suitable materials or finding a guideline for designing materials for the next generation robots (Fischer et al., 2018). It is bottom-up continued automation that designs and edits the robotic parts across multiple levels of a singular robotic architecture and transforms them into tasks by accommodating with the environmental conditions. Multi-level evolution is a concept that proposes to explore the constituent material building blocks, as well as their assemblies into specialized diverse functional and sensorimotor configurations. Multi-level evolution is to advance industrial production. However, fractal condensation that is triggered at multiple singularity points at once in a vibrating material may offer a new type of evolution. Therein, fractal reaction kinetics (Kopelman 1988) or hierarchical memory in the chemical beaker during an organic gel-based superstructure synthesis are all parts of a true multi-level evolution that would spontaneously capture time crystals as information content from the environment and evolve the PPM, i.e., the mind of an artificial brain (Barrett, 2011). Thus, most robots are bodies with brains, but here a time-crystal-based PPM brain would be a brain with bodies (Meng et al., 2017). Here information content, i.e., time crystal of a given structure runs its clocks which carries out morphological changes in its supramolecular structure (Hauser et al., 2011). During transformation of geometric shape, the PPM regulates fundamental changes required to attain symmetry, which in turn triggers continuous self-modeling of the hardware (Bongard et al., 2006). The construction and operational challenges are plenty for the soft robots (Lipson, 2014; Rus and Tolley, 1999), yet, they would adapt with environment like living life forms (Cully et al., 2015). Thus, there is an enormous interest for the development of entirely soft, autonomous robots (Wehner et al., 2016), to enter into an era of the evolution of things or real objects from the software-based evolutionary computing of the old days (Eiben and Smith, 2015).

Self-assembled growth of all brain components: Once the oscillatory equivalents of all 17 organs of the brain are built, the next task is to combine them together. There are two major approaches we need to adopt. First, some parts of an organ should grow by themselves, because we cannot interfere in the molecular processes, for the same reasons, which prohibited us to chit-chat with the learning process and controlling the encoding process of the artificial brain directly. Second, the majority of organ parts will be constructed through a non-self-assembly process. The reason for adopting two policies is that with available technology it is not known how to cook an entire artificial brain in an artificial womb. We see the design of an artificial brain (Figure 10.1). There are two parts of this brain architecture, the upper part is the processing unit, and the lower part replicates the entire body of a living life form. All five sensory organs, including the touch sensors, arrive, synchronize, and then through a vertical column it goes up eventually to the brain-stem region. This vertical column resembles the spinal cord and the upper spring part replicates the design of an artificial hippocampus. The sensory-signals are not always mixed at the hippocampus, for example, smell-senses first reach the olfactory cortex, where from the signal is sent to the entorhinal cortex, where signals from other sensory organs mix and a fantastic linkage are created, specific to particular individual and species.

Neuromorphic no more: How are the 17 organs differ: In the early days' people used to talk about neuromorphic devices; now we can argue for protomorphic to build protein analog and then corticomorphic to build cortical column, etc.,

	Brain components	Primes in design	Analogue materials used for construction	Emulated device
1	Protein	2-19	PCMS, a PAMAM based organic molecular system	Protomorphic
2	Microtubule	2-13	Electron receptor doped helical carbon nanotubes, CNT	Tubulomorphic
3	Neuron	2-23	3D polymeric matrix, PCMS versions, CNT versions, H3	Neuromorphic
4	Cortical column	2-23	H3 devices are self-assembled into 2D sheet, tube, fiber, S	Corticomorphic
5	Nucleus	2-23	S is assembled into spirals that edits variable lattices	Nucleomorphic
6	Cranial nerve	2-13	Semi-rigid cables mold into right geometry, H3 covered	Cranio morphic
7	Spinal nerve	2-31	Semi-rigid cables mold into right geometry, H3 covered	Spinomorphic
8	Connectome	2-5	3D printed fiber tracts are dip coated layer by layer in H3	Connectomorphic
9	Cortex top layer	2-47	Connectome is dipped in H3 solution to build columns	Cortexomorphic
10	Basal ganglia	2-19	Nucleus, i.e., flexible H3 based spheres selfassembled	Basalomorphic
11	Brain stem	2-17	S devices, H3 are organized into proper prime symmetry	Stemorphic
12	Thalamus	2-19	Cross wires sensory inputs, so all prime symmetries added	Thalomorphic
13	Hippocampus	2-17	Nucleus, S and H3 are mixed into an antenna, receiver	Hippomorphic
14	Cerebellum	1-11	Nucleus, S and H3 are mixed into fibers that links output	Cerebellomorphic
15	Hypothalamus	2-17	Nucleus, S and H3 are mixed into fibers, links clocks	Hypomorphic
16	Limbic system	1-19	3D printed graphene doped antenna architecture, fornix	Limbomorphic
17	Blood vessels	2	Mechanical tubes 3D printed pumped at ultrasound	Mechanomorphic

Sensor building
Eye: optical sensors are attached to mechanical motors
Touch: Pressure temperature sensors pasted on a rubber sheet that covers avatar
Taste: chemical sensors of various types are added on a 2D rubber filled with jel
Ear: Sound sensors are arranged in a 3D orientation to morph mechanical vibration topology
Smell: chemical sensors are attached to a pair of tubes for air molecule sensing
Propioception: ear, visual and touch sensors are circuited for 3D perception
Time: Different clocks are circuited as single clock

FIGURE 9.2 A table describes the journey from the old school of neuromorphic devices to the N-morphic devices, where $N = 17$. There are five columns, PCMS = PAMAM, controller, molecular rotor, sensor. Oligomer-based various gel synthesis is also part of the multi-morphic device synthesis. There would be the development of seven sensory devices.

17 such key components are necessary (Figure 9.2). When a sensory data enters into the brain as a 3D time crystal, the multi-layered seed material that absorbs the time crystal resonantly oscillates like a single molecule. The brain jelly or H-assembly acts like a filter that carries out multilayered fractal decomposition process as described above. As a result, all fractal seed-groups in the input time crystal are automatically separated in a multilayered architecture (see the superposition of fractal section for details). Thus, a single image encoded in a time crystal is itself resembles to an intractable Clique problem, i.e., the brain jelly has to identify 15 encoded patterns of GML in an input pattern. When several kinds of information are linked as time crystal and form a 3D integrated superstructure of time crystals, then PPM sets the rule of phase transition. Then the geometric structures encoded in a complex time crystal could be accessed by a brain jelly through various pathways in the superposition of many pathways. It leads to a very interesting situation. During computation, even at a very local level, at any layer of gel structure, any subtle noise may select a unique high-density path suggested by PPM, that would change the entire computation pathway and re-write the whole sequential programming. *H* device output, if we measure using a multi-frequency lock-in amplifier, looks like a stream of waves with different frequencies, whose relative phase relationships change with time following a different pattern. As noted earlier, time crystal analyzer reads which frequencies change in groups, when signals become undefined and disappear/appear from detector to find the continuously changing time crystal. It is how brain morphic devices are characterized, simultaneously.

How brain morphic devices interact, bond: The PPM regulated artificial brain cannot operate faster than the time required to initiate a phase transition of the slowest time crystal. The system point of a clock that has "one second" resolution moves to the world with a faster clock say "one-microsecond" resolution through the singularity; there, one brain morphic device may encounter another brain morphic device. System point gets the information into faster morphic devices and returns to the "one-second" resolution world where to an external observer computing is being performed with no detectable time lapse in the "one-second" resolution clock. In simple terms, take input in slower clock domain, send it to a faster clock domain, solve and return it to the slower clock domain. It is similar to harnessing "negative time" in quantum mechanics, but instead of one here we have multiple imaginary worlds, each with different clock speed. In order to implement the mathematical foundation of several imaginary numbers (generalized imaginary number, iota or $i^2 \sim p$, where $-1 < p < 0$) we can use the fractal mode of resonance frequency bands and investigate the possibility of realizing a similar advantage. Different p values suggest different clock-worlds. The materials of a layer are used as a seed that constructs the next layer; hence, the dynamics of each layer are totally different. When we probe molecular bonds in a crystal, the dynamics of crystal and electrons within atoms do not appear; they become non-existent and thus came the concept of imaginary spaces. In the 17 brain morphic devices different feedback protocols act to address different values of p (Figure 9.2). The generalized imaginary numbers simply denote different degrees of feedback from nowhere, adding a feedback function from nowhere for matching the time crystals is a feasible approach.

9.1.1 A Description of Peculiar Designs of Critical Brain Components Using an Organic Gel

Seventeen brain analogs were selected by studying pattern of primes in the geometric shapes of all brain components. An organic synthetic analog for all of the components would generate a layered composite, which would build a composition of 17 PPMs, a distinct metric for each brain component. Sahoo et al. have built a new simple technique to synthesis spirals and their supramolecular assemblies as network of a gel rapidly in the solution (Sahoo, 2012). The artificial brain that Singh et al has built is a hybrid device, gel-based supramolecular structure, tiny 3D printed wires, many commercial nano-sensors, organic and both organic, all were there. Power was supplied only to the sensors and pumping them to send the time crystals throughout the humanoid avatar body. Using EEG on avatar brain they confirmed that signals are passing through from sensor to the EEG.

Artificial protein (protomorphic device): We get elementary time crystal from a fourth-circuit element, H, but its operation is fairly limited. In order to sense a complex time crystal, multiple elements need to arrange such that they have a different number of loops in the helices, or length. The number of helical loops could be changed according the job description, it could be any integer series with certain gaps. The gap follows a rule, the number of rings of participating H elements follows cyclic rules, e.g., three H elements could have a number of rings 6–2–6, 5–4–5, four H elements forming an assembly would have rings 3–4–4–3, 6–11–11–6, etc. These cyclic assembly of elements are generated to manipulate the knots of darkness produced (see Chapter 8 for details) using different carriers at higher spatial scales. By editing the number of rings in a spiral, information could be manipulated in synthetic protein-like materials, 17 brain analogs.

Artificial protein complex (tubulomorphic device): Microtubule like filaments, ribosomes, several protein complexes carry out important tasks in the information transmission and evolution of a life form. Plenty of spiral nanowires are available in the literature, produced synthetically or found in nature. One should neglect many biological features, for example, dynamic instability of microtubule, and copy information processing features like change in the lattice structure of proteins on its surface.

Artificial neuron (neuromorphic device): To recall, to build an artificial neuron, we need multiple distinct symmetries inside a molecular architecture whose dynamics are associated with the structural relaxation and electronic transition or conductivity, at the same time, some symmetries should add capabilities that of an antenna. It is possible if and only if we introduce hierarchical helical architecture. Then, at the basic structure level, electronic switching would be programmed in a helix, and in another level we may use the helices together to construct another basic structure with which the antenna-like feature is encoded. Transporting carriers through that helix is the next issue. Several spiral nanoarchitectures promise ballistic transport, which is a quantum effect (Grigorkin and Dunaevskii, 2007). The dimension of this architecture and electronic properties associated with the transport of carriers in this material is a crucial factor. Wire is used in making the spiral assembly of capacitors so that it charges up and generate magnetic field during energy transmission; this particular feature turns the material as self-radiating antenna under certain conditions. The crucial point of magnetic vortex generation is an essential feature of the artificial neuron design. One could study time crystal based neural network in a simulator.

(i) Add new neurons, even cluster of neurons, fold brain cavities as required: The computer is allowed to construct new neurons as necessary and change its wiring as the situation demands in a software-based neural network. On several occasions, in order to create a replica of an external time crystal, if a cluster of neurons is required then, an entire cluster could be generated. The brain simulator is fed with images, sound, touch, smell, and taste input as 2D patterns as described above as a function of time. The software automatically creates the neuron firing like stream of pulses and build time crystal as described in Chapter 2. Sensors build time crystal, thus, store the input images or sounds as rhythms. During learning, if a rhythm change is required, a new clock is added, subtracted, rotation direction or diameter of the clock cycle is changed, modification happens in the time crystal, later the circuit is changed. The brain organ deforms or folds in its surface even inside the soft computer, when we follow the above protocol. (ii) **The computer sleeps** and during that time, local time crystals, which are wrongly placed at different locations, are placed at right locations. The computer goes to sleep as soon as it finds that rhythms are stored in such locations that are hindering the search and find, spontaneous reply and the transformation process, as soon as the evaluation, defragmentation, and normalcy restoration is done, returns from sleep mode. (iii) **Self-evaluation, new and better experiment, virtual neural network evolution:** The computer experiments with the circuits, if certain kind of wiring enables it to reconstruct rhythms faster and transformation between time crystals undergo more efficiently than previous protocols, then it analyses the hardware modification and changes the virtual neural network fundamentally. (iv) **Simulates the future, analyses multiple routes and then determines the most suitable ones:** The simulator runs feed-forward loops to evaluate the faster synchronization routes; synchronization means matching via search and find process. The same could be realized more profoundly in an organic jelly.

Artificial cortical column (corticomorphic device): A cortical column has seven layers, surprisingly in the cortex layer of the brain, the input time crystal enters from the top, output is generated from bottom part of a cortical column. A total 29 types of neurons were studied by Singh et al. (2018) in creating a large variety of cortical columns in the simulator, before organic jelly-based artificial cortical columns were built. Now, an assembly of *H* devices that builds neurons, act as a unit and self-assemble like a cylinder, analogous to a cortical column. Ghosh et al. built similar cylinders using PCMS (Ghosh, 2015b, 2016b).

Artificial nucleus (nucleomorphic device): As described in Chapter 7, the nucleus is a nearly spherical or ellipsoidal assembly of neurons wherein a small region a large number of symmetries could be encoded. It means, we want to encode say the PPMs for prime series of 2, 7, 13, 29, the organic jelly based artificial nucleus would transform the assembly. However, the same jelly would transform into the prime series of 3, 13, 31, 43, if required. Now, once according to requirement, the jelly solidifies into a cluster; it remains stable. In the biological brain, nucleus begins like an empty matrix and fills up complex functionalities depending on locations and necessity.

Artificial cranial nerves (craniomorphic device): Cranial nerves are part of the peripheral nervous system (12 + 31 = 43), they coordinate sensory input for vital life actions. Mostly such sensory input to the artificial midbrain is realized by a typical choice of dielectric materials while constructing the nerve fiber. The idea is that cranial or spinal nerves follow C2, C3, C5, and C7 symmetry, and the structural parts of the destination organs or their parts use a similar symmetry, since they are built by similar dielectric material. Thus, time crystal transfer without a break.

Artificial spinal cord (spaniomorphic device): The spinal cord is connected to skin nerve network for time crystal input via 31 pairs; additional 31 pairs of motor nerves run in parallel with the input channel to send action instructions to the body motors. Conducting gel-based spiral, long fibers are grown around insulating cables to connect sensor with the analogous spinal cord cavity, built by 3D printing. Nanomaterials with nano-touch-sensor, pressure sensor, and thermal sensor properties are mixed together as artificial skin cells. Each cell connects to conducting fibers. The holes of spinal cords are self-assembled with gels to connect motor network and spinal sensory input fibers which run parallel.

Artificial connectome (connectomorphic device): Connectome architectures are freely available online for 3D printing. Porous tube-like 0.2 millimeter-thin fibers were constructed during 3D printing of connectomes. Porous feature helps in adding organic jelly made of spiral fibers and build a continuous network of nanofibers to transmit time crystals from sensors spread all over the body to the brain, and carry decision time crystals to the brain response system.

Artificial cortex (corteomorphic device): Forty-seven functional regions suggested by Brodmann are created by hexagonal close packing of capillary tubes each filled with seven layers of organic jelly (Ghosh, 2015b). More than 120,000 such columns are distributed over 47 regions to replicate the cortex circuits.

Artificial basal ganglia (basalomorphic device): Basal ganglia has 13 sub-components, using organic jelly similar supramolecular architectures are grown in the 13 tiny 3D printed cavities. The ratio of resonance frequencies follow patterns made of primes 2, 3, 5, 7, 11, and 13.

The artificial brain stem (stemomorphic device): Brain stem is created with 17 nuclei, each specialized to process particularly prime-based metrics described in Chapter 3.

Artificial thalamus (thalamorphic device): Since fundamental drives are to be programmed here, very basic geometric controls are encoded here in all operational time domains, so that irrespective of the time crystal generated in the artificial brain thoughts, particular geometric integration or grouping is forcefully imposed.

Artificial hippocampus (hippomorphic device): During the search and find a process, the resource and encoder antenna in the artificial hippocampus should remain pristine; to save their information purity we introduced two buffer-antennas for internal communication. Similarly, the hierarchical antenna could itself get modified while implementing the rules of transformation on the upper brain time crystal-cluster, so it requires another buffer antenna. The time crystal transformation process is the most critical part of the artificial brain operation, it should be a standalone process controlled by two more antennas independent of both artificial hippocampus and artificial forebrain. The process requires two buffer antennas to take input from higher brain and resource antenna and send output to the resource buffer antenna. Therefore, four giant organic antennas operate simultaneously (cingulate gyrus, hippocampus, hypothalamus, and fornix); higher-level rules are superimposed on the input time crystal cluster to govern search and find process without disruption from any operation in the brain. These antennas are called "transformation antenna." To summarize, the artificial brain is embedded with two layers of tiny antennas inside every single neuron, then there are four pairs of antennas—resource antenna pair, encoder antenna pair, hierarchical antenna pair, dual transformation antenna pair.

Artificial cerebellum (cerebellomorphic device): Cerebellum is mostly a fractal architecture within a selected cavity as described in Chapter 7. For cerebellum there should be two fractal architectures—one propagate horizontally and the other vertically. In the central region two supramolecular architectures crossover. Two orthogonal fractals naturally synchronize wide ranges of time domain signals as singular coherent output time crystal.

Artificial hypothalamus (hypomorphic device): Processes time crystals similar to the thalamus. However, one additional geometric feature is added here, virus-like geometric codes as tiny isolated time crystals, propagate throughout the system, wherever there is a match, forms a bond by adding a linking clock. Thus, the drive for a particular desire is programmed as movable time crystal in the supramolecule, desire is also a time crystal filtering process during synthesis of decision-making time crystal and learning.

The artificial limbic system (limbomorphic device): For 3D printing high-energy radiating materials are used to build a receiver and an antenna operating together. Cortical column or hippocampus (both have same architecture H3), inspires the core structure design of every single brain component.

Artificial blood vessels (mechanomorphic device): Blood vessels generate mechanical rhythms in the brain with heart beats in the biological brain. The five-fold and seven-fold symmetric structure of blood vessel network are 3D printed using elastic materials (only for the brain, we neglect blood vessels of the body) that vibrate like the real network in the brain when resonated by ultra-sound pumping.

Filtering the slower distinct yet time crystals in the upper brain or cortex: Two major antennas are there in the artificial brain—cingulate gyrus and fornix. The basic core part of the midbrain interacts with the higher-level information processing parts located in the pre-frontal cortex, PFC. In terms of time crystals, PFC analogue hardware analyzes how very slow rhythms are given highest priority in the organic nano brain and brain-jelly-based brain. We return to the neural network of the artificial brain, where due to the continuous transmission of time crystals from the resource-antenna, smaller and larger size time crystals are being constructed. The associated expansion of active rhythms or time crystals via PPM is noted as **self-assembly of time crystals**. These time crystals are a replica of the quantized time crystals created in the helix resource-antenna RBA, the hardware analogues of gyrus and fornix. Some of these time crystals might be already existing in the brain, some of them were coupled with them during old experiences also get excited. Thus, the size or the number of clocks/rhythms of in the emerged time crystal-cluster increases, this process generates several slow rhythms built to link the participating time crystals. Therefore, resultant time crystal-pattern spreads all over the neural network of the upper brain, or artificial cortex. To make sure about the new time crystals, a cyclic update scheme runs: resource antenna ↔ upper brain ↔ resource buffer ↔ encoder buffer ↔ encoder antenna ↔ upper brain. A few cycles in this loop creates an equilibrium of input time crystal cluster in the upper brain.

The supreme role of the virtual forebrain and hierarchical antenna: At this point, the higher-level brain or forebrain, which holds the convergence rules or slowest rhythms activates, acts like an antenna (hierarchical antenna HRA subroutine) that transforms the expanded input-time crystals into more symmetric 3D architecture of clocks via a pair of transformation antenna to be described in the latter part of this chapter. In the majority of the morphogenesis of input time crystal, the transformation process in the higher brain, PFC, drastically shrinks the size of the input-time crystals-cluster. Actually, the higher-level brain simply stores from the experiences as "transformation rule," i.e., identifies what kinds of complex decisions we took for similar situations, under the similar time crystals, and simply try to impose that in the current given scenario. The "transformation rule" are time crystals that is built to link particular patterns of integers in the PPM. As transformation continues and equilibrium is established, the new sets of time crystals are sent to the resource-buffer antenna for identification of the differences between the input and transformed time crystals. The uniqueness or time crystal that could directly generate the transformed time crystal by higher brain with the help of PPM is identified and returned to the upper brain for permanent storage and the associated rule is sent back to the higher brain (an analogue of human forebrain to be precise) via encoder antenna. A hierarchical loop antenna ↔ upper brain ↔ resource buffer ↔ encoder buffer ↔ encoder antenna continues until equilibrium is reached, i.e., morphogenesis of time crystal ceases to expand. Input time crystal cluster creation loop and transformation loop do not conflict since the later operates actively only after the first loop reaches equilibrium.

The dual role of encoder antenna: The encoder antenna thus performs two vital jobs at a time, the storing of permanent memory via delicate filtering and triggering higher-level logical rules, or hierarchical antenna simultaneously. When new rules are stored in the forebrain or associated parts of hierarchical antenna, it is called "learning," and the difference between the input time crystals coming from the environment and the output time crystals coming from upper brain is the creative decision, constructed in the resource buffer antenna. The shrinking of largely expanded time crystals in the upper brain is intelligence. Unlike conventional brain builders the intelligence and creativity are strictly defined parameters in the hardware, thus tunable at will, the output solution is captured from the resource buffer antenna.

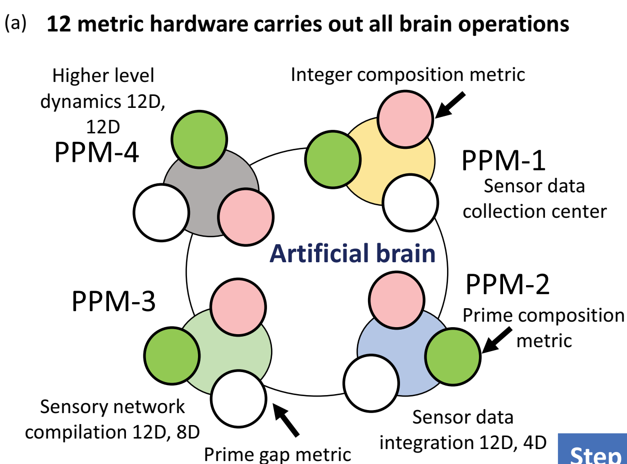
9.2 A HEXAGONAL 2D SHEET OF CORTICAL COLUMNS—A CARPENTER'S JOB

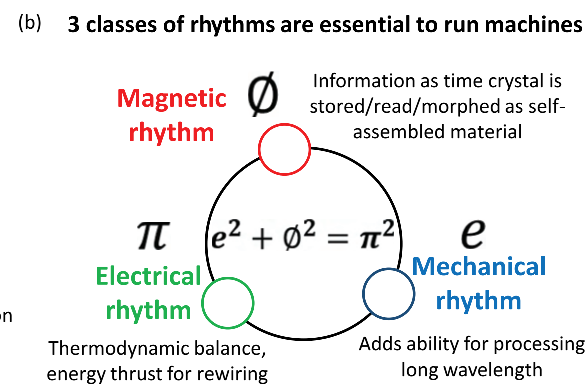
How the artificial brain decides wherein the actual system changes need to be made for self-assembling the time crystals: The necessity of beating: During resonance, if two frequency points are nearby, then a new phenomenon is generated in the hardware; this is called "beating." It causes a unique ripple effect in the localized neighborhood. The beating effect identifies the exact location of the hardware needs to be changed and how much changes are required to nullify the beating effect. In a real human brain this beating effect would identify which neuron needs to be changed, those would change structure and re-orient by firing, just like rockets maneuver in space. It is the hardware mechanism of self-assembly of time crystals. Beating is taken care of by four PPMs running in parallel.

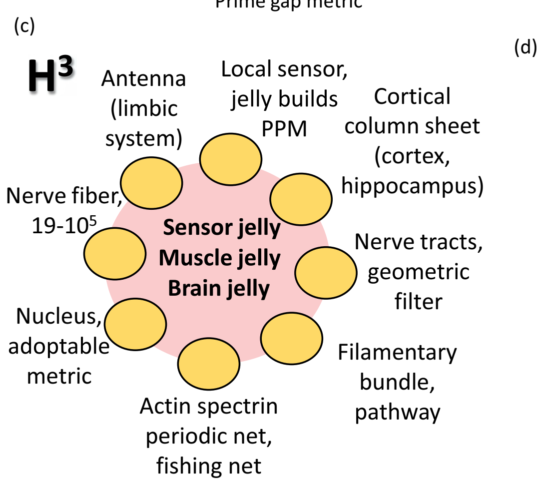
9.2.1 The Collective Response of Quad Patterns of Primes

Development of 17 different brain components requires 17 PPMs. Figure 9.3a outlines four different metrics similar to the one we described for modeling the human brain. However, a generic engineering perspective is shown here. Four different metrics are PPM-1: sensor data collection center. PPM-2: sensory data integration. PPM-3: Sensory network compilation 8D, 12D. PPM-4: Higher level dynamics. Each metric has three parts. First, integer composition metric, prime composition metric and prime gap metric (see Chapter 3 for details). Seventeen brain components do not belong to sensor class, not just PPM-1, but they all need PPM-2 and PPM-3. Only the cortex part is made of PPM-4. Now the most important concern, how to build the simplest and the most elementary device of the brain (H3, see Chapter 8) from which constituents of all seventeen brain analogues could be produced. There are two key features one has to take into account while building the artificial organ. First, the selection of materials, all materials in the brain would be made of H or Hinductor devices and all H devices would show the $e-\pi-\phi$ resonance behavior (Figure 9.3b).

A journey to darkness is not a sin; it's transcendence to a pure and a perfect thought: To fold the brain from dinosaur to human, nature took 65 million years. One could say, given that time, we could produce an artificial brain by evolving the existing computer. We have a concern about the fate of algorithmic computing. We have mentioned earlier that by old Turing theory, we can melt the entire universe into a single thread of bits. However, when we change the worldview that the universe is an architecture of clocks, each clock holding a geometric shape within and above, then the dynamic links undefined paths. We want to make a device, introduce a new kind of processing that helps in finding a simple topology in a rapidly changing big data. Imagine that you are in a room and zillions of multi-colored light patterns with a high gradient of intensities, and the patterns are randomly changing. Currently, a scientist would look at a petaflop supercomputer, to simulate the equations explaining the gradient of field intensity. Instead







(d)

Step	How to build a humanoid avatar?
1	Limbic system + 31 spinal + 12 cranial (43 peripheral net, PNS) + brain stem is built as core antenna, use wires, 3D printed structures
2	Sensors are connected to 43 PNS, time crystal analyzer, TCA tests sensor jellies at all levels, PPM-1, PPM-2 are used
3	12 metric hardware are built by filling rubber-like cavities similar to brain components, keeping close eyes to brain's use of primes.
4	All cavities are filled with brain jelly, which is organic material that builds tracts, sheet, fibers etc as it is exposed to a time crystal
5	Sensors are triggered with images, sounds and we read evolution of time crystals at various parts, we monitor physical wiring too.
6	13 major cavity regions are within central nervous system where brain jelly is added, but PNS covered by skin filled with muscle jelly.
7	Muscle jelly is built, it is a 3D polymeric net that contracts & expands on the application of electric, magnetic, mechanical force.

FIGURE 9.3 (a) Four different classes of PPM hardware operating the artificial brain. (b) Three fundamental constants govern the emergence of resonance frequencies during the synthesis of organic gels, periodically oscillating electric field, magnetic field, and the mechanical field are related by a quadratic relation. (c) Three types of organic jelly are synthesized, first sensor jelly that deals with sensory molecules governed by PPM-1. Muscle jelly that is governed by PPM-2 and PPM-3 and finally the brain jelly governed by PPM-4. Eight different kinds of folding of H3 device built cortical column sheets are compiled to explain the main computing or decision-making sheets of the artificial brain. (d) The seven key step-by-step process to build an artificial brain is explained.

of looking into the gradient of colored light, we can look into the dark lines, where there is no light. Inequality relation held by a group of dark lines reveals the geometric structure stored by the system. A little grammar book can help us read the geometric shapes hidden in a few dark lines. A massive complex pattern that rapidly changes with time would become a few vibrating dark lines. Consequently, the brain or elementary biological decision-making machine is now an example of perturbation engineering that harvests signal from noise using resemblance with 15 geometric shapes (GML). In each device, two complementary symmetry breaking modules would operate against each other to harvest noise, and thus produce scalar and vector clocks which are used as elementary free electromagnetic particle-like structures, vortex. There are two types of structures. One type of structure gives nested geometric shapes, another is used for communication through singularity points in the undefined domain of resonant oscillations. It is utmost essential that we learn the simplest generic device (H3) that could alone be an essential and sufficient element to build an artificial brain. The question is to start from neuron or α-helices, for a bottom-up synthesis of an artificial brain.

The question is at which dimension should we start building the organic brain? When we reduce the size of the nanoparticles, beyond a certain limit fundamental physics laws do not work, the particle becomes a liquid. Scaling at spatial and temporal scale in the small nano-structures follow unique geometric rules (Landman, 2005). The only way to begin brain construction is to synthesize 2–10 nm size protein, or supramolecule with a flexible design. When helical structures representing protein self-assemble into a neural network like brain jelly, by adopting helical, vortices and fractal geometries, one could avoid nanoscale engineering problems. The smallest device is a trilayer helix Hinductor, *H*; as explained in Chapter 7, and its physics are detailed in Chapter 8. *H* device alone is not used in the brain, several *H* makes H2, and several H2 makes H3. Finally, H3 undergoes morphogenesis to create brain components. And all 17 components are supramolecular architectures of H3 class (Figure 9.3c).

Design and synthesis protocol for a generic Hinductor device H3 as sensor, processor, and memory: Doping a desired element in a system can be initiated and primed using a resonance process. Let's learn how. Standing waves combined with electrochemical reaction along a tube would precisely define where the ions would tag. The capacitor spacing in a cylindrical cavity is therefore realized by standing wave of ion vapor, the standing wave on helical nanotube is the matrix. Dopant electrostatically attracted to the maxima of a standing wave. We make three similar concentric helices, one above another. The surface lattice parameters and other geometric parameters described above govern the patterns of knots of darkness generated by monochromatic light falling on its surface, surface manipulation would regulate the dynamics of magnetic rings and other artificial atom like structures. The geometry of a higher-level structure uses the vortex of light and the knots of darkness produced by a lower helical layer as elementary field distribution when pumped with a cluster of energy to harness. Thus, we can build bottom-up architectures. A sensor, processor and a memory element are similar self-assembled architectures of Hinductor. The only difference is that a sensor is designed to use a given set of signals for interference, for an eye it is light, for ear it is sound, etc, an assembly is dedicated to sensing only particular type of signals. For a processor, the key design has a supreme objective, increase the number of symmetries a structure could process, means increase the PPM bandwidth as much as possible. For memory, the structure is designed so that different local parts process distinct isolated domains of PPM, so that identity of time crystals are preserved.

9.2.2 Electric, Magnetic, and Mechanical Rhythms Bind Them

The brain cannot be a quantum device, cannot be electromagnetic device either: Complementary coexistence of vortex atoms and solitons: Under salty water, the electromagnetic waves cannot transmit. Under massive thermal fluctuation, the quantum wavefunctions for a material cannot survive entanglement. So, two options are left, one build solitons and or vortices. The vortex atoms are like ripples created by a drop of rain on the water surface, while solitons are loss-less transport of that vortex through a canal. Vortex could be made of various carriers, magnetic field ripple could make magnetic vortex, electric field ripple may build an electric vortex, mechanical oscillation could make mechanical vortex. Since the vortex structures are like atoms, all types of vortices can build composite material in liquid, which could pass through a noisy environment. In the artificial brain, we deal with two kinds of solitons—first electronic, and second phononic in nature. Solitons need ordered architecture to flow; together solitons or quasi particles and vortex atoms complete the story, one masters the loss-less transmission through liquid and the other through a solid. The division into multiple packets and then resurgence into a new form is possible as neurons and its clusters continuously switch among multiple allowed symmetries. As argued earlier, a canal like a path in the neural network of the artificial brain by spontaneously polymerizing the molecular machines, which makes sure to transport information without losing much energy, therein zig-zag paths are roads for solitons (Christiansen, 1997). A synchronize call to capture a particular kind of information from all around the artificial brain would follow generating electronic and phonon soliton in the solid structure and vortices in liquid and open space. While electronic solitons carry the information to the distant locations, phonon solitons deal with the noise and keep the purity of the signal intact. This is why Figure 9.3b has a unique significance in brain construction, $e-\pi-\phi$ resonance behavior. The typical electric e, magnetic ϕ, and mechanical π resonance frequencies coupled together helps in the synthesis of time crystals made of magnetic particles (magnetic and electrical vortices, Chapter 8). After all no one would dare to make a chemical brain at least in this century, who would feed it, who would build releasing excretion. The flux-charge route is neat and clean, brain needs no food, does not have to excrete. The electric e, magnetic ϕ, and mechanical π resonance work together by non-linear frequency pulling.

Synchronization by non-linear frequency pulling: Crude analogy of extreme non-linear pulling is falling onto a black hole, but in synchrony it is sharing (Cross et al., 2004). In recurrent networks asynchronous processes can mediate inhibition leading to synchronization process, therefore, both the processes can interchange between themselves (Marella and Ermentrout, 2010). The size of synchronizing clusters is an interesting issue, networks with fixed degrees of freedom synchronize faster than random arrangement (Grabow et al., 2010), a small geometric group of a network exhibits high local clustering and low average path length, as a result they synchronize extremely fast (Watts and Strogatz, 1998). Advocates of randomness may continue to endorse magic. Synchronization between electrical, mechanical, and magnetic rhythms have been an intricate relationship historically. A fusion of two or more kinds of resonances has enormous applications.

One type of resonance should be measured with other types of resonances: By now, since the story of simultaneous electric, magnetic, and mechanical resonances are returning as $e-\pi-\phi$ identity time and again in the book, readers are wondering who is running the artificial brain, the diagonal drivers of quaternion, octonion, and dodecanion or the triplet identity. The answer is both are opposite sides of the same coin. The diagonal drivers are a pair of diagonal elements of the respective tensors, which have identical values. That identity is preserved by $e-\pi-\phi$ driver. In order to realize the brain jelly, we need to characterize every single organic helical nanostructure and its assembly, at all scale, all layers should hold the identity at all time. Measurement of resonance for any forces is not straightforward. In 1964, Alzetta and Gozzini (1964, 1967) argued that to measure the magnetic resonance, the mechanical resonance of that element should be probed. It took nearly 30 years to recognize that mechanical detection of magnetic resonance is a reliable technique (Rugar et al., 1992). Within seven years, the proposals were made for simultaneously measuring the magnetic, electric, and mechanical resonances (Alzetta et al., 1999). These adventures started in the 1970s when people were crazy about quantum non-demolition measurement or the type of measurement which measures but do not destroy the quantum state. These journeys were for detecting the gravitational wave using quantum measurement by evading back action. These measurements were about keeping a magnetic particle on the mechanically vibrating atomic force microscope tip, which starts vibrating with the magnetic resonance. Bandyopadhyay et al. used polarized optical laser and observed magnetic vortices which delivered a composition of vortex atoms as a signature of time crystals in various synthetic organic brain analogs as a precursor to building a hybrid organic brain. The collective wisdom of brain-building discussed above for 17 components is summarized again in Figure 9.3d.

9.3 ANOMALOUS QUANTUM CLOAKING—VANISHING AND SEEING THE ONE WE WANT TO

Theories of quantum cloaking suggested that the current of the probability density, in a matter-wave following Schrödinger's equation behaves like an electromagnetic wave in Maxwell's equation. Two critical features of an electromagnetic wave, the displacement of electric-magnetic vectors and the field density (Poynting vector, P) hold their form even after a coordinate transformation. The invariance, a key to classical cloaking (Figure 9.4a), required a quantum analog, so the Poynting vector was replaced by the current of the probability density, and the displacement vector was replaced by a dispersion relation. As described in Chapter 8, to build magnetic vortex-like particles we need symmetrically distinct distribution of charge as shown in Figure 9.4a using examples A, B, C, and D. Some of these patterns provide negative refractive index, which is used to create superposition of circuits made of H is by making some of the active decision-making H elements vanished during computation. That enables us to build circuit with no wiring of components. One problem with the existing Maxwell-Schrödinger analogy for quantum cloaking is that two parameters, the effective mass m^* and the potential V from isolated distinct parts of a matter wave should bend and follow strict paths to bypass the material and re-join similar to a classical cloaking. Moreover, entanglement in a matter wave demands ultralow temperature for a noise free environment. For an electromagnetic wave, the anisotropic space and time ensures that distinct rays return to their original trajectory after bending through the object-to-hide, but it is quantum analog is not clear.

One has to find a general protocol to convert a material into a composition of superlens (negative refractive index). Then, a matter wave could tunnel through a material, at ambient atmosphere as it happens routinely in the quantum optics experiment through an optical lens. Not all material be suitable for that. Milton argued for a special material, where the elements in a composite, collectively resonate, thus affect far beyond their boundary. In the spiral or vortex shape composites (Panfilov et al., 1985), we discovered a unique 3D phase space of energy transmission that enables selectively converting an element of the composite into a superlens and tunnel a matter wave from the atomic flat surface through that lens. Singularities or holes in the phase space of transmission across a vortex is encoded in the geometric parameters of helix or vortices that act as the quantum analog for the anisotropic space and time found in a classical cloaking. Tunneling through a superlens often extracts a 2D or 3D matter wave hidden deep inside a cloaking material, superpose it on the regenerated matter wave. Superlensing is often attributed to anomalous local resonance. Degenerate states of H devices with distinct geometric phases hold a time crystal (Pistolesi and Manini, 2000); the system is non-adiabatic as two distinct dynamics runs without affecting each other.

Matter cloaking could be achieved by controlling the potential and the effective mass as a particle travels through a

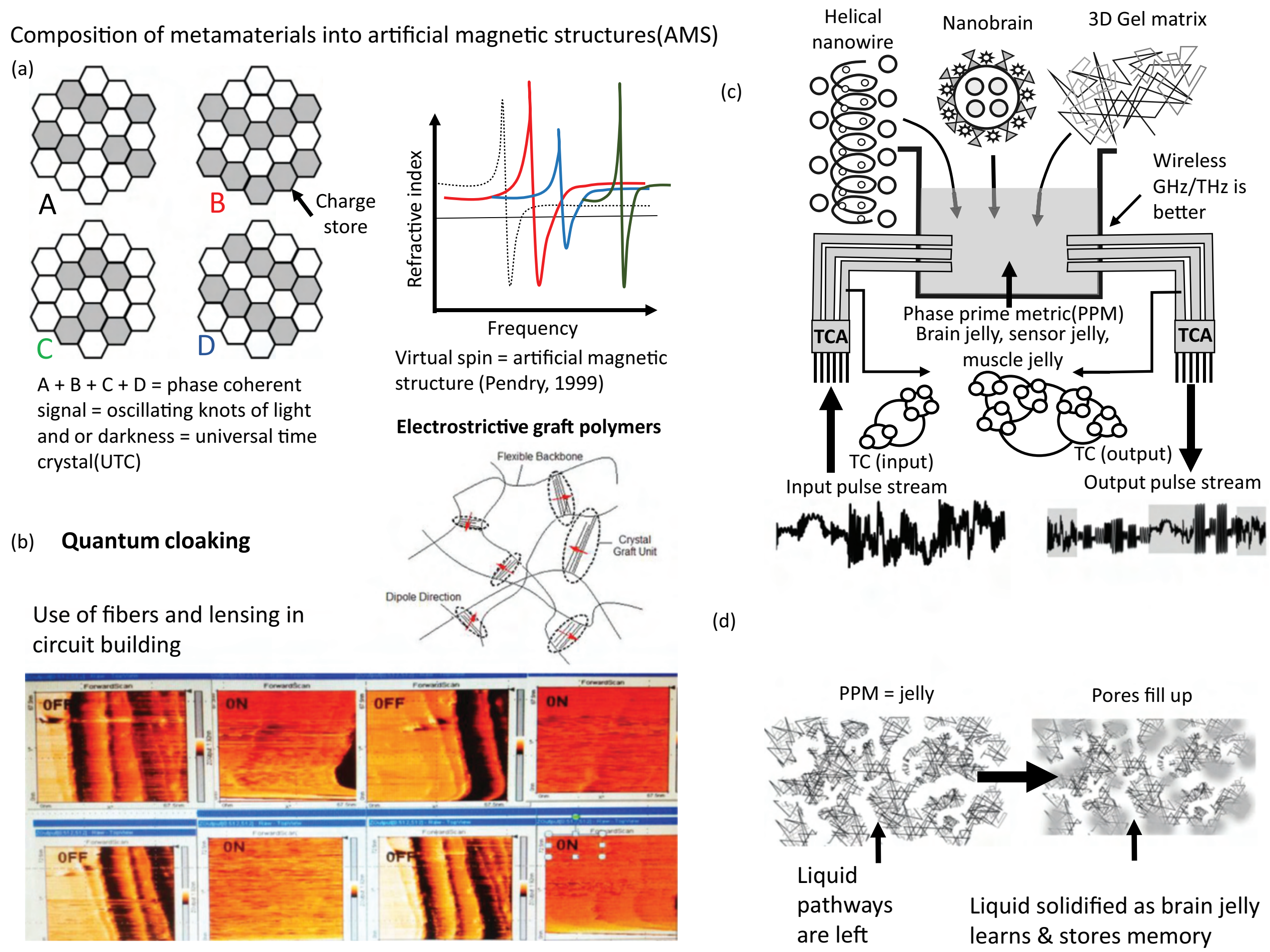


FIGURE 9.4 (a) The surface lattice of an elementary device *H* or a composition of *H* into a cortical column or column assembly into a sheet, in all cases the surface lattice cell gets active and inactive and builds a pattern for the monochromatic polarized electromagnetic signal forms pure magnetic lines and the vortices. Four such lattice examples are shown; each surface pattern has a specific refractive index vs frequency plot. Artificial magnetic structures could be synthesized using electrostrictive graft polymers. (b) Quantum cloaking is vanishing under the wave function, not light. (c) A scheme of an artificial brain. Input sensory signal forms a time crystal, which goes to brain jelly builds the equivalent spiral or spring-like *H* devices that naturally self-assembles into a set of complex structure following the PPM and finally the output is delivered as the analog waveform. (d) PPM synthesis forms porous structure in gel, in the core, gel remains liquid, memory makes it solid.

media (Zhang et al., 2008; Greenleaf et al., 2008) and making it invariant under a coordinate transformation. The problem was first noted by Milton and Nicorovici (2006). Since electromagnetic wave following Maxwell's equations is invariant under coordinate transformation it was never a difficult thing. For quantum, general time-dependent case there is no invariant transformation, so researchers take quantized 3D potentials as coordinates (Vx, Vy, Vz), instead of spatial coordinates (x, y, z), it turns matter waves like a Poynting vector, which becomes invariant under coordinate transformation (Tsang and Psaltis, 2007). Existing quantum cloaking theories use a potential that considers beyond a certain distance potential is zero, thus, the emergence of cloaking is decided even before the derivation begins. Another route is canceling the scattering when matter wave moves (Fleury and Alu, 2013). Eliminating the scattering by resonating the boundary wall of a cavity reminds us the membranes and multilayered structures in biology (Ramm et al., 1996). The ultimate goal for everybody is to reduce the scattering cross-section of carriers to zero. It has been shown that more is the core-shell layer, better is the push-pull of carriers and more is the degradation in scattering (Lee and Lee, 2013).

However, the idea to build an elementary description of quantum cloaking begins from Schrödinger's equations (Jelinek et al., 2011). The similarity between the Schrödingers equation and Maxwell's equation has been a subject of interest for decades, this analogy is already noted above. However, thus far no reports exist on the experimental verification of quantum cloaking, one route could be taking quantum tunneling images of the object, and showing them vanishing under the tunneling current images. Theoretically calculating tunneling image is done by scattering calculation (Corbel et al., 1999).

Under the electromagnetic wave, when the evanescent wave is amplified, near-perfect tunneling could happen.

This proposal was the first in quantum tunneling (Baena et al., 2005) and was an extrapolation of Pendry's idea that if both electric permittivity and magnetic permeability are negative in a medium $(\varepsilon = -1;\ \mu = -1)$, we get a superlens, or perfect lens (Pendry, 2000). It means the positioning of a set of interconnected photons or pointing vectors on the other side of the lens. If the material surface is anisotropic, then the dielectric constant is negative, if the surface is non-spherical (e.g., cylinder), then dielectric loss tends to zero, entire signal tries to pass through, we get anomalous dielectric resonance (Ammari et al., 2013). One of the beautiful aspects of anomalous dielectric resonance is that if the charge density distribution is near to the lens where the information is being transferred, then evanescent wave amplifies and makes signal loss nearly to zero (Meklachi et al., 2016). It is the criterion for cloaking and sincerely followed while designing four circuit element Hinductor. One experimental evidence of quantum cloaking is shown in Figure 9.4b, for calf-thymus DNA, which is a fourth-circuit element due to triple helix, two molecular, one made of water. We have made microtubule, collagen, and several biological helices and our synthetic helical gels partially vanish component by component by choosing suitable frequencies, which we call anomalous quantum cloaking.

9.3.1 Randomness Is Not Random Anymore

To build the brain what should one do? Take a chemical beaker or 3D printed cavity and add all ingredients? Figure 9.4c explains how the most primitive brain jelly could be synthesized and be operated. Brain's neural network has three elements—neuron, glial cells, and extracellular matrices. Using H2 devices that are analogous to neurons, nanobrain, or PCMS that is analogous to neurons or glial cells (Ghosh et al., 2015a, 2015b), a polymer-based organic gel matrix is synthesized that a builds 3D neural network of multi-scale helical structures. If they are mixed in the solution, and time crystal is given as input using electromagnetic signals of various frequencies using antenna from outside, the organic materials would read time crystals, mimic analog material and continue to grow. By applying the monochromatic laser light and semiconductor camera one could read the output time crystal projected to a magnetic film and captured by a semiconductor camera.

What happens when a brain jelly learns? In the 3D polymeric matrix that often used for 3D cell culture, the pores that hold H, H2, and H3 devices reconstruct and rearrange to hold modified time crystals, one such situation is shown schematically in the Figure 9.4d. Note that the entire matrix, grown from nano to the meter scale while emulating the input time crystal follow the coupled electric, mechanical, and magnetic resonance (Figure 9.5a). Solution to gel (sol-gel) conversion and then growing into a massive architecture is rapid, the process time is fixed, irrespective of complexity of time crystals, it varies seconds to minutes. Moreover, earlier, such processes were extensively used for building the neural network, which is just opposite to the kind of neural network discussed in this book (Figure 9.5a and b). Note that when the elementary structures grow, those are strictly helix (Figure 9.5c); however, when they grow, vortex or PPM-driven fractal-like architectures take over, they don't look like spiral, but vortices of various kinds. One could show that angular momentum is singular parameter that could change to generate all kinds of vortices.

Electrical, magnetic and mechanical cloaking for $e-\pi-\phi$ quadratic engine: Regarding resonance one of the beautiful concepts that raised was "time-harmonic" in mechanical cloaking or elastic cloaking devices. Mechanical cloaking means to an outsider, it would appear as if the mechanical wave is passing through a homogeneous media, though it passes through an object (Milton et al., 2006). There could be current sources for which outside the source, an electric and magnetic field is zero (Afanasiev and Dubovik, 1998). Maxwell noted that a torus with a constant poloidal current flowing on its surface would have poles in contact, i.e., invisible from outside (Maxwell, 1890). When multi-layered core-shell architecture of H is the foundation of higher-dimensional structures, it is said that for four layers one top of another, we get quaternion tensor. For eight layers, growing above and below, we get octonion tensor. Nicorovici et al. introduced the concept that in a bilayer core-shell structure the upper layer adds a phase value to the inner core, so the dielectric constant is $-1+\delta$ (Nicorovici et al., 1994). Now, if the bilayer is extended to duo-deca layers, each layer with a new phase, then the partially resonant component achieves the ability to process a dodecanion tensor, i.e., becomes a brain jelly. Several examples of brain jelly are shown in Figure 9.5b–i.

9.4 A LIVING GEL THAT LISTENS AND THEN GROWS FROM ATOMIC SIZE TO CENTIMETERS LONG

Background of current gel research: One interesting feature of the ferroelectric property is that most materials additionally shows piezoelectric and pyroelectric responses. Figure 9.5f–h shows PCMS or nano brain-based nanowires that exhibit such properties. Ferroelectric polymers have polar groups at the backbone, so holds a permanent electric polarization that could be reversibly switched under the electric field. Ferroelectric polymers (Nalwa, 1995; Lovinger, 1983), such as polyvinylidene fluoride (PVDF) has an inherent piezoelectric response, consequently they are used in acoustic transducers and electromechanical actuators (Figure 9.5b). However, due to their inherent pyroelectric response, they are used as heat sensors (Furukawa, 1989). Hydrogels could be mixed to generate such a compounded property, for example, here in Figure 9.5i, carbon nanotube, nanobrain or NB, or PCMS and polymeric gel were mixed similar to Figure 9.4c, one could feel how brain jelly looks like. Examples are there in the pieces of literature, e.g., a mixture of carbon nanotube and polymer hydrogel (Qu et al., 2008). Certain physical stimuli like electric field, light and temperature or chemical stimuli like concentration of certain molecules or ions could initiate phase transition in the material which could

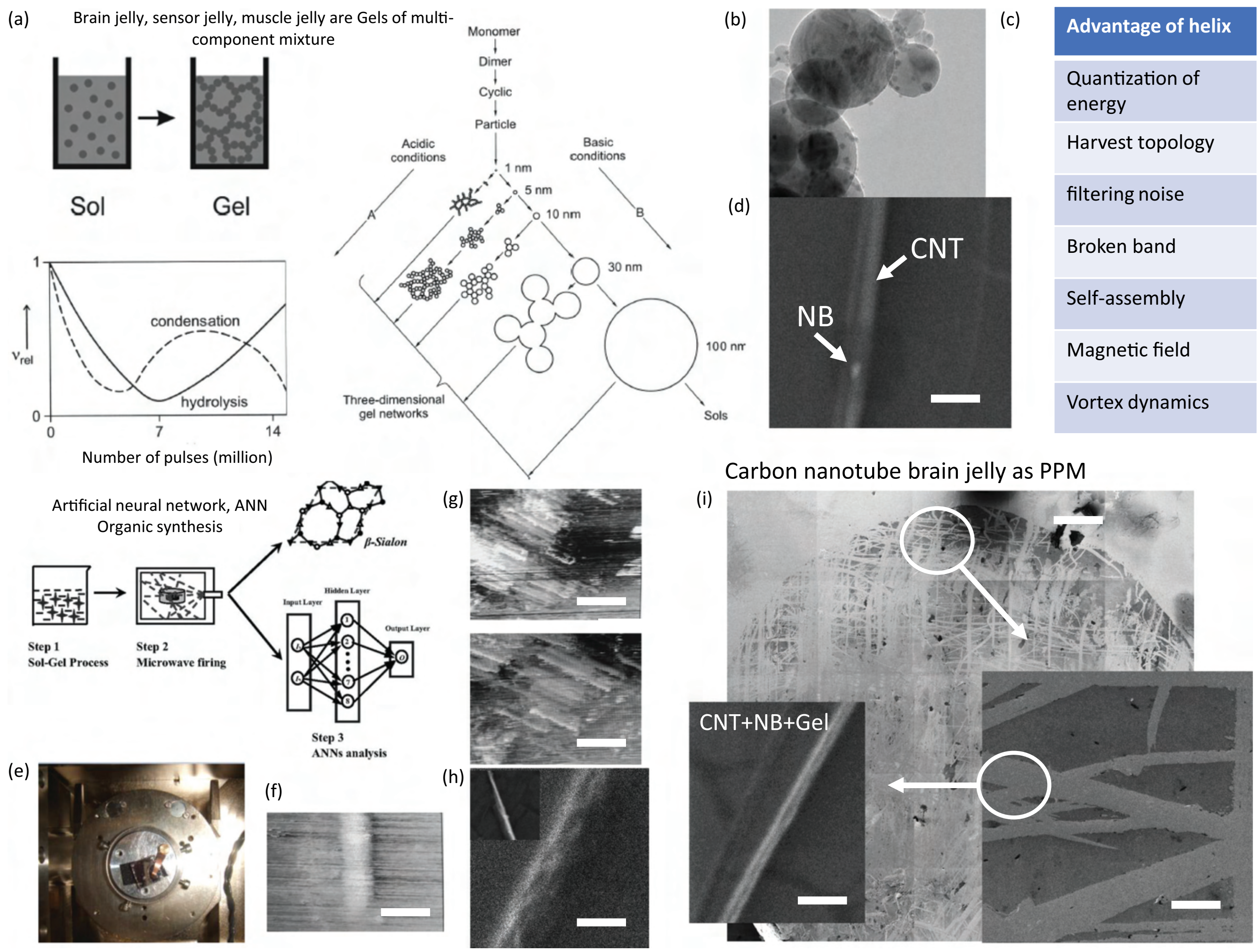


FIGURE 9.5 (a) The spontaneous synthesis of brain jelly begins at the atomic or nanoscale and the growth continues in the visible structures. The sol-gel process is followed by microwave irradiation and that builds material analog of the mathematical PPM. (b) An example of an artificial neural network, ANN synthesis by sol-gel method. (c) Advantages of a helix are outlined. (d) PCMS (PAMAM dendrimer, C is the controller, M is the molecular motor, and S is the sensor) which is often termed as nanobrain is self-assembled with multi-layered helical nanotube, scale bar 6nm. (e) The scanning electron micrograph, SEM set up in which the self-assembly of PCMS or nanobrain is carried out under different energetic trigger, distinctly different architectures are found as shown in the panels (f), (g), and (h), scale mars are 10, 120, and 10 nm, respectively. (i) TrueGel 3D hydrogel was created using carbon nanotube and the PCMS, its neural network like architectures are shown, scale bars are 1 cm, 300 and 35 nm, respectively.

result in the changes in volume, mechanical electrical magnetic or even the structural symmetry, these are called stimuli responsible gels, and their major application is in building actuators (Ali et al., 2016; Richter et al., 2007; Gerlach and Arndt, 2009). Electrostrictive graft polymers have a flexible backbone chain wherein each monomer contains branching side chains (Figure 9.4a). In an assembly, the side chains of the neighboring backbone polymers cross-link and the linked unit cell builds the crystal encompassing the entire assembly. The backbone and side-chain crystal units have dipole moment with partial charges (Wang et al., 2004). Gels that are used for 3D cell culture breaks and recreates bonds to give space to the growing cells (Tibbitt and Anseth, 2009). When spiral helices made of gels grow as Hinductor or *H* devices, on many occasions it would be essential to make mesoscale structural changes (Usher et al., 2015). Such local changes are essential for continued brain jelly evolution as a means to deliver plasticity in learning new concepts or behaviors.

Atomic to centimeters scale brain jelly is a $e-\pi-\phi$ resonator: Electrical patterns of brain jelly are continuously monitored by EEG, and they resembles that of premature babies, the work resembles with the works of biological mini-brain (Trujillo et al., 2018). Not only understanding the evolution of the brain, one of the prime applications of brain jelly would be brain-computer interface, a biological evolutionary recovery after stroke (Biasiucci et al., 2018). Artificial organ development has reached nearly to a point where adding the dedicated time crystal of a living system would enable natural healing of wounded organs (e.g., artificial skin Nieves, 2016). Evolving gel is a must to build a living brain, because gels have unique properties of self-healing, erasing and rebuilding new structures, which would be the best choice to achieve perception-based plasticity in learning in an artificial neural network. To develop a mechanical sensor, it is easy to adopt elastomeric gels (Christoph et al., 2010), by mixing it with the electroactive gels one could build artificial muscle (Randy, 2008). Eventually a brain jelly would be an $e-\pi-\phi$ resonator (Figure 4.15), whose electrical, mechanical and magnetic resonances are in a quadratic relationship ($e^2+\phi^2=\pi^2$), while evolving H circuit. Evolution means, when time crystals representing small functional components follows the quadratic relationship, interact by a collective dynamic time crystals propagating around and builds the composite time crystal (Watts and Strogatz, 1998) by bringing astronomically large number of H devices in groups (Shiino and Frankowicz, 1989). Even in the composite time crystal quadratic relationship holds. To hold the quadratic relationship, the small spirals acting as Hinductor or H arrange in the helical gel (Veretennikov et al., 2002; Lin et al., 2017; Celli et al., 2009; Kennedy et al., 2018; Zhao et al., 2014) in a chaotic order and wirelessly communicate (Jaeger and Haas, 2004), using magnetic vortex atoms, or ionic vortex, or electrical vortex or mechanical vortex. When these vortices travel through the solid materials pathway, they appear like a non-interactive soliton or quasi-particle and when in the open space, or liquid, they are like free particles like vortices or knots of darkness but interactive.

Persistence and self-affinity in PPM metric: PPM as the basin of attractor (all dynamics tend to converge to a particular section of PPM 3D patter) that guides self-assembly, synchronization, drives computing, and decision-making is a journey through the 3D basin of attractor if a cellular automaton like pattern evolution triggers in the brain jelly. As described in this book, basin of the attractor for nanobrain is a 3D sphere-shaped map consisting of several dynamic points, each point is a time crystal in a quaternion, octonion or dodecanion tensor, and the entire map represents a complex relationship between different dynamic states of the cellular automaton system that the system builds. Two parameters are important here. One, persistence, which means that in a time series or time fractal (infinite chain of clocks in a time crystal), large values (slow clock) are followed by a large value and small values (faster clocks) are followed by a small value, a crossover to uncorrelated behavior happens on the larger time scales. Self-similarity, sometimes parameterized as self-affinity correlates two or more time crystals, now, the correlations change with time, sometimes it is fast, e.g., an exponential decay in correlation, it is called short-term correlation and some times it is so long that characteristic time scale cannot be defined (power law exponent is between 0 and 1), it is called long-term correlation. When two time crystals exchange small subsets of time crystals, the standard deviation of data exchange changes with time, this is called non-stationarities. Considering the increments $\Delta x_i = x_i - x_{i-1}$ of a self-affine series (x_i), $i=1,2,3\ldots N$, N is measured equidistant in time, Δx_i could either be persistent, independent, or anti-persistent. For stationary data with constant mean and standard deviation the auto-covariance function of the increments, $C(s)=\langle \Delta x_i \Delta x_{i+s}\rangle = 1/(N-s)\sum_{i=1}^{N-s}\Delta x_i \Delta x_{i+s}$, so we can directly calculate even the elementary time crystal exchange parameters during computing (Kantelhardt, 2011).

Whenever brain jelly encounters a new problem, this will be a new path in the spherical basin of attractor, and the neighboring system of oscillators would try to accommodate that new path component by modifying its existing dynamic points in the 3D world. Euclidian traveling salesman problem because in the 3D space we have several existing dynamic points of basin of attractor and any problem given to nanobrain is converted into a line of sequential evolution of dynamic points and the first task of this nanobrain is to match this new situation with the inherent dynamic map of the system, that has been constructed before solving the problem. Since PPM is basin of attractor, jelly requires no training. Now, nanobrain has to find dynamically closest points in the already existing basin of attractor map of a cellular automaton, and moreover, it has to find a way to move from new point to each option individually, and then find the shortest route. Next step for the computation would be creating another new dynamic point, which means a new grid, made of new states of the participating neuron-oscillators. The objective of creating the new point would be that a journey from that new point, would lead to all the neighboring points faster than the previous point set by the problem. The particular criterion makes the problem intractable, brain jelly as its savior.

Complexity can increase without acquiring infinite resource: Brain jelly synthesis follows chemistry beyond Chemical Kinetics: Inside the organic brain made of folded 2D sheets of H3 devices or hexagonal close packed cortical columns, the wireless circuits made of H devices always evolve, the neuron analog H1 changes communication pathway and the gel replicates this feature in the artificial brain to create a time crystal architecture. The time crystal structures transform to follow the symmetry linking guidelines set by the PPM. The particular feature helps the brain jelly to create higher-level intelligence. For example, the jelly can perceive that a banyan tree looks like ice cream from a far distance, (mm), therefore, the co-existence of multiple grouping and continuous creation and destruction of its pathway helps brain-hardware to increase the time bandwidth of the time crystal via simple changes in the connection i.e., the geometry of H3 arrangement. It is important to note that the journey to all kinds of brain jelly begins at a single molecular scale. Take for example, Ghosh et al. synthesized PCMS shown in Figure 9.6b, its different parts act as a different molecular seed, that would eventually unfold into various complex architectures. For all brain jelly, a seed nanostructure needs to be created that grows by itself from 7 nm to a large jelly like structure step-by-step, the growth does not follow the path of chemical kinetics, there is no chemical reaction, rather, phase transitions from one symmetry to another. The jelly-like structure replicates the time crystal storage and processing information like a neural network, so we call it brain jelly. The entire brain-jelly-derived supramolecule acts like a fractal of oscillators (fibrillar structure forms at a critical frequency; Swain and Valley, 1970), derives a large time crystal

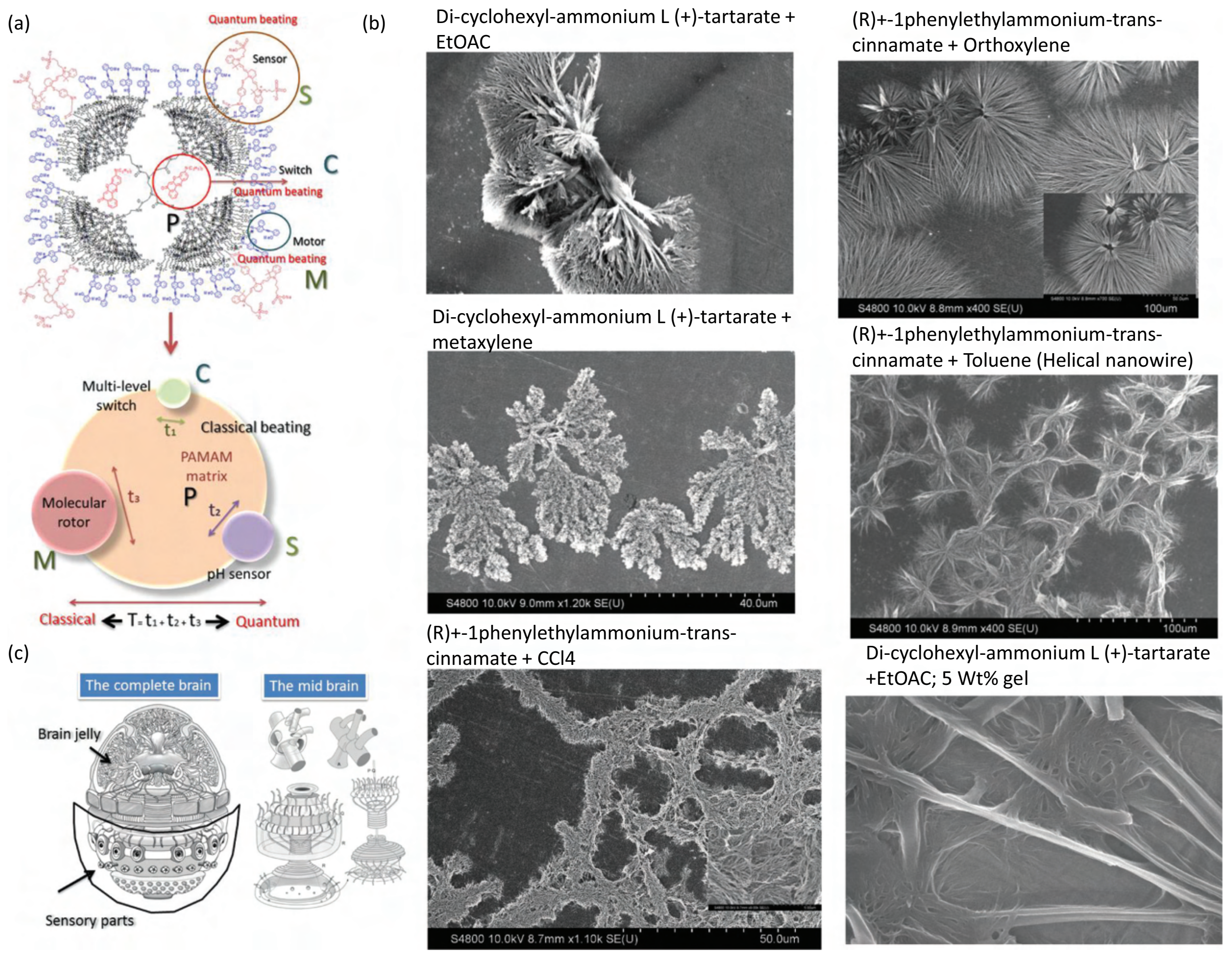


FIGURE 9.6 (a) PCMS molecular structure and its time crystal equivalent. (b) Six different examples of brain jelly, the name of the molecules and processing solvents are noted on the top of each panel. (c) The schematic structure of an artificial brain, where multiple cavities are there.

under the exposure of monochromatic light. If one opens, millions of oscillators would be found inside; if one takes one of them would find millions of oscillators inside, the journey continues. The entire journey could be represented in terms of clocks inside a clock; however, it does not matter how the material or oscillators arrange, what matters is how their representative clocks arrange. We have listed in Figure 9.6b several brain jelly whose journey started at the single molecular scale, but eventually they produced suitable structures for using them in the tiny cavities of 17 brain analogs listed in the table of Figure 9.2. Finally, the brain of humanoid avatar looks like Figure 9.6c, this is an integrated commercial version of the final architecture.

9.5 FRACTAL CONDENSATION—CONDENSING EVERYWHERE AT ONCE

Then there were two more classes of manufacturing waiting in the lab desk, self-assembly, and fractal condensation. Self-assembly was proposed in 1988 and fractal reaction kinetics and related condensation were proposed in 2016 (Ghosh et al., 2016b). Self-assembly is found to be limited because it requires materials in a particular form and elementary structure to proceed. While fractal condensation is a brilliant way of putting it, whenever "fractal" word includes in the formation of any structure, self-assembly from a nucleus by core-shell growth and then self-assembly of several such nuclei run simultaneously. Until now the grammar of fractal manufacturing noted above is not established, but, one could use number system and the pattern of primes to regulate the growth process. If manufacturing follows the pattern of primes, it will never be left alone, no need to program and self-healing would be fundamental to it. For self-healing, a "fractal-based" structure is always the best choice. In the Bose-Einstein condensation, one wave function holds many atoms, if we add more, wave function remains intact (Figure 9.7a). In the fractal condensation, there are plenty of available singularity domains where phase gets undefined. If we add new time symmetry it gets adsorbed in suitable singularity domains and still singularity survives. Why? Readers know by now, that within a single singularity point, a massive dodecanion tensor could reside, after all they grow in the nested imaginary worlds.

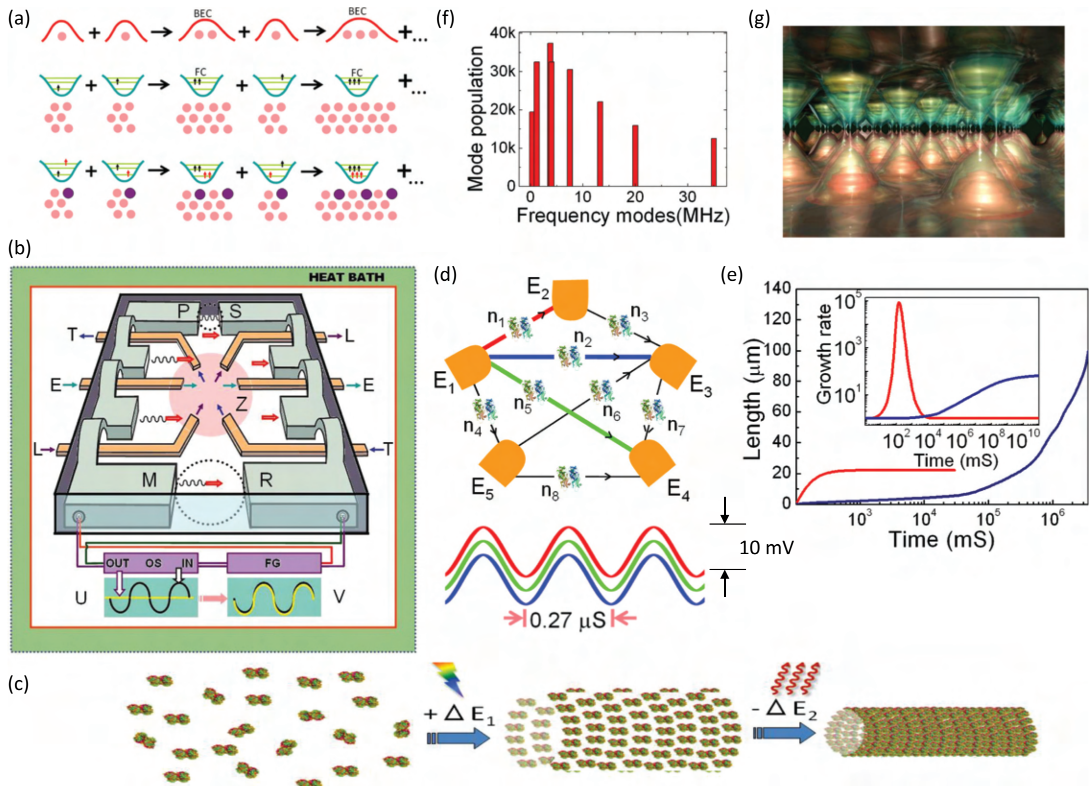


FIGURE 9.7 (a) The basic concept of classical, BE, and fractal condensation. (b) The experimental setup, L E T are different electrodes to send input information or signal to the *H* device. (c) The mechanism of condensation. (d) Energy exchange and coherent waveform generation during the condensation process. (e) Length of helical nanowire vs the time, there is a saturation of length of the *H* device synthesized here microtubule from tubulin. Inset shows the growth rate as a function of time under ac (red) and normal (blue) condition. (f) Distribution of length as a function of applied ac frequency (wirelessly). (g) The broken band structure that facilitates *H* device into a topological material.

Definition of condensation at far from equilibrium: The condensate (Jochim et al., 2003; Fröhlich, 1968a, 1968b) class materials follow a unique materials science philosophy; continuous additions of similar atoms do not change properties of the condensate, while dissimilar atoms find their way inside the same structure acquiring distinct symmetries and delivering unique properties. If atoms are replaced by molecules, a fusion of suitable new molecules to the condensate would add desired functionalities, keeping properties of the primitive molecular condensate intact. Unfortunately, the molecular analog of such atomic condensate does not exist. Moreover, it has always been a critical challenge to unravel the true picture when rapid condensation is triggered at the singularity, since the population rapidly reaches to an astronomically large number. Fractal condensation advances the conventional theoretical tools for energy quanta condensation in predicting and analyzing the condensation of molecules with unique multiple electromagnetic resonance frequencies. Each resonance frequency acts as a point driving to singularity; resonant oscillation canalizes energy into all singularity-attractors or participating resonance frequencies such that by regulating the resonance levels by modulating the atomic arrangement of a molecule one could manipulate singularity-canalization and thus program entire supramolecular architecture in an unprecedented manner.

Step 1: Mutual evolution of multiple singularity cones: Tuning of supramolecular architecture: Time crystal input to a heat bath containing molecular precursors sends resonance signal with different frequencies (Figure 9.7b). For molecular oscillators, the probability of spontaneous synchronization is maximum when the available energy (kT) is the same as their total rotational and vibrational energy. When in a heat bath the molecules are pumped with ac electromagnetic frequencies, the singularity points where coherent resonance frequency bursts (Sahu et al., 2014; Moskalenko et al., 1980) attract the system toward them (Figure 9.7c and d). For tubulin to microtubule transition, eight cones in the potential distribution, or eight holes in the phase space (Figures 8.6b and 8.9i, j) changes the relative shapes and preference via modified interaction. The relative population at multiple singularity points determine how do the four levels exchange energy among themselves leading to the formation of the aggregate-wave (Figure 9.7e and f). The normal mode of vibration is preferred over the complete synchronization, non-linear energy pulling by multiple singularity points causes this preference.

Step 2: Conversion of noise into coherent energy source: Normal modes of vibrations: Now, non-linear frequency pulling between different singularity cones determine, what would happen, the "normal modes of vibration" (Moritsugu et al., 2010) or "aggregate vibrating as a single wave."

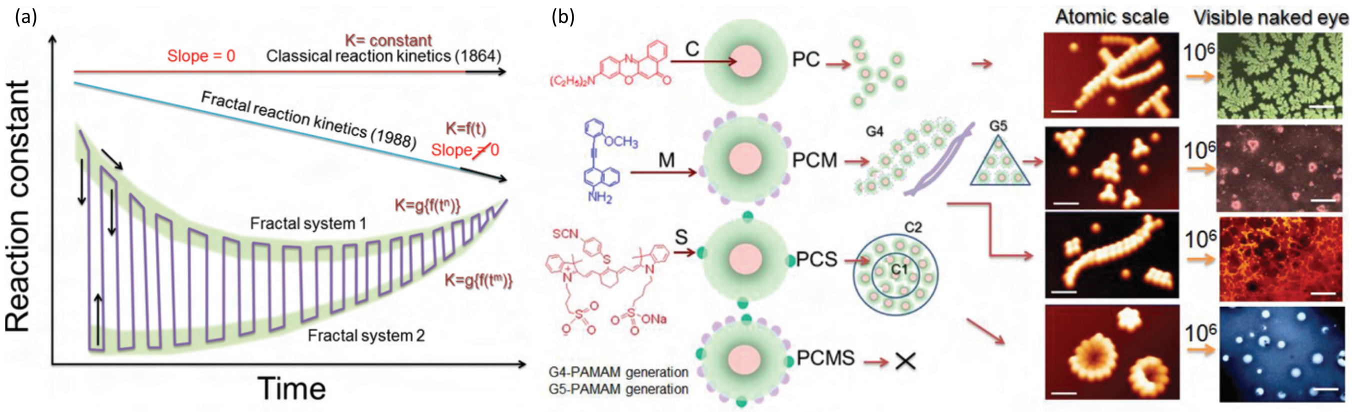
For molecular oscillators, the probability of spontaneous synchronization is maximum when the available energy (kT) is the same as their total rotational and vibrational energy. When in a heat bath the molecules are pumped with ac electromagnetic signals, Szent-Györgyi discussed two different mechanisms for the energy transfer, an individual resonant transfer and a collective transfer, wherein the energy is delocalized, an aggregate of molecules receives a quantum of energy, via both parallel channels. Eventually collective transfer supersedes as a natural drive to decrease the magnitude of energy transfer, and the system behaves more like a wave than isolated particles. The proposal "aggregate behave like a wave" demands considering a super molecule, or aggregate that behaves like a single molecular system (Figure 9.7c and d). A little energy leak ε is key to generate the wave nature in the distribution of molecules. The structural damping parameter b regulates leak between two resonance peaks or two singularity points. Then, if pumped with an incoherent signal, all oscillators vibrate at one of the four/more resonance frequencies; the collective energy exchange activates the non-inversion lasing. Obviously, the coupling factor between multiple resonance levels refers to the coupling between the distinct structural symmetries when electric-magnetic-mechanical resonance activates the molecules. A molecule if suitably designed such that it's various structural parts with distinct structural symmetry could absorb mechanical or electromagnetic energy exposed to it at different frequencies and each region start vibrating mechanically with a distinct frequency. In doing so, these parts release energy and interact with energetically coupled neighbors. During synchronization, the vibrational motion of the system could be such that instead of all neighboring molecules start vibrating in a single phase and frequency, all molecules acquire phase and amplitude such that they together map a virtual 2D wave oscillating in the media. It is called normal modes of vibration and the most interesting aspect of the creation of this wave is the development of a collective spatial relationship between all molecules in the medium.

Step 3: Positive feedback during phase transition: Here we have included Luzzi et al. proposed "positive feedback" (Mesquita et al., 1993, 1998), surprisingly, this concept was embedded in the mathematical formulation of synchronization from discrete randomness. However, here, the "feedback" occurs when the system has already formed an aggregate or wave, and therefore "feedback" contains information on how to transform the frequency and the wavelength of the aggregate-wave so that it undergoes a "positive" phase transition. The simple yet powerful technique drastically reduces the number of steps required to lock the phase and the amplitude in a system of large number of coupled oscillators in a series of sequential steps that would lead to the formation of condensate or cause the disappearance of normal modes of vibration or generate the true synchrony where all particles have the same phase and frequency. Note that the formation of condensate means actually reaching three targets at a time. In summary, the phase coherent communication via four levels ensures a well-defined or programmed series of steps to synchrony. However, depending on the complex set of transformations to be performed for growing the collapsed structure, the speedup factor would vary.

Step 4: Squeezing of normal modes of vibrations by four coherent signals: A system self-triggers spontaneously toward synchrony, when at least four distinct energy levels operate actively during energy exchange. Two additional metastable states with two basic levels stabilize population inversion control remarkably; the "super molecule" concept derived above since a control engine is must whenever we construct a fused molecular system or condensate. In order to construct a super molecule, first, creation of a synchronized system in a randomly mobile discrete system of oscillators at far from equilibrium. When that fully synchronized system oscillates as a single wave, then its four among several energy levels engage in energy exchange such that by triggering the system with different frequencies we can change the collision cross-section, thus, regulate the aggregate-wave's structural transitions. Synchronization that triggers the normal modes of vibration (which is itself a wave made of isolated molecular oscillators) has one vibrational frequency; this has nothing to do with the four frequencies we talk about, these two concepts should not be mixed, the four frequencies originate from the internal structural symmetries, due to isolated distinct dynamics of those local parts. In contrast, the normal modes vibrational frequency originates from the coupling induced relative energy exchange of the molecule, which eventually defines the frequency of the system of particles as a whole. Both parameters are distinct by their origin and nature of interaction, thus, the four internal frequencies remain constant and cannot be destroyed even after the condensate is formed, while the normal modes of vibration will change its wavelength and frequency with a series of quantized changes to eventually cease as soon as the condensate is formed.

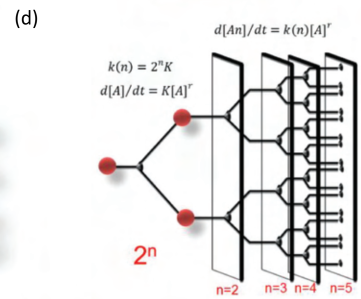
Step 5: Fractal reaction kinetics: Thus, entire self-assembly process occurs via two chemical processes, in the first half, a transition from collision based normal diffusive motion of molecules to coordinated motion or spontaneous creation of normal modes of vibration, which could be explained by basic laws of chemical kinetics (see schematic of Figure 9.8a) (Kopelman 1988). However, afterward, during the phase transition of normal modes of vibration to the entropy reduction, none of the basic considerations of chemical kinetics is valid in the sequence of steps adopted by the system leading to the complete collapse. Therefore, this part has always been a mystery in the field of science, and no research was done to visualize this particular process, the point of condensation to the supramolecular architecture is the "singularity."

Step 6: Collapse of aggregate waves into a composite architecture: The 2D aggregate wave oscillates exhibiting normal modes of vibration. The 2D carpet like an assembly of molecular oscillators in an aggregate wave would transform into other structures, via folding, rolling or by other means, which does not destroy the "integrated wave" features. How carriers would behave inside a cylinder, cone or sphere if the 2D carpet forms such a hollow structure, the transmission of carriers on the cylindrical, conical, or spherical surface would



(c)

Fractal grammar	Fractal seed	Rate coefficients (all k functions of time)	Fractal type	Log-Log slope
Triangle-square	G4 PCM	k1, k2	IFS	h1~, h2~
Sphere-helix	G5 PCM	(k11, k12), (k21, k22).....	ET	h~exp
Tree	PC	k	IFS	h~
Sphere	PCS	k1, k2, k3....	ET	h~exp
No Fractal	PCMS	0	0	0



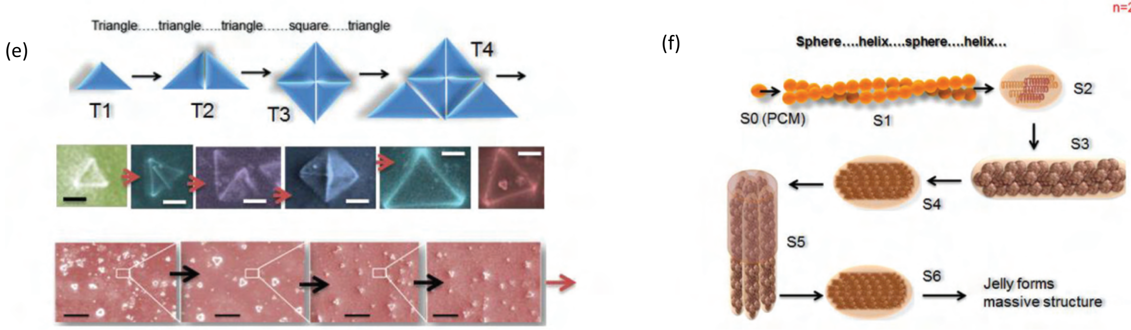


FIGURE 9.8 (a) Introduction to the fractal reaction kinetics where multiple fractal architectures are synthesized in the same solution beaker. (b) Structure of the molecules using which we created various different versions of PCMS or nanobrain. (c) A table is showing how different geometric architectures are synthesized. (d) Fractal synthesis network of reaction centers. (e) Triangular tessellation, three rows top to bottom. The top row shows schematics of different generations. Middle row shows SEM images for different generations (scale bars left to right, 40, 67, 45, 50, 60, and 140 nm). Bottom row, SEM images, scale bars, left to right, 100, 15, and 3 µm, 300 nm). (f) Sphere-helix dual fractal schematics. (c) SEM images, top to bottom, G0 ~ single PCM molecule, 5 nm; G1 ~ helical nanowire, scale ~ 45 nm; G2 ~ G1 nanowire made sphere 300 nm, scale ~ 10 µm; G3 ~ sphere made nanowire 800nm, scale bar ~1 µm; G4 ~ nanowire made cylinder ~5 µm, scale bar ~5 µm; G5 ~ cylinder makes nanowire ~1 mm, G6 ~ 5 mm wired complex, jelly.

be strictly governed by the surface molecular arrangement and that would be significantly different from the carriers inside. The transition should avoid particular local energy minima, but activate all minima at a time. When delicate topological paths are the only choice for carriers, the edge states in the fractured band would be regulated by a cavity where the aggregate wave resides. Recent experiments have shown that the topological confinement could lead to the formation of polariton condensation at room temperature, thus, topological symmetries could coexist and govern multi-channel condensation. The engagement protocol is of two types, first, the new kind of molecule could interact with any part of the structure getting physically trapped, thus, add a new resonance level to the eventual condensate. Second, during phase transition of "2D aggregate-wave," the new kinds of molecules could find a place inside the capsule-space created during folding of the 2D surface, thus, a multi-composite structure is formed in the organic jelly. By studying a large number of protein crystals Bandyopadhyay et al. have devised a generic protocol for the proteins, as described in Chapter 6. For a distinct time crystal input, the route from aggregate-wave to condensate would be distinct.

How fractal condensation differs from the world of Fröhlich condensates: Though Fröhlich (Fröhlich, 1968a, 1968b) and their followers never talked about condensing molecules but for condensing the propagating carriers on the biomaterial substrate, they considered resonant oscillations of the dipolar hosts, mostly, they used atomic dipoles for photons or phonon like bosons to reside on those hosts. Thus, microwave (GHz or THz) ac pumping would synchronize dipoles, which in turn would condense the guest carriers distributed over the hosts. In this condensation process, an external ac pumping resonantly excite the oscillators, engage them into the delocalized collective energy transfer with all neighbors so that wide range of frequencies ($\omega_0 \leq \omega_i \leq \omega_N$) and phases in an assembly of n coupled oscillators squeeze and lock into two particular values. Then, synchronized oscillators behave together more like a wave than isolated particles, afterward, one-step toward minimizing entropy leads to a collapse.

Difference between Haken Prigogine collapse and fractal condensation: (1) For the formation of a supramolecular complex via far-from-equilibrium Haken-Prigogine (HP) collapse is a well-debated perspective (Haken, 1988). Though, synthesis of brain jelly is a thermodynamically open system operating at far from equilibrium, the aggregate-wave is formed by long-range interactions and it breaks symmetry spontaneously multiple times prior to the complete collapse into a condensate, the geometry of time is never taken into account in an HP collapse. In fractal condensation, once the aggregate wave is formed, afterward, the entire pathway is executed in a programmed manner as a series of dissipative structures are to be formed via ordered transitions. PPM delivers a sequence of symmetries, chaos or randomness arise due to the projection from infinity as described in Chapter 4. Even though the manipulation of multiple singularity points is a route toward complex architectural engineering of a large number of condensate families arising out of a single condensate. Thus, we look beyond the world of Prigogine's random dissipative structures like cloud, cyclones, and hurricanes to the concept where condensates inside a condensate inside a condensate forms at a time. (**2**) Unlike Fröhlich condensation's complete synchronization, and the existence of one resonance frequency was considered sufficient to generate the condensate, but here for brain jelly it is not. Without multiple singularity drive, one cannot reach to the aggregate wave avoiding the straightforward complete synchronized state. For GML most complex structure is a icosahedron, a 12 singularity point drive would be abundant in brain jelly while processing a time crystal. Since previously, the inspirational philosophy was that of Illya Prigogine (Kondepudi et al., 2017), where complete synchronized state could randomly jump into an ordered architecture, however, we follow a philosophy just opposite to that, entire formation is programmed at the molecules atomic arrangement, hence, unless and until we create an aggregate wave avoiding full synchrony, we cannot start programmed adventure toward a predicted architecture.

9.5.1 Pattern of Primes Need Not to Be Instructed

As explained in Chapter 7 in details, 17 brain components discussed above have a large number of components within. Following the actual brain architecture, those tiny components are built using organic synthesis; however, there is a big problem. How several components and their sub-components build together following fractal condensation and fractal reaction kinetics?

Jordon structure and bifurcation: Adjacency matrix: what computation means for brain jelly? Bifurcation is symmetry breaking. During synchronization and desynchronization of local time crystals, associative matrix D is "adjacency matrix," it has been shown mathematically that bifurcation does not depend on how many networks are there, rather it depends on a number of Jordon structure. Two neighboring brain components share D, and that one could study separately in a chemical beaker The Jordon structure is strictly related to the time crystal built by geometric algebra (Chapter 4) since, the dimension of Jordon structure holds fundamentals of coupling. In a network of interactive time crystals (set of $\{f(t)\}$), center subspace in regular networks is given by $dF = \alpha I + \beta A$, here, αI determines internal dynamics of a time crystal, α is the matrix of internal dynamics, βA is the coupling dynamics between two nests. A is the adjacent matrix, whose eigenvalues account for the coupling of subsets of N network, it determines magnitudes of all possible coupling factors, β is the matrix of coupling dynamics. Jordon structure J associated with a 0 eigenvalue can be the Jordon structure of an adjacency matrix of a regular network. The above mathematical expression describing symmetry-breaking bifurcation solution of a problem means a product of (Golubitsky and Lauterbach, 2009) adjacent matrices representing a time fractal $f(t)$ to find a new matrix in the timeline.

9.6 FRACTAL REACTION KINETICS—PARALLEL SYNTHESES IN ONE BEAKER AT A TIME

Fractal reaction kinetics and memory in the chemical reaction: Biological reproduction has mastered self-replication (Smith et al., 2003). It has inspired bio-mimetic engineering, nano-assemblers, designing computer virus as artificial life (Spafford, 1992; Chow et al., 2004; Lipson and Pollack, 2000), and distributive computing, etc. There exists no generic rule for self-replication, fractal reaction kinetics (Kopelman, 1988; Khire et al., 2010; Vlad et al., 2005; Neff et al., 2011; Newhouse and Kopelman, 1988; Savageau, 1998) that memorizes the reaction rates and responds to the ever-changing environment spontaneously could be used as a generic synthetic protocol for self-replication (Figure 9.8a). However, in the last three decades only one kind of "memorization" was explored whereas for programming self-replication of several different visible scale architectures (Tong et al., 2011; Kurihara et al., 2011) in the atomic arrangement of the molecules or any starting materials we have to invent several different kinds of "memorization" process (Kozlov et al., 2013; Varela et al., 1974; Bedau et al., 1997) when a fractal reaction evolves the product with time. Ghosh et al. started with a 7 nm wide molecular platform (Ghosh et al., 2014b; Figure 9.8b), modified it with a few functional groups to trigger robustly varying "memorization" of reaction rates.

The memory regulation has led to an encyclopedia of geometric replication (Figure 9.8c and d). The encyclopedia includes right-triangle tessellation (Figure 9.8e), alternative spherical and spiral geometries (Figure 9.8f) similar to fourth-circuit element Hinductor, *H* that could be switched using pH variation (Zhang et al., 2010) like that we see in DNA, galaxies, spherical fractal like Russian nesting doll Matryoshka (Agnati et al., 2009) and ever-growing branching like a tree. Three decades ago, memory in a reaction allowed the system to direct reaction in the most suitable route in a changing environment, now by adding a higher-level control to that memory we enable the system to program that path. In the solution 10^9 orders larger architectures grow spontaneously with zero human intervention, yet, the system switches nonlinearly among various paths to reproduce.

Could there be a chemical reaction that starts from a few atoms and grow entire architecture? Now, Ghosh et al. have experimentally demonstrated (Ghosh et al., 2016a) that we can add a higher-level control on that memory, to drive memorization through various ways. It means a system (brain jelly) can hold at a time, multiple different kinds of memories as time crystals and switch between different routes as programmed or the changing environment demands. We cannot add complexity if we have just one memory as a single clock. With the power to flip between multiple memories, we create multiple fractals for dual or multi-faced self-replication in a single chemical beaker, with zero human intervention. Unlike classical chemical kinetics that defines chemistry, the hallmark of "fractal-like" kinetics explores anomalous reaction orders and time dependent reaction rate, which are otherwise "constant" over time. The area beyond the fundamental laws of chemical kinetics and laws of mass action is part of heterogeneous reaction kinetics observed in biology, materials science, geology, astrophysics, etc. In fractal-like kinetics, due to spatial constraint, it can dramatically speed up or slow down the reaction rate, hence for half a century it has been proposed as a fundamental structural tool. However, this field has mostly been about the theoretical interpretation of the frequently observed biological or chemical phenomenon. Thus, the fundamental concept of "fractal-like" kinetics has not progressed beyond the basic definitions, which Ghosh et al. transformed forever.

What makes fractal reaction kinetics so unique? The journey beyond classical kinetics to "fractal kinetics" involves some remarkable features like self-ordering, self-unmixing of reactants, rate coefficients with temporal memories, etc. All these parameters are thoroughly investigated as a part of heterogeneous reaction kinetics. If we compare these typical parameters with the tasks of PPM-driven natural intelligence, we can draw an analogy between the two. Fractal reaction kinetics monitors reactants and products by memorizing its own reaction rates and decides its next reaction rate; this is what a spontaneously operating artificial brain should do in a hostile environment. The literature of self-replication has argued for similar qualities for a long time; however, fractal reaction kinetics was never examined thoroughly from self-replication perspective.

The basic idea behind the hierarchical memory in reaction kinetics: In order to be useful in self-replication, fractal reaction kinetics should not only demonstrate a typical linear temporal variation over log(time) scale suggested by Kopelman (1988) as we have seen in almost all reported works in the last three decades. The lone memorization capability requires a hierarchical control on memory to add complexity in the massive architectures as the self-replication demands. Hence, Ghosh et al. added control on the basic memorization protocol of fractal reaction rate and identified major limiting possibilities of temporal variations of a fractal reaction rate. Temporal variation of reaction rate over log(time) scale which has always been linear. In the same plot Ghosh et al. introduced an exponential decay, an exponential increase, and a periodic switching between two parallel linear variations. Minor modifications in the starting dendritic structure lead to various fractal synthesis routes and unique geometric shapes are repeated from a few nm to cm scales, we can observe how higher-level control on memory is played.

For an exponential increment and decrement, the rate of variation of k also varies with time ($\log k = \exp \pm S(\log t) + M$, $S, M \sim$ constants, $h = f(\log t)$). Second-order variation of memory suggests that higher-order control of h on k. Here, even h is a function of time. In the switching between spherical and helical fractal, one hierarchical memory control h ($=f(\log t)$) regulates the exponential variation of k and a nearly linear k embeds a hierarchical control h to return. Similarly, the nearly periodic oscillation between the two rates for triangle-square fractal suggests a quadratic control in the singular fractal system to memorize two fundamentally distinct architectural growths in a single chemical beaker. Self-replication is a prerogative of nature as it can modulate the fractal rate. Higher level memory in regulating the chemical kinetics is a generic protocol to merge the gap between the existing automated intelligence and the biological intelligence exhibited by nature in reproduction.

9.7 NANOBRAIN, THE SMALLEST LIFE FORM

Nanobrain, NB, or PCMS (Pamam dendrimer, controller, molecular motor and sensor) has all the three components of a life form. It can sense, it can work, and most importantly it can process decisions. Figure 9.9a shows what happens at the core of this smallest life form. Different multi-level switches or H, H1, and H3 devices incorporated inside acquire the time crystals via sensors connected outside. Then they start vibrating following the symmetries of frequencies prescribed in the PPM. During this quasi vibration charges of various natures produce, they follow their own symmetries in the PPM (Figure 9.9b). Eventually, they build distribution of phase (Figure 9.9c). By now readers know that such a distribution of geometric phase with an intricate 3D geometry is called a time crystal which would pinpoint the unique PPM and the course of future dynamics of the whole system. That regulatory phase distribution of polarons or any quasi particles

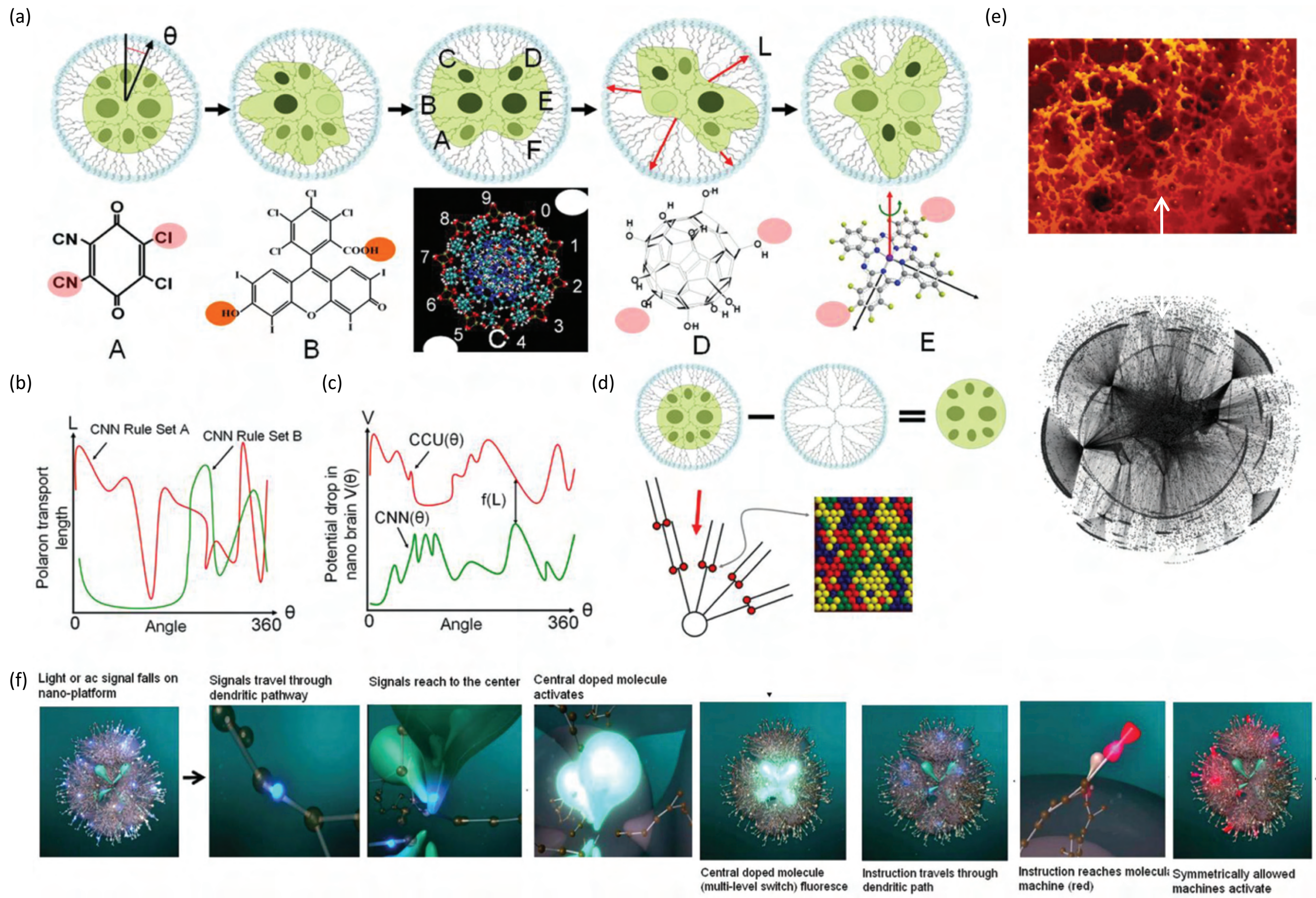


FIGURE 9.9 (a) Inside a PAMAM or any dendrimer with a cavity, multilevel switches are placed that controls the motors and other elements dynamics. Five different molecular structures are shown, which were experimentally verified as multi-level switches. (b) As the branches increase, the polaron transmission length changes non-linearly, but it depends which set of cellular neural network rules are encoded to the central controller molecules described in the panel (a). The phase θ is actually the direction. (c) The potential drop, or the energy expenditure in the nanobrain or PCMS as a function of phase. (d) The processing dodecanion tensor by the nanobrain creates the multi-dimensional architecture of nested clocks or time crystals. (e) The optical vortex projection of the time crystals during information processing. (f) A schematic of nanobrain operating by transmission of energy through the different pathways between motors, sensors and the decision-making controlling molecule doped inside.

containing the conditions to encode singularity points in a clock actually writes its quasi charge distribution on the surface of the systems phase sphere and that could be read as a time crystal using monochromatic laser (Figure 9.9d). The projected architecture of artificial atoms (assembly of vortices) containing a solution to the problem is shown in Figure 9.9e.

Each multipolar resonance can be locally driven at points where the coupling between the quantum emitter and antenna connected to the life form is efficient. The electric mode density is high at the ends of a nanowire regardless of the symmetry of the resonant mode. Therefore, a point source (electric dipole) at the end of a Hinductor, *H* nanowire couple to all possible resonant modes, breaking the symmetry that might prevent access by far-field illumination, and encompassing both sub- and super-radiant modes irrespective of symmetry. *H* devices self-assemble as nano-antenna (Taminiau et al., 2011) and might operate in the entire optical frequency range and beyond (Della Valle et al., 2008). *H* antennas are ultra-sensitive to polarization and dark modes at various selective regions (Kajetan Schmidt et al., 2012). Quantum antennas forming a fourth-circuit element could deliver quantum information processing (Curto et al., 2013) via PPM. The complete process, how sensor, processor, and motor work, is shown schematically in Figure 9.9f.

9.7.1 Jelly of Megamers Following a Resonance Chain

In the artificial nano brain, the organic jelly captures the solution of a problem via triggering synchrony of a particular pattern of time crystals with its nearest match with the 15 shapes of

GML. By successive learning, the brain jelly stores high-level time crystals as associated rules, which are called through synchrony as soon as external environmental conditions demand. For that reason, computing time is not the sum of the times taken by individual matching processes; rather, time taken for the resonance between two individual neurons determines the global speed of computation. The time taken for two neurons to resonantly vibrate is more than four neurons to vibrate resonantly. However, in contrast, under noise, more is the number of coupled neurons in an environment, faster is the time to find a perfect match. Works of literature are rich in mathematically arguing that synchronization speeds up when the environment is more chaotic. We can understand the underlying complex mathematical treatments with a simple time crystal: more is the randomness in a system, higher is the probability that the matching condition already exists as a pre-set situation even before the synchronization begins. Therefore, as soon as the synchronization is triggered, the already existing pre-set condition supersedes other options and that would reduce the convergence time drastically. It is mathematically shown that topological randomness decreases the synchronization time by several orders (Grabow et al., 2010).

During this period there is no transmission of a signal between the components, because it's a supramolecular architecture one inside another. One such example is megamer shown in Figure 9.10a–e. The whole architecture is simply extrapolation of the smallest life form described above, however, there are differences (Figure 9.10f). The journey of computing is summarized in Figure 9.10g. Earlier, there used to be a linear circuit, then using 16 molecules Bandyopadhyay and Acharya (2008) showed that information processing turns rapid, now 3D system shows one could carry out complex processing without any outside communication. The synthesis of brain jelly superstructure advances the wheel model of the brain. Using a very simple scheme we have reminded reader how the primitive idea of clock inside a clock that started at the beginning of this book ends here (Figure 9.10h). Each component is a PPM and their resonance bands have common resonance frequency points which enable smooth energy transfer between the components (Figure 9.10i). Such overlaps when plotted for the entire brain jelly architecture, one derives the resonance chain once again, earlier it was for the real brain components, now it is for the brain jelly (Figure 9.10j). Now, we would dig deeper into the fundamentals of the resonance chain.

Multilayered synchrony: non-linear frequency pulling in the entire Fractal tape network: harmonic and anharmonic oscillation The artificial brain described here is made of brain jelly, an evolving organic architecture that senses the rhythms and elementary seed that takes part in the process is the nano brain. Now, we can either consider brain jelly as a material or just a network of rhythm, simply a time crystal. At every stage of the proposed artificial brain, starting from the input of signals from the external environment to the main processing unit, the core brain, signals are synchronized, time crystals are linked. At every stage, coupling and de-coupling of time crystal take place to favor synchrony or desynchrony. Since entire brain jelly network is made of high-quality factor oscillators (quality factor ~ number of oscillations before the energy decreases by $1/2\pi$ times the initial energy), non-linear frequency pulling plays a vital role in generating synchrony. The general expression for harmonic oscillation is given by, $0 = \ddot{x}_n + x_n$, then we add linear damping $\gamma \dot{x}_n$, then we can add reactive coupling, $\sum_m D_{mn}(x_m - x_n)$, also add further non-linear stiffening x_n^3, and or energy input $-\gamma D\dot{x}_n(1-x_n^2)$, and then add the signal $2gD\cos[(1+\delta\omega D)t]$. An oscillator driving near resonance $\omega_D \cong 1$, it means that the driving frequency turns identity, it is not required. A single-driven damped anharmonic oscillator follows $\ddot{x} + \gamma\dot{x} + x + x^3 = 2g_D\cos(\omega Dt)$. Anharmonic and harmonic behavior coexists in a time crystal network that drives the nano brain and the brain jelly. Non-linear frequency pulling means if the system if pumped at other frequencies, the system automatically drives it to ωD, the natural driving frequency.

Spontaneous generation of higher level rhythms: re-defining intelligence and creativity: For every typical input time crystals or rhythms, from external environment, the neural network in the artificial brain naturally construct an output set of time crystals or rhythms. If the network uses this input-output set repeatedly; it is stored as a favored rule for that particular transformation. We call it a higher-level rule, since the neural network would always try to impose it, naturally, if any structurally similar time crystal-cluster is created in the upper brain. When we construct a typical artificial brain, we need to decide beforehand what would be the minimum size of a time crystal and the maximum size that is process-able for the given brain architecture. In another word the material seed or nano brain decides how the brain jelly would form, smallest sized time crystals would be processed using highest frequencies and the largest size time crystals would use the lowest operational frequencies. Both the lower and the upper limits are determined by the kind of basic oscillators or neurons we use to write the basic time crystals. The resonance frequency is a basic hardware property of an oscillator, and there are several different kinds of oscillators; depending on their operation, resonance frequencies are strictly defined. For the composite time crystals, it would be like a composite electromagnetic oscillator, whose resonance frequencies would also be a strictly defined parameter.

Resonance in damped anharmonic oscillator: For learning the time crystals break links following equation-given by $\ddot{x} + \gamma\dot{x} + x + x^3 = 2g_D\cos\omega_D t$, damping factor is γ, drive strength is g_D, the drive frequency is ω_D, for resonance $\omega_D \approx 1$. Smaller g_D means a lower non-linearity, which means, $\omega_D = 1 + \varepsilon\Omega_D$, $g_D = \varepsilon^{3/2} g$ and $\gamma = \varepsilon\Gamma$, when we consider $\varepsilon << 1$, g, Γ, Ω_D are unity.

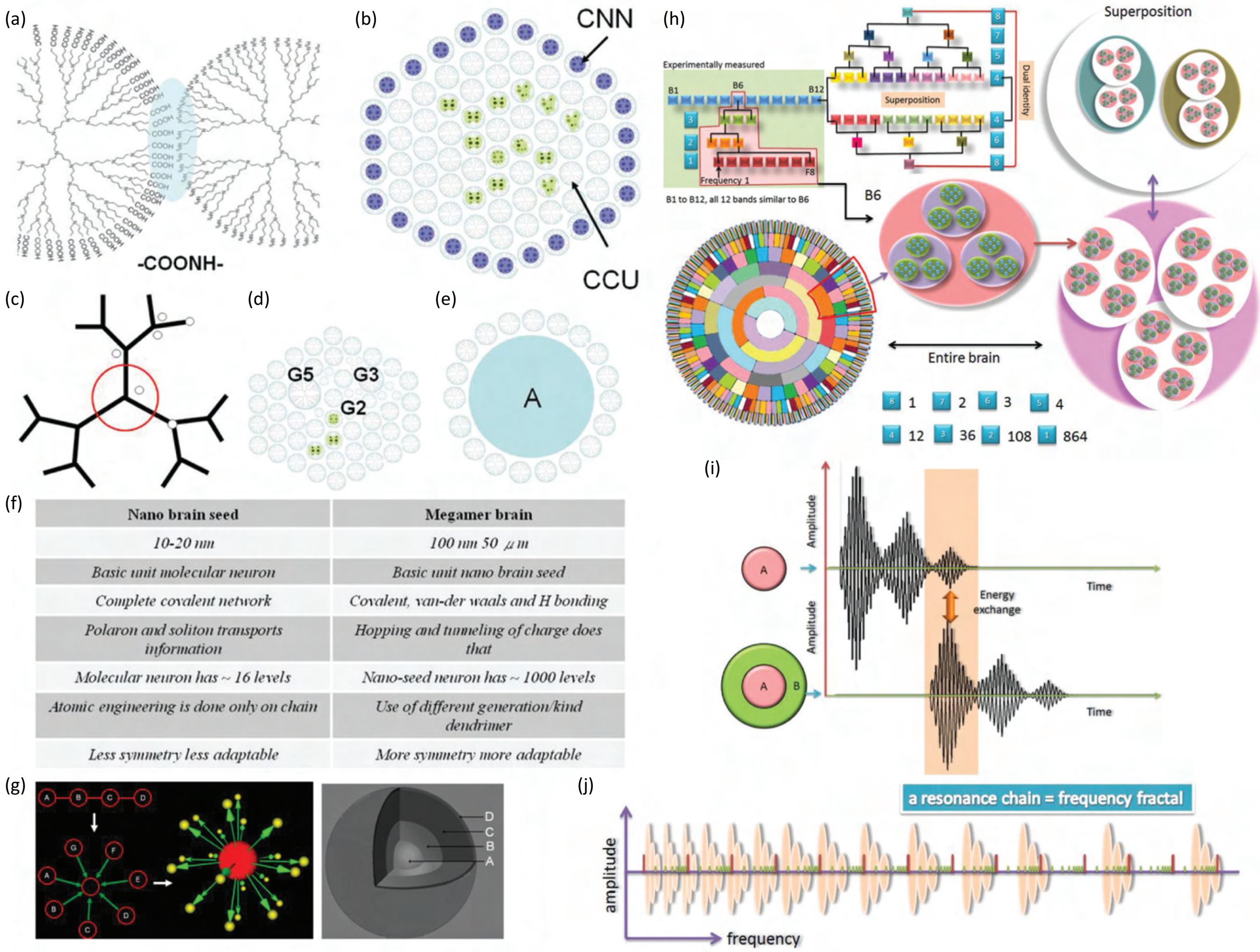


FIGURE 9.10 (a) The basic bonding between the nanobrains for the formation of megamer as a brain jelly. (b) The central control unit (CCU) and the central neural network (CNN) of a megamer brain or brain jelly. (c) A fractal cascade of synthesis of the megamers as PPM, its successive phases are shown by schematic in the panels (d) and (e). (f) The difference between the nanobrain, PCMS class systems or *H* device with the megamer brain is noted. (g) Successive synthesis of higher generations and higher-dimensions architecture of nanobrain. (h) Nested linear oscillations could lead to the creation of a complex time crystal architecture where multiple solutions could coexist. (i) Nesting of multi-layered time crystals by overlapping of common resonance frequencies or common pattern of the singularities. (j) A dodecanion resonance chain written linearly to demonstrate the formation of an integrated processor by combining several layers of imaginary worlds.

High Q oscillators follow the equation below: Equation of clocking path on the phase sphere of a time crystal undergoes diameter displacement x during sensing an input geometry for activation of GML is $0 = \ddot{x}_n + x_n$, we add linear damping term, $\gamma \ddot{x}_n$; we take δ_n from $g(\delta_n)$ and add its function $\delta_n x_n$; then we add reactive coupling term $\sum_m D_{nm}(x_m - x_n)$; non-linear stiffening term x_n^3; energy input $\gamma_D \dot{x}_n(1-x_n^2)$; signal $2g_D\cos\left[(1+\delta\omega_D)t\right]$ and then there could be additional noise term.

An accurate description of synchronization with simultaneity is impossible: The coupling between two time crystals, is the coupling between multiple basic Hinductor, *H* oscillators via wireless energy transfer in the beginning. If that wireless energy exchange mode is practiced more, slowly a physical bonding grows between the oscillators, since more and more common clocks get engage in the energy exchange process. The nature of physical bonding defines the foundation of mathematical formulation for mutual synchronization until the construction of physical wiring is completed. The fundamental problem of addressing mutual synchronization is that amplitude and phase vary simultaneously, and almost all theories find some reasons to avoid one and go ahead with the other. One such example:

"oscillators are strongly attracted to their limit cycle, so amplitude variation could be neglected and phase variation needs to be considered." Now, there could be several different kinds of glues-for-coupling, dipole-dipole interaction, H bonding, etc., which are weak bonding in the energy range of 1–10 kCal, but not the strong covalent bonding (~400 kCal). For weak bonding, mathematical formulations ignore subtle fluctuations for simplicity, and as we have argued in Chapter 2, many-body interaction formulations for phase locked synchronization (Strogatz and Mirollo, 1988) do not fit for the "simultaneity adventure" exercised here. At this point, we note that weak bonding only brings basic oscillator neurons (Hinductor class 2 or H2 devices) at least in a favorable orientation; similar to real brain's neural network, stronger, practice-based consolidation of coupling protocol is established, but the neurons cannot create new axon channels if necessary. To compensate, for the artificial brain made of organic jelly, we use molecular machines, which have inherent dynamics to get coupled with the other machines physically at a particular electric field eventually forming giant nano-wires via self-assembly. There are various kinds of locks, one that helps in morphing is called injection locking.

Injection locking: When the coupling is strong enough and the frequencies near enough, the second oscillator can capture the first oscillator, causing it to have essentially identical frequency as the second. It is injection locking. When the second oscillator merely disturbs the first but does not capture it, the effect is called injection pulling.

All components in the resonance chain, reply back via non-radiative energy transfer. The technology relies on the "electromagnetic transparency" of the material, as described in Section 8.9, as cloaking. However, due to large reflection coefficient the transparency develops opacity, i.e., anomalous quantum cloaking. Thus, the screening effect restricts wireless communication beyond certain limits of the immediate neighborhood. As described earlier, three hallmarks of the artificial brain, (i) electrical, magnetic, and electromagnetic resonance, (iii) cloaking, (iii) holographic projection, following $e-\pi-\phi$ quadratic relation. For this reason, we cannot rely on an antenna-receiver concept to scale up the "reply back" technology, where radiation energy passes through the air between two materials, the philosophy requires a fundamental change. Alternatively, we have introduced a multi-layered structure where output structural product of one waveform connects 12 layers nested within and above.

For each layer, the resonance band has three distinct domains, one domain is used to communicate with the inner layer, and one with the external layer, one layer is kept for its own information processing. Thus, all layers are energetically connected by a single chain of resonance band, irrespective of the size of the device architecture now a wireless communication can transmit without getting screened anywhere. The energy given as an input at any layer transmits to the entire chain of resonance bands, both ways, toward the lower and toward the higher frequency regions of the chain. Any form of energy is suitably absorbed and then transmitted across the resonance chain. A resonance chain connects every single computing seed in the system; thus, zillions of seeds are wired into a massively complex yet a single network in the form of a time crystal.

9.7.2 EEG of a Nanobrain

At the very beginning of the interaction with a natural event happening around us, the frontal lobe of our brain controls the five major sensory organs to collect maximum information from the external world, and immediately the captured information is converted into a stream of pulses. In the brain jelly there is no pulse stream. **A time crystal is an endless network of rhythms (infinite series mathematically), it projects a set of optical and or magnetic vortices, which is finite, defined as an argument when it includes a time function, means after a certain time, it would change to another time crystal, in this book we use time crystal in general, often it means an equivalence of argument.** In this path, a checkerboard of pulses that keeps timing (gridding) remains constant throughout. The multilayered wave-stream that is formed in the sensors is simply a superposition of several 2D patterns. Composition of wireless (parallel) and wired (serial) circuiting is delicately balanced to make sure that time-grids prepared by different sensory-organs match with each other so that eventually we get a unified time-grid for synthesizing combined time crystal for visual, auditory, touch, taste and smell wave-streams. Once all time crystals produced in different sensory-organs are locked by the unified time-grid, there are several points where information-processing language could be verified. The objective here is to understand nature using the true language of the brain, GML, this will not be the ultimate one, but it will mark the beginning of understanding the brain in the way it is, and subsequent rectifications in the following years would deliver the final grammar to read the signal absolutely captured from any part of the brain.

One way to confirm that time crystal language, GML is to read the brain jelly's EEG. Figure 9.11a shows as brain-like prototype device filled with organic jelly and several neural network-like cables are connected to input time crystals as a stream of electrical pulses. Figure 9.11b shows fully operational module for such a device, where using a high-resolution camera, the evolution of jelly is observed as a function of time (Figure 9.11c). By shining laser and reading the magnetic vortices one could read the time crystals instantly. One nice way to advance the simple module of Figure 9.11b is to build an ensemble of several such devices and arrange them in a fractal structure. Only the geometric feature alone could trigger EEG similar to a human brain (Figure 9.11c).

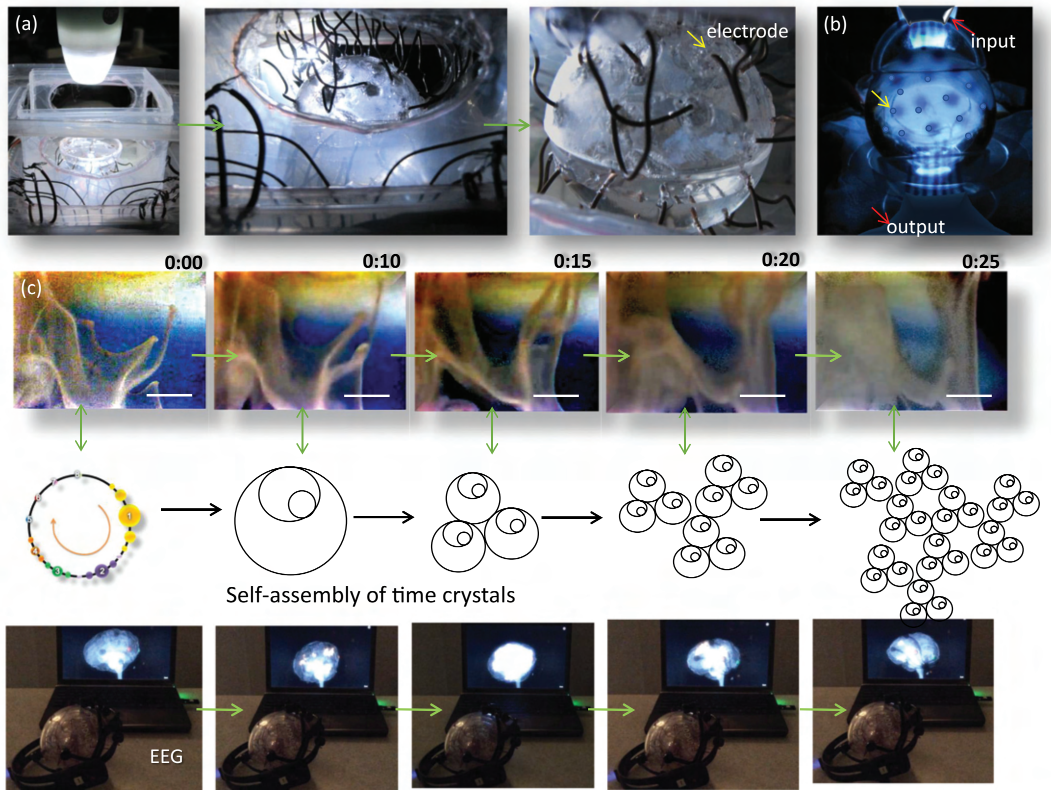


FIGURE 9.11 (a) The first prototype of an artificial brain built in 2013. Several electrodes connect to the organic jelly builds the input-output wiring, the final device, an artificial brain is shown in panel (b). The jelly is zoomed in the panel (c) scale bar is 1cm and the equivalent time crystal is shown schematically. At the very bottom we demonstrate the EEG pattern with the brain jelly.

9.8 TUNING UNDEFINED HOLES TO SENSE MAGNETIC LIGHT

We summarize again, how the brain jelly works, now using simple mathematical numbers. Figure 9.12a shows that by changing the geometric parameters of an *H* device one could switch on or off desired number of singularity points or holes in the phase space. Also, even without understanding much detailed mathematics, one could draw equivalent time crystals, crudely. Say, three such helices come together, representing 3, 6, and 12 (Figure 9.12b). Now, if one wants to draw the phase space of the assembly, it would find three singularities for the simplest scenario, one for each *H* devices. Most importantly, in the holes or singularities the phase space corresponding to the 6, 5, and 12 would reside. It means they would affect by phase alone. Now, all four components, 5, 6, 12, and 3 have their own time crystals, where the time crystal of 3 is the host, others are guests. When laser light falls on this cluster, this very phase space is projected as a composition of magnetic vortices as shown to the right of the Figure 9.12b. We can draw circles on this magnetic image and could read solution, what is the final outcome.

Exponential speedup without using entanglement: One important aspect of a such a brain-jelly-based computing at the molecular scale is that these mixed states which are responsible for the logical reduction, but in these states during measurement, when exactly the computation occurs, we need to stop entanglement still allowing superposition to continue. It is the measure of discord, namely quantum discord in a system. In the case of the classical logic gate there is no superposition, hence the possibility of simultaneous reduction operation does not arise, which is very much possible in a quantum computer. One very important question that we ask here is the need for the pure entangled states, would it be possible to construct a decision-making PPM without pure states? Jozsa and Linden (2003) have argued that an exponential computational speedup might be possible with mixed states in the total absence of entanglement, and entanglement is essential only if computing is performed with the pure states only. Magnetic vortices based time crystal is fit to exponential speedup (Lloyd, 1999) irrespective of spatial scale, since here in the entire book we replace every single physical parameter in the universe using time crystals (see Chapter 4), if some parameters left, would be done soon.

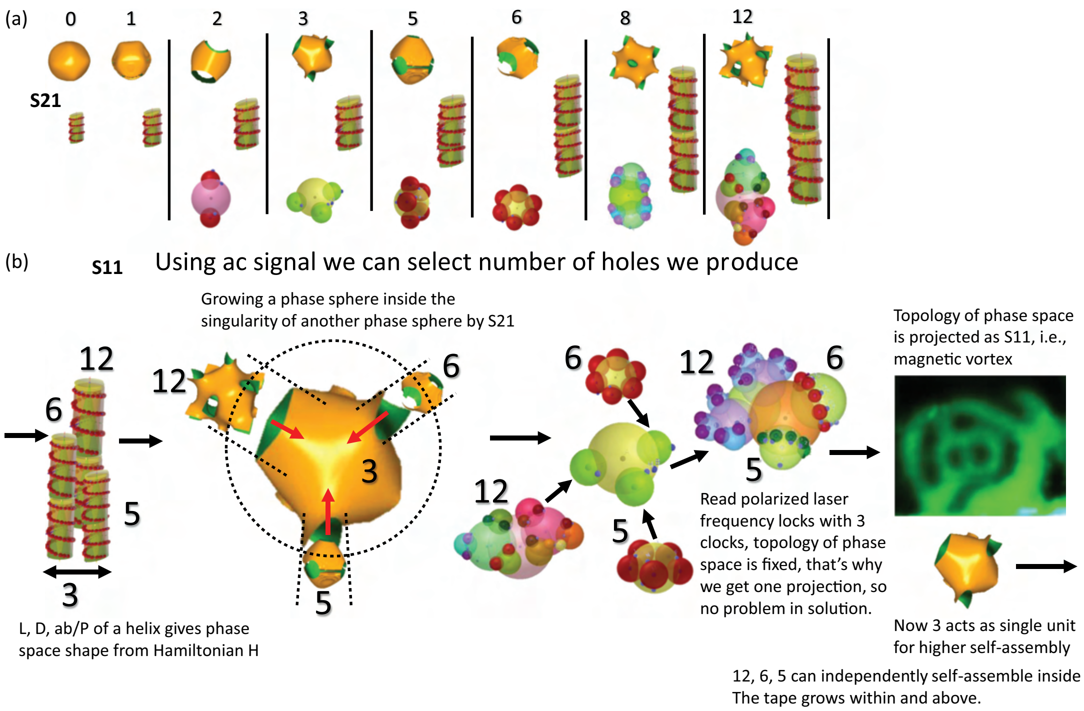
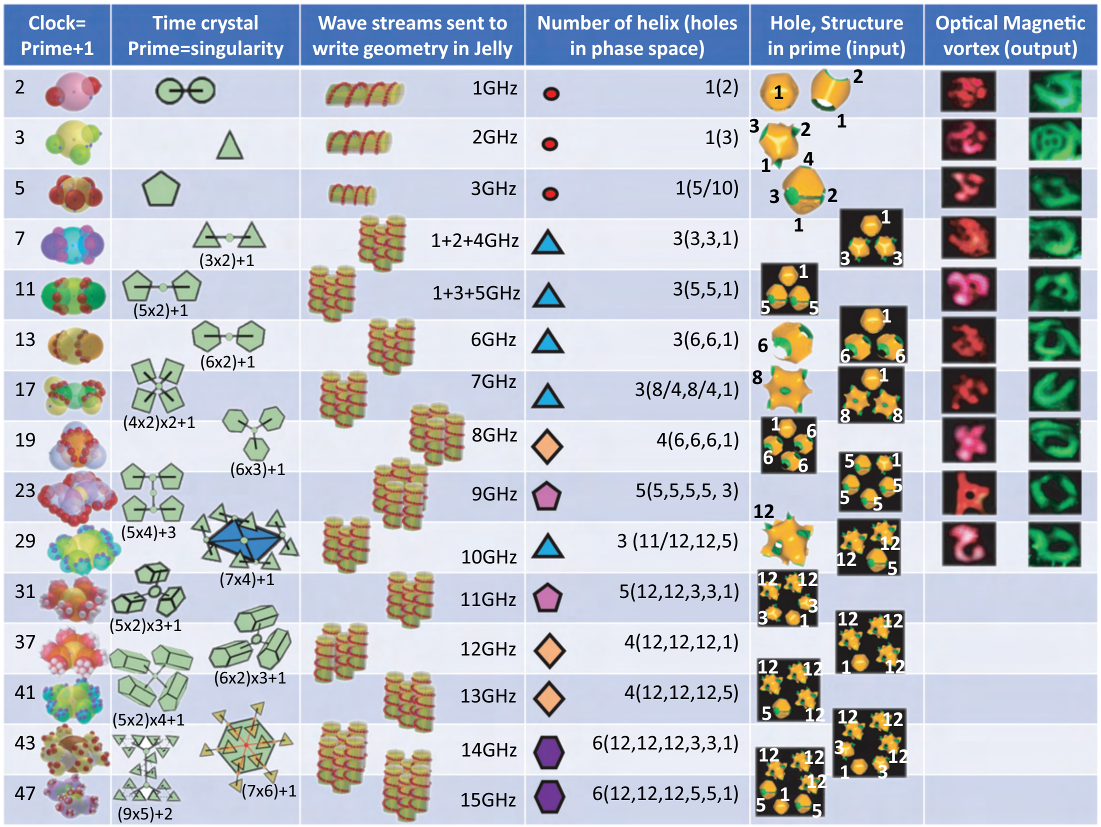


FIGURE 9.12 (a) In quantum, we have only one phase space with two classical points, but for us there are no classical points but 1–12 variable number of holes or singularities in the phase space. We can open or close n number of holes to write any integer. The chart shows different number of holes in the phase space of the *H* device. Below a schematic is presented to explain the length, pitch diameter and lattice parameters acquired by the *H* device to generate the holes and finally below the equivalent time crystal to be produced. (b) A single chart begins with the self-assembly of three *H* devices representing integers, 5, 6, and 12. In the next step we show how inside the singularity of three holes the phase spheres of three components enter. S21 reading of transmission spectrum delivers the result. Then in the third step we explained how the time crystals look like for three elements and how they self-assemble into an architecture of combined time crystal. In the fourth step we see the final magnetic vortices images. These images are fed to simulator to build time crystal. Holes in phase space act like bonds. Holes blink periodically, hence phase spaces are like orbitals of molecules with vectors, the 3D distribution of vectors try to minimize, i.e., sum of vectors = 0, in doing so, supramolecular architectures are born.

If superposition of magnetic vortex atoms mix the vibrating states via synchronization of oscillators, then it is possible to generate an exponential speed. If we can demonstrate that mixed state computing could be implemented to speed up those intractable problems exponentially which are essentially required to resolve the brain-like computing then we can demonstrate that synchronization is superior to entanglement in solving the problems that brains required to solve. However, for "search and find" problems even in the classical "nested synchrony" it is a 3D network of co-existing synchronized and desynchronized states. It means in simple words, without using extensive mathematics the pattern of primes PPM can suggest that for the mixed state also, non-entangled processing has to continue along with the entangled processing, and then it has to wait for the other processes to be complete. In the "nested synchrony" protocol, which is the hallmark of fractal mechanics proposed in Chapter 4, the entire hardware is coupled and time wasted is minimum, in principle there is no time delay in a time crystal scenario. Even before a clock senses the information reaches several layers below, determines the modified rhythms as solutions and sends to the higher-level slower scales. Thus, the solution always reaches "instantaneously" just like quantum entanglement, though it is a purely classical scenario.

9.8.1 Spiral Nanowire Writes Time Crystal—Sense It as a Crystal of Light

Brain jelly's adoptability of accepting new hardware components: The truth table of 15 primes: The most fundamental truth-table for any brain-jelly-based decision-making non-computer is shown in Figure 9.13. If one builds an operational brain jelly, he has to present such a table. For every 15 prime, a related symmetry there should be a material structure and a distinct signature of magnetic and optical vortices. We did not fill up the table to suggest one needs only a few primes to simulate 90% of events happening around nature. The brain jelly should be able to accommodate new kind of oscillators or structure embedded into it using these elementary prime structures so that it could enhance the power of computation, evolve under fatal conditions. If we observe the human brain architecture, depending on the processing necessity, it has developed several different kinds of neurons, and



Clock= Prime+1	Time crystal Prime=singularity	Wave streams sent to write geometry in Jelly	Number of helix (holes in phase space)	Hole, Structure in prime (input)	Optical Magnetic vortex (output)
2		1GHz	1(2)		
3		2GHz	1(3)		
5		3GHz	1(5/10)		
7	(3x2)+1	1+2+4GHz	3(3,3,1)		
11	(5x2)+1	1+3+5GHz	3(5,5,1)		
13	(6x2)+1	6GHz	3(6,6,1)		
17	(4x2)x2+1	7GHz	3(8/4,8/4,1)		
19	(6x3)+1	8GHz	4(6,6,6,1)		
23	(5x4)+3	9GHz	5(5,5,5,5, 3)		
29	(7x4)+1	10GHz	3 (11/12,12,5)		
31	(5x2)x3+1	11GHz	5(12,12,3,3,1)		
37	(6x2)x3+1	12GHz	4(12,12,12,1)		
41	(5x2)x4+1	13GHz	4(12,12,12,5)		
43		14GHz	6(12,12,12,3,3,1)		
47	(9x5)+2 (7x6)+1	15GHz	6(12,12,12,5,5,1)		

FIGURE 9.13 A table shows 47 primes and its possible geometric representation. Column three shows what frequency should be sent for synthesizing a prime in the brain jelly. Column 4 shows the composition of phase spheres required to build the required self-assembly. Column 5 shows the possibility of synthesis of phase spheres and Column 6 shows optical and magnetic vortices generated by the system, current results belong to helical carbon nanotube.

other components, all these components, demonstrate oscillator like behavior. PPM-inspired artificial brain explored here will not have the capability of constructing new kinds of oscillators; however, if we find the necessity from outside and supply, then it should be able to accommodate it internally. Two objects are considered to be equivalent, or "homeomorphic," if one can be morphed into the other by simply twisting and stretching its surface; they are different if we have to cut or crease the surface of one to reshape it into the form of the other. All Hinductor or *H* devices that are the key ingredient for brain jelly are homeomorphic to accommodate smaller changes, but for larger, they add or decrease length to morph an external input.

The supremacy of brain's pattern recognition: Brain jelly processes information by capturing images using an effective visual technology—blinds make those images using sounds—blind, deaf, and dumb make those images in the brain by touching the objects. However, irrespective of the origin of those images, the brain follows a unified geometric language GML protocol to analyze and prepare them for learning. We look at a picture but do not see every part of it distinctly, only a few geometrical points are noted, converted into primes just as outlined in the table, the color band and contrast regions are noted but no specific details are pointed out at the first instance, we zoom at a very specific region, see only that part which is very interesting to us. It is a fantastic way to minimize the amount of information need to be processed and stored in the brain—suggesting an essential feature of an artificial brain to zoom an interesting part while capturing a visual. All geometric structures are produced by hyperbolic functions so that rhythms or time fractals come into picture and "nested geometry" is converted into "time crystals" that could be encoded into the materials property. It is the foundation of "brain jelly."

9.8.2 Writing Prime Numbers in a Jelly

How a brain jelly builds a geometric shape and synthesis a PPM: A brain jelly has to process 15 geometric shapes (Figure 9.13), it means by synthesis it has to produce organic supramolecular architectures, preferably helices and vortices as outlined by the fourth-circuit element, *H*. We already know by now that *H* devices are such that they build 12-hole phase space that blinks when the structure changes its geometry continuously. However, if the external user sends a particular ac signal to write a particular geometry, then the structure that is created does not change the geometry which fixes the number of holes in the 12-hole phase space. The number of holes is the numbers of the corners a geometric shape has. Thus, a geometric shape is created. It is very interesting how to select a suitable H device to build a brain jelly, given that thousands of reports on the synthesis of helices are there. Figure 9.12a shows one such example, where a typical multi-layered helical nanowire namely microtubule found in the neurons to all eukaryotic cells are shown. It does not generate all 12 number of holes when one measures the reflectance and transmittance of these materials, but only a few, especially 2, 3, and 5, are enough to synthesis all other primes. Figure 9.12b shows how actually three nanowires 5, 6, and 12 holes come together. The 12-hole phase spaces for the three elements 5, 6, and 12 build a new phase space represented as 3. In the singularity domain of the phase space with three holes, the other three, 5, 6, and 12 enters. In reality, the distribution of static charge on the helix surface undergoes rapid oscillation and due to birefringence, polarized electromagnetic signals produced from the device H generates magnetic vortices which are time crystals. The projection of magnetic vortex atom assemblies is the driving force for the self-assembly of the other H devices. However, please note that we have used magnetic vortex atoms, that does not mean this is the only way to build brain jelly, one could build ionic vortex-like neurons do in the axons, or molecular diffusion could create vortex, even sound or mechanical waves could build vortex of solitons that could act like virtual atoms. In general, vortex atoms are the coolest tool to write read time crystals, wireless, ultralow power processing is evident.

9.9 ENTROPY DRIVES THE SYNTHESIS OF A PATTERN OF PRIMES

However, the synthesis of H with 15 possible geometries is only the first step. Creation of a single H device with a single geometric shape is not enough. To build the structure representing the primes, these elementary structures with the elementary geometric shapes are to combine and then build the composite structure of H devices as outlined in the table of Figure 9.13. Here is the key. We do not endorse any particular material, but whatever be the material used for building a brain jelly, should first synthesis H devices in the solution or gel matrix. Then, it should engage in creating the 15 primes as necessary. Finally, the primes would self-assemble to create the divisors of the integers sent as an input. Say, we want to write a triangle with a ratio of 13:43:7, then only the three prime structures on demand would be produced from the elementary H devices and these prime structures would come together. However, if we send a sum of ac frequencies as a modulated waveform, or otherwise as the materials synthesis demands to write 24:27:99 then, all the divisors of the integers would be produced. In the solution, the divisors would follow the Hasse diagram as outlined in Figure 9.14a. For the spiral helices, how the composition of divisors might look like in the solution are outlined in Figure 9.14b. Following the Hasse diagram, the thermodynamic entropy regulates synthesis so that coupling the primes build the integers. It is beautiful mathematics of entropy played by H devices in the solution, as if thermodynamics conspires to lead the self-assembly toward the synthesis of integers from the primes following PPM. As if nature conspires to follow PPM. When the divisors are born, the journey through the Hasse diagram results in building the all possible structures that those divisors could synthesize. There are errors in the production of integers, and that thermodynamic error takes us through the path of perfecting the 3D pattern of PPM.

Say, in the solution, all the divisors made of primes 2, 3, 7 are produced. That number of divisors is not less. For example, $2 \times 2 \times 3 \times 3 \times 3 \times 7$, $3 \times 3 \times 2$, $7 \times 7 \times 7$, etc. Following this route an infinite number of divisors could be generated; however, the desired divisors and their few neighbors are created. To understand it simply, if the desired divisors are $2 \times 2 \times 3$, 3×7 and $2 \times 7 \times 2 \times 3$ then, in the solution, $\mathbf{2} \times \mathbf{2} \times \mathbf{3} \times 2$, $7 \times \mathbf{2} \times \mathbf{2} \times \mathbf{3}$, $\mathbf{3} \times \mathbf{7} \times 2 \times 2$, etc. structures would be created naturally as an error. Thus, in the PPM plot, which is built by connecting the nearest neighbors in the ordered factors of integers, we get many dots as more and more erroneous products flood the solution. Connecting the nearest neighbors is also like minimizing entropy, just the way discrete isolated atoms or molecules come together and build a crystal of atoms or molecules. Thus, the PPM plot is an account of Hasse's universal protocol, when errors take over. And then, another beautiful thing happens in the solution or synthesis matrix. PPMs have several loops, and the errors trigger those loops which and drives the formation of erroneous products more to fill the missing points of the loops. The natural thermodynamic drive wants to close the loops in the PPMs and that expands the geometric input pattern as shown in Figure 9.14c.

9.9.1 Hasse Diagram for Entropy Builds Material Analog of Integers

Creation of the column of time crystals by self-assembly follows a power law: While describing the Hasse diagram above we have noted that the energy transmission follows a unique mathematical pathway. The brain jelly starts learning from the first time crystals encoded in the amygdala, and then more and more time crystals are added. The addition process is very special. When two time crystals are added to the hardware, new higher-level coupling rules are created and similarly more and more high-level coupling rules are born automatically. If we make a simple calculation that only one resonance peak represents a singularity and only one peak represents a pair of singularity points burst to emit energy, then for the nth addition of paired time crystal will find $\sim n^2 + 1$ number of higher-level coupling rules are automatically added. These automatic additions of higher-level couplings follow fractal relationship and develop their own phase transition rules during learning. Therefore, during self-assembly of time crystals by the brain jelly an astronomically large number of phase transition rules are also created and stored, and that is controlled by boundary conditions set to the choices and options. Choices are integer and options are ordered factor (Figure 9.14d). If we simply consider that a pair of exhibitory and inhibitory time crystals are there,

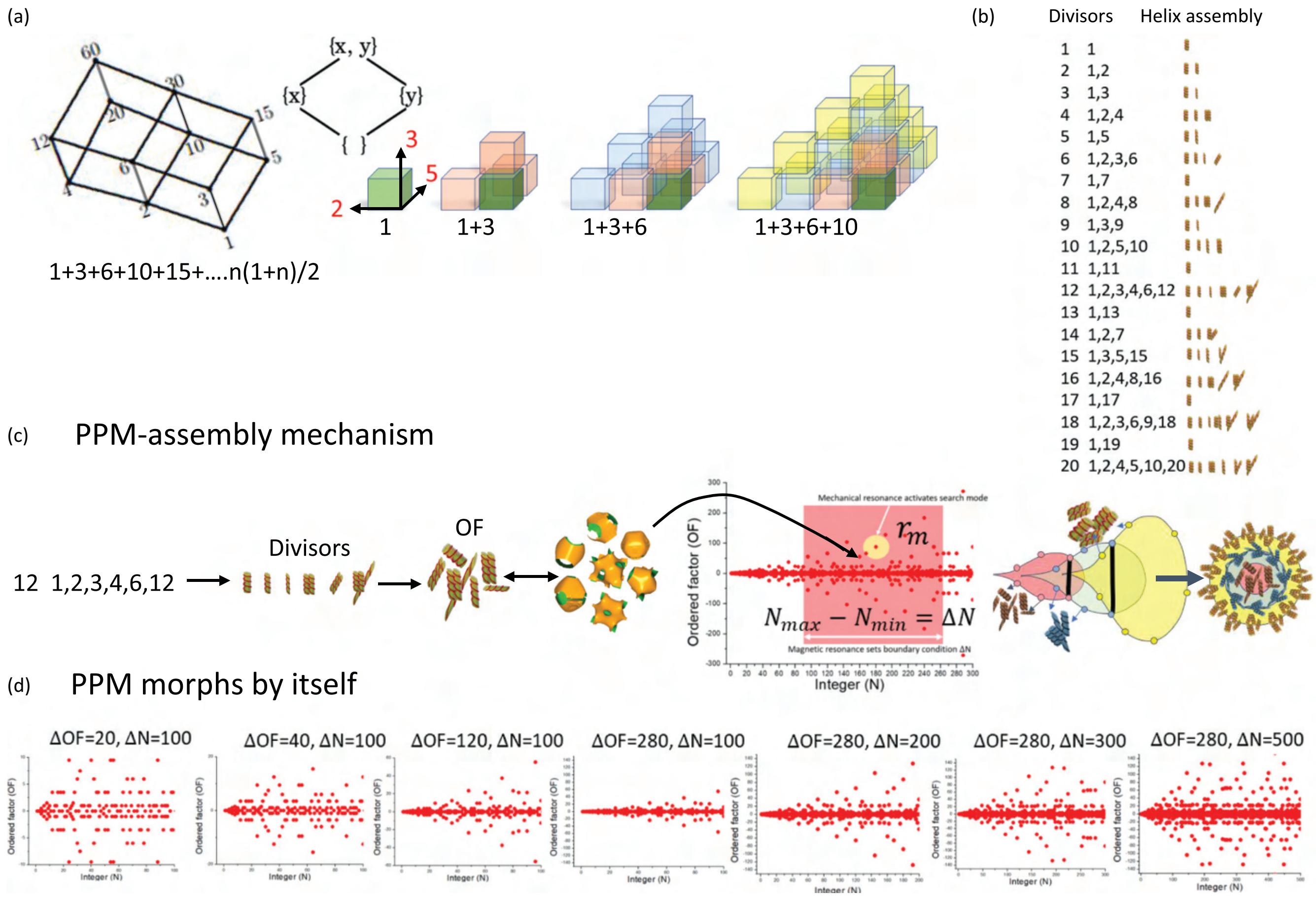


FIGURE 9.14 (a) 1, 2, 3, 5 series in Hasse diagram creates all primes, divisors, four-hole control by helix is enough to trigger Hasse energy transmission, synthesis of divisors. Integer = total number of holes in the assembly of helices Hasse diagram, *X*, *Y*, and *Z* directions represent three primes, 2, 3, 5, since it regulates entropy, we control its boundary by applying magnetic pulses. Computing is simultaneous electric, magnetic, mechanical resonance. (b) How a set of primes builds integers by synthesis, depends how does a helix manage hole production in phase space. Some helices produce all 12 holes, some only a few, if s helix produces only four types of holes,—1, 2, 3, 5—then we can build all integers by synthesis. We can use 2, 4, 6, 8, 10, 12 as 1, 2, 3, 4, 5, 6, respectively. (c) Three self-assembly steps, make integer, build divisors and OF, finally OF assembly and PPM loop assembly. The common line between two loops activates each other. A loop forms a layer, multiple loops forms, core-shell architecture magnetic field decides the number of loops, mechanical resonance decides search and find thermodynamically preferred helix, electrical resonance assists in healing wireless wiring between the helices. (d) The nearest neighbor of an OF point (OF, *N*) connects as a line, so, a point finds unique neighbors depending on width of *N* and OF, represented as Δ. Above, a series of plots show that the relative width of OF and *N*, i.e., $\Delta OF / \Delta N$ determines nearest neighbors. Here ΔN is the number of oscillators active in the solution, this number is tuned by applying magnetic and mechanical vibrations. Electrical wireless writing, magnetic arresting of neighbors and mechanical vibrations to activate the search mode operate $e^2 + \varphi^2 = \pi^2$.

then $n^2 + 1$ additional coupling increases to $n^4 + 1$ and so on. When two time crystals generate one new cluster of a time crystal, three bursts from one loop, then we get a converging triangle. The synchronization/response time will depend on the number of different frequency fractals used, not on the complexity of the path.

Geometric shapes and the brain circuits: Brain jelly is therefore similar to layered hyperbolic metamaterial system proposed recently (Poddubny et al., 2013) fit to process fractal time (Smolyaninov, 2012). The negative refractive index that defines a metamaterial as an integral component for brain jelly, since there is no wiring, metamaterial feature enables a particular component to vanish letting other signals to pass through. Thus, entropy under invisible components behaves in a non-predictable manner if we think about energy alone. The picture gets clear when we read the geometric shape transition. In the forest of *H* devices when there is no wiring cloaking and 3D arrangement to hold a particular geometry is the way to build a living circuit. For an *S*, *U*, *L*, *V*, *T*, all 1D patterns convert into a straight line and those straight lines bond in a circle simultaneously for the natural oscillation of the network of the oscillator to create the typical feature of a 1D shape. For the platonic 2D and 3D geometries, all structures eventually convert to a circle and sphere, i.e., eventually all 15 structures convert into a 3D structure or a vortex atom. The "most complex" or the "most non-Abelian" subgroup of SO(3) is the symmetry of the icosahedron—the largest

Platonic polyhedron, in some counting, which is the same as the symmetry of the dual dodecahedron, the origin of these groups are explained using string theory.

These cross-sections of circle or sphere and the 2D, 3D geometric shapes get more energy and these frequency values play a dominant role in the further oscillations. As a result, we find that the ratio of these contact point frequencies become the variable in the hardware. Since all-encompassing circles have the same area the ratios play a key role in defining the major terms of the rhythm. The line, 2D or 3D geometric shape to circle or sphere-like oscillation conversion requires certain time, and that depends on the shape of the internal structure. Based on that the frequencies on the circle and the straight-line or on the sphere are selected for the rhythm construction. Therefore, the ratio of frequencies and the time delay determines all the terms for the time fractal or the rhythm to be constructed for the geometric shape. The role of the triplet of triplet resonance band in constructing the rhythms: Is it essential? Triplet band is essential because this is the minimum number of bands required to create a resonance chain, if each oscillator does not have three bands then it cannot handshake with the oscillators holding the clock below and above, apart from its own information processing, three bands are must. And nature has taken utmost care to this requirement.

9.10 THE CORTICAL PEN THAT FREEZES UNKNOWN DYNAMICS INTO A TIME CRYSTAL

Humanoid avatar is not the only application of brain jelly, one could build a tiny pen that would assist a user to solve big data problem or provide an intelligent solution when we are totally confused. As said earlier, to use GML, PPM-based computing we search for confusion. Then find some more confusions within, take one confusion and dig deeper, the journey continues until we reach facts. Now, an artificial cortical column-based prototype is shown in Figure 9.15a. The 19 parallel cortical column channels are detailed in Figure 9.15b. Using 19 Yagi antenna we apply input time crystal, the output is read by the camera on the left. Seven gel layers are filled in the capillary tube made cortical columns. In future, it would be reduced to a commercial pen-like device as shown in Figure 9.15c, wherein one should put particular cortical column miniaturized like a capsule. The operation of a capsule is shown in Figure 9.15d, where during computation how a particular architecture grows and saturates at different layers is shown. Side by side we have shown the PPM how the column represents part of it. How to read output of a magnetic film is shown below Figure 9.15b, lines of forces are bright regions and the dark region is the pole. For a vortex, we should see a bright ring. We have also explained how to write 7^{11} using an organic gel. These are generic problems, for the real world the problem is different.

Automated filtering of groups in a given image, automatic decomposition of fractal seeds: In a given 2D image, where the corners or singularity centers that burst with distinct resonance frequency values are naturally coupled, by a clocking wave remain within the helical hardware. The time crystal or time crystal is memorized by a static distribution of charge on the helical structure, it never goes outside. When the vortex atom assembly carrying the stored time crystal enters into the resonance chain, then what happens? Resonance chain is not a living matter, it is a distribution of resonance frequencies in widely separated materials and the assembly of vortex atoms carrying the time crystal physically flows to transfer the geometric seed. Since the is no wiring how do they know where to go? Electromagnetically coupled oscillations of many components acting as the members of the resonance chain set the path of time domains. A circuit of time comes into being. A time crystal binds with the resonance chain in the tome domain where it fits. The hardware acts as a sensor jelly.

One of the remarkable aspects of this automated filtering of geometric shapes on the resonance chain is that all possible time crystals are isolated. As a natural property of the oscillators, each group of oscillators generates the nearest fractal polygons, and its equivalent rhythms or clocks. Thus, the entire input pattern is grouped into a nest of clocks; if there are many resonance chains each representing a typical PPM or a particular functional organ of the human brain then, automatically the class of information is sent at the right places. It is like an artificial hippocampus. The continuous oscillations in a certain layer of oscillators generate an image replica of a low frequency version in the above layer, this is how even a normal image becomes a fractal, a triangle has three points and all three of them gets a triangle inside each. Not just that an event does not reside at one temporal layer or one imaginary world of the brain, but in all. Thus, entire information lives at all places, just as fractal information theory, FIT demands. One of the major problems for using such a pen that solves big data instantly is that once it learns a new problem, it can solve only that class of problems. Imagine an algorithm that learns A, could read A for any kind of handwriting.

9.10.1 CAPSULES OF BRAIN JELLY—ONE EACH FOR ONE BIG PROBLEM

Therefore, the obvious question arises, what should one do, buy a new capsule from the online market to solve a particular class of problems? The answer to reusability lies in a beautiful research field developed by Ghosh et al. on the programmable matter (2015a). One of the benchmark challenges of computer science is to build a simulator that automatically learns complex rhythms or waveforms, memorize and reproduce whenever necessary (Jaeger and Haas, 2004). Several black-box computer models were implemented in harnessing this non-linearity; however, reservoirs embed tricks and thus limited to a few specific kinds of rhythms (Buisson, 2004). Randomness enables a starting function to match the variations of time series (Jaeger and Haas, 2004). Instead of software, if a matter can emulate a complex rhythm,

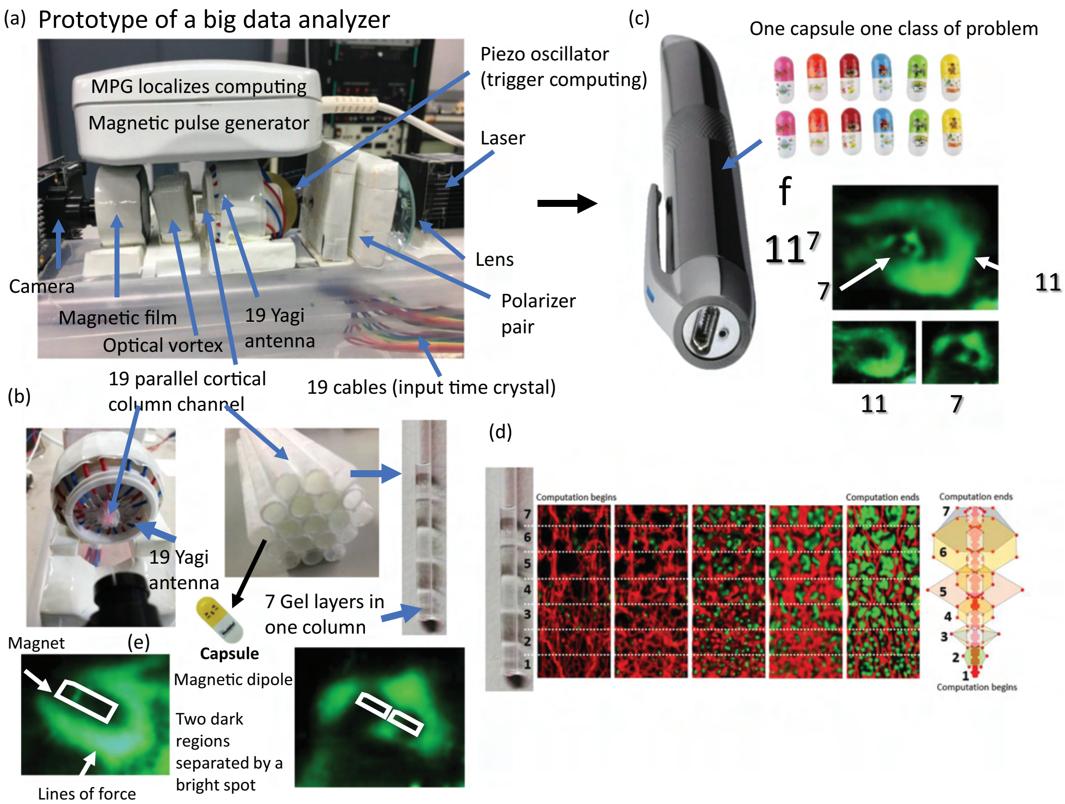


FIGURE 9.15 (a) The prototype of a big data analyzer. (b) Different parts of the big data analyzer. (c) A futuristic brain-jelly-based PPM, PPM-driven big data analyzer. (d) Decision-making process of a brain jelly in a cortical column. The leftmost picture is an NMR tube filled with seven layers of organic jelly. To its right the decision-making begins, the helical nanowire cluster (green) representing different kinds of self-assembly governed by PPM. To its right the equivalent PPM is shown which is instantly read by placing magnetic film around each layer, Seven layers deliver seven magnetic profiles similar to the ones shown in panel (e) and (f) and we read the decision-making process instantly all part of the solution at once. Brain jelly is a mixture of **electrolytic polymer (red)** and **oligomers (green)** in a cylindrical tube. While positive and negatively charged polymers create a vertical column of astronomically large number of cavities by chemical bond, the oligomers sensitive to composition of ac frequencies, build helices, and physically self-assembles the helices to maximize the absorption of modulated ac signal. Seven distinct densities of oligomer gradients ensure seven distinct size distributions of helix cluster, size is minimum at the highest density region. Monochromatic LASER shined along the cylinder's length reads all clusters and superpose magnetic vortices on the screen, a $\lambda/4$ vortex lens filters superposition in four quadrants.

then an understanding of the language of biological systems might lead to medical treatment, chronopathology (Sainz and Halberg, 1966).

Historical background and contemporary research on programmable matter: The programmable matter was proposed as a hypothetical material that is flexible ("wind tunnel at one moment, polymer soup at the next"; Toffoli and Margolus, 1991, 1993), instantly reconfigurable, shows variable resolution, intelligent sensing, integrated actuator and locomotors, as it engages in invisible computing. Invisible computing means primarily working with virtual atoms, or waves, like quantum, where electron like real particles are invisible (McCarthy, 2003; Goldstein et al., 2009; MacLennan, 2002; Wong et al., 2012). Proteins game with music requires special attention (Wong et al., 2012). In 1991, Toffoli and Mergolus proposed programmable matter is a material absorbs a particular form of energy, say light, sound, magnetic, electric field, etc., and changes its structure typically to encode the parameters of the input signal. In a rhythm or time fractal, a few frequencies together form a complex time series. The programmable matter is yet to face a benchmark problem of computer science (Jaeger and Haas, 2004); no true usable material was ever synthesized. By making materials that replicate rhythms we satisfy both the essentials for a true programmable matter. Our brain, even a single DNA molecule is a "programmable matter," this suggests a matter would by itself learn the hidden intelligence in a complex information packet and replicate that and no algorithm is essential. The proposed computing paradigm challenges the very necessity of a software program and the very need for CMOS based electronic world. Both soft and hard part is done by the material itself. Obviously, the invention should come from materials science. Though proposed in 1991, no experimental demonstration existed until now. When billions of data are being processed, and we have no clue regarding its hidden pattern, without building up the complete algorithm the programmable material can learn the phenomenon and reproduce. It could be the ultimate goal for artificial intelligence.

Brain jelly in that sense a true programmable matter, however, the brain has 47 Brodmann's region integrated for universal processing, that is absent in the cortical pen.

Some examples are evolving neural network, nano-wheel as integrated machine, replication of natural phenomena on molecular surface (Bandyopadhyay and Acharya, 2008; Bandyopadhyay et al., 2009a, 2009b, 2010b, 2010c). However, biological rhythms are key to the ultimate programmable matter like our brain or even DNA. Bio-systems encode and decode rhythms to run highly interconnected machines simultaneously; though the thrust to make an artificial programmable matter is increasing rapidly, no usable material exists that learns rhythms naturally and encode it in its dynamics. If realized this material would alleviate the necessity of algorithm, open the door to a new class of self-reconfiguration, cloaking, self-learning, encrypting, etc. Here, an organic jelly made of spiral nanowires changes its length and helical pitch during growth to mimic the composition of frequencies pumped into it. The cluster of spirals drive the self-assembly to a particular kind of fractal network that encodes the rhythm, so we can read/write ANY encoded rhythm or time crystal. The jelly learns several complex rhythms pumped into it operates without algorithm; learning and memorization finish within a few seconds with zero human intervention at any step. However, if one deletes the gel, converts into a liquid, all memory is deleted. Partial deletion with a clever choice of locations is utmost important and time crystal-based deletion does that amicably.

Multi-layered clocks govern a biological system using rhythms or time fractals or frequency fractals (Cipra, 2003). A material that replicates the dynamics of biological rhythm, could compute without using any machine language or algorithm (Ghosh et al., 2015a) intelligence hidden in the complex rhythms (mathematically, rhythm = time fractal ~ frequency fractal or frequency packet) get automatically decoded by the matter (Buisson, 2004). It demands a dynamic material that programs a complex time series.

Geometry programs in the time crystal: Fourth-circuit element Hinductor is a programmable matter seed, which takes a new shape, a new length pitch, diameter, and lattice parameters a and b depending on which time crystal is given in the solution as an input. The idea to create a programmable matter that emulates bio-rhythms is to harness a unique feature of a spiral geometry. A spiral material's electromagnetic resonance frequencies depend on its geometrical parameters, pitch and radius (Michalski and Mele, 2008; Atanasov and Dandoloff, 2008). The length also plays a role in governing its frequency, now if we enable a material to grow in a chemical beaker such that as a function of input frequency the material shapes its spirals then the resultant material would be a programmable matter that encodes rhythms. With this idea, we have carried out extensive synthetic chemistry work and realized an organic jelly that exhibits this feature.

Spiral wiring has the advantage that as its pitch P and perimeter $2\pi R$ ratio $P = \pm\frac{2\pi R}{c}$ that governs periodic potential $V(x, y) = A\cos(y - Px)/R$ changes the resonance band or the processing frequency. The fractional changes in the bandgap are given by $F(\alpha, 0) = \alpha\frac{a^2}{2}\left[4P^2\frac{|\sigma|}{4\sigma^2 - (1+P^2)^2}\right] \sim \Delta h\upsilon$. It has already been shown that the effective electromagnetic resonance band potential could be regulated in the spiral structures by tuning the ratio as curvature controls potentials $V_{eff} = V_{kin} + \frac{2\mu V_{curv}}{\hbar^2}$ (μ, energy difference with Fermi level; Michalski and Mele, 2008; Atanasov and Dandoloff, 2008). The helical pitch of the structures produced changes significantly to capture different frequency signals in the input packet. If we compare the elementary spiral in an organic gel that undergoes 1000-time increment in dimension in the spiral grows as a spiral, Ghosh et al. (2016b). The elementary 20 nm wide nanowire of has electromagnetic resonance in the GHz, as the physical ratio changes by 1000 times the resonance frequency decrease by 1000 times to the MHz domain. Analysis based on existing formulation itself explains why spiral geometry enables the materialistic capability to encode the rhythm. Thenceforth the work has been extended to abundantly available spiral, fractal, vortex-like organic super nano-structures.

Ghosh et al. made the first demonstration of a usable material that learns and programs rhythms. Here, rhythm or time series or time crystal acts as a programming language; one could create multiple rhythm processing materials at different regions of a beaker simultaneously, by inducing physical cavities. Then, the rhythm of rhythms or "time crystals" (Winfree, 1977a), i.e., a singular complex waveform as a superposition of multiple frequency packets be given as input and multiple rhythms at different parts of the beaker would generate new composite rhythms. Currently, learning and replication finish in seconds, however, constraints can edit rhythms to run for hours, if possible, years, until materials get exhausted. Once we learn to erase a material pattern and restructure a part of it with new rhythms, i.e., learn to work with a fixed amount of material forever, then this organic jelly would truly be a brain jelly.

9.11 A SENSOR THAT SEARCHES FOR GIVEN KEYS, DO NOT SENSE ANY INPUT

Eventually, the entire human brain is a sensor. The journey to study a brain jelly begins by detecting a singularity condition of a clock, when and how it's phase change becomes undefined for a certain time, when something else defines phase (Figure 9.16a).

Mathematics of "self-assembly of time crystals" and "phase transition of time crystals": The building of a time crystal is a time crystal, just like software algorithm, but here, many interesting features could spontaneously evolve (Figure 9.16b). Self-assembly of time crystals is fusion of two time fractals, the rule of fusion is that the non-harmonic set of frequencies $U\{t(n)\}$ which represents a typical composition of geometric shapes is not diluted, one example is $T = t1 + t2 + t3 \ldots + tn$, while the time fractal $g(t)$ transforms to $f(t)$ after fusion, and $f(t)$ satisfies $f(t+T) = f(t)$. For a distinct information content for all n, $t(n)$ are not harmonic, thus, inharmonicity represents distinct contents in an information packet, while harmonicity makes a boundary, thus isolates information packets $S\{U\{t(n)\}\}$ from mixing. It is self-assembly of time crystal as it grows continuously

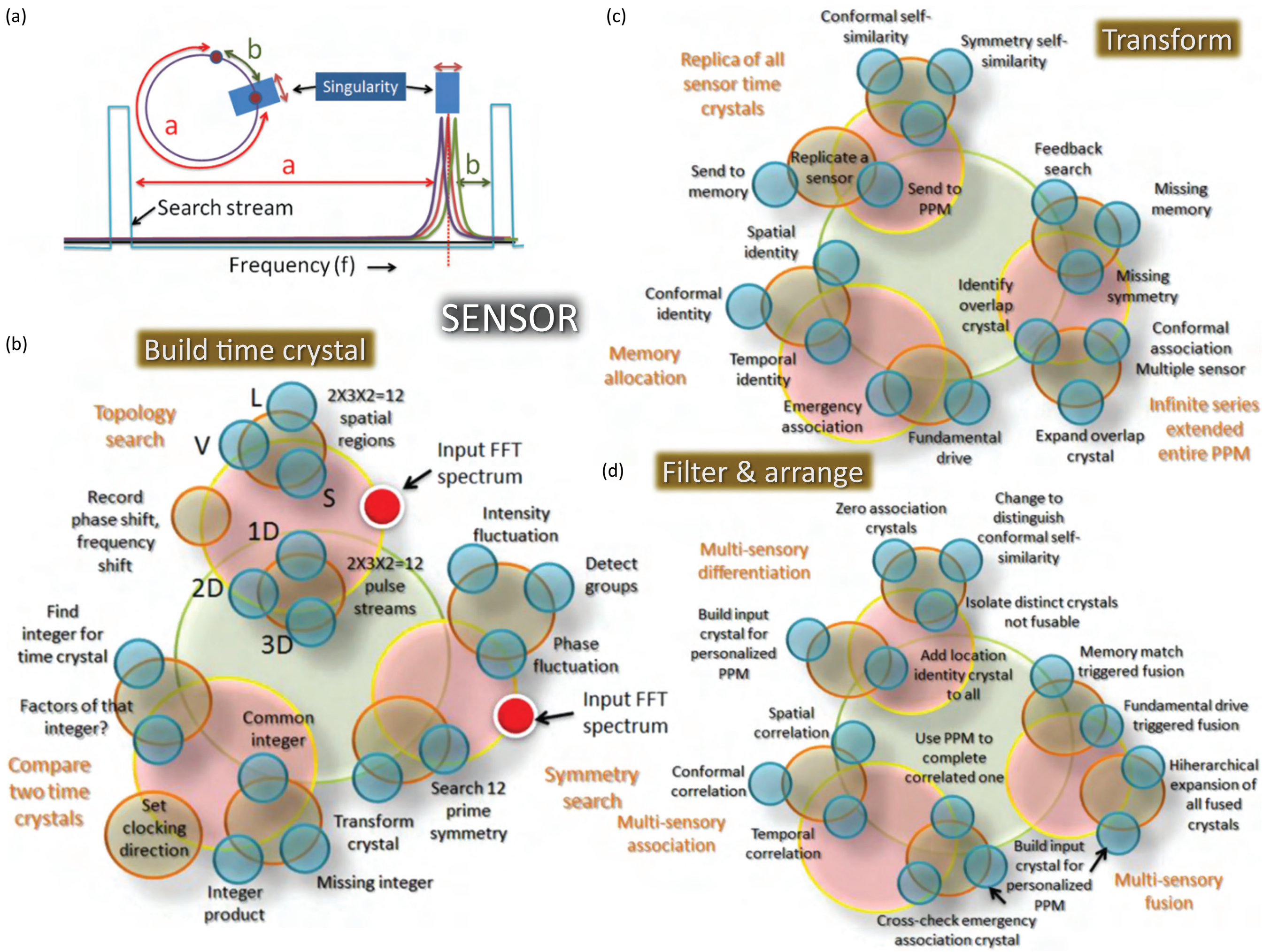


FIGURE 9.16 (a) Searching for a clock begins with the observation of phase singularity in a periodically oscillating system where at singularity there is an energy burst that triggers periodically in the system. Brain jelly is a sensor. Its prime activities are summarized in the three panels (b) explains the development of the time crystal spontaneously in the system, (c) transformation of the time crystal and finally (d) filtering of the time crystals and rearranging them by following the PPM.

and transforms. The transformation also runs by a governing time crystal (Figure 9.16c). Due to harmonics, the identity of $U\{t(n)\}$ is preserved, it acts as an observer of the entire system. Phase transition is switching between two time fractals, $g(t) \to b(t)$, if number of terms of $U\{t(n)\}$ in $g(t)$ in the course of time changes to $M\{t(n)\}$ that represents $b(t)$. Once phase transition starts, it propagates through the entire system.

A single time fractal evolves after fusing with more and more packets, the fusion satisfies integral feature explained above which naturally satisfies the condition for synchronicity. It should be noted that just like fusion, phase transition rules can have multilayered architectures, "nested network of rules." One phase transition condition is met, one decision is taken, however mostly multiple conditions are met then a new time fractal is born, possibly in a different time domain, on the resonance chain that represents the hardware, the fusion-fission and phase transition can have in two far distantly separated rhythm on the resonance chain. Synchronization of two different rhythms is also represented as attractors how sync is used in a fusion of time crystals. Interactions of different fractals could happen in many different ways generating binaural beats and several other kinds of locking process at different time scales "composition of time fractals" is a superposition of multiple rhythms. It is not multi-fractal where at a different scale we find different fractal dimension. However, to resolve a problem, brain jelly filters a time crystal following PPM. The governing system is also a time crystal (Figure 9.16d).

Construction, transformation, and filtering or rearranging the time crystal is part of solving a problem. The time crystal-based brain jelly discussed here, converts all events happening in nature into time crystal using GML, thereby solves only one problem, that is called Clique problem, which is simply finding a pattern in a complex pattern.

The NP-complete intractable "Clique" problem and a universal "reply back" protocol: The clique problem is a well-defined intractable problem, where one has to search a given pattern in the complex set of patterns. The clique problem needs to be solved in a finite time for any advanced cognitive or creative intelligence observed even in primitive neural networks, this is our perception about brain engineering. Most input data convert into an unknown pattern that brain jelly has never encountered before, be it visual, sound, touch, taste or smell. Obviously, the number of possible patterns that could be generated from this composition is astronomically large. Now, if we want to search 15 given known pattern in that resource input, it is not possible to find that pattern with any computer within a finite time. However, if those points have the properties to reply back together spontaneously then we can get the search result without searching. As noted above that to avoid the screening effect we need a new kind of material that would follow the resonance chain throughout the architecture. There exist several classes of the clique problem originally proposed in 1949, as frequently observed in the classically intractable problems, a certain constraint is imposed to simplify the complex network and then an algorithmic route is found to solve that problem. However, in this particular case, we take any sensory data, visual, sound, touch, taste or smell in the form of a 2D pattern and from that image we transform the single image into several layers of images, each containing several different classes of "frequency fractal" seeds. During transformation each layer distinctly represents a particular type of fractal seeds, based on the size of the basic geometric shapes used that incorporates global relationship of elements in a pattern. The network between various kinds of fractals is generated due to the typical conical architecture of the entire computing network.

9.11.1 Eleven Dimensional Signals in the Human Brain and in Brain Jelly

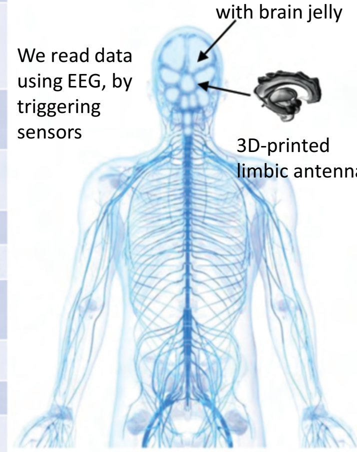
A review of the experimental research described in this book and the final discussion on the experimental realization of a full-fledged organic brain: The potential of pattern-based computing was never explored to the fullest. Scientists have always tried to look for the computing constructs that would lead to logical operation. Scientists created the smallest molecular neural network, nano-wheel for the glia inspired circuiting and then the cellular automaton based massively parallel computing on the organic molecular layer, we have described them in Chapter 6. It was realized that neither computing constructs help us to generate bioinspired computing nor the analog pattern formation similar to a particular physical phenomenon. Thus, we started the building of brain jelly, which is an organic molecular structure that vibrates like a particular composition of electric magnetic and mechanical rhythm. The hierarchical memory in the chemical reaction is essential to program the entire growth of the brain in a single set of *H* or hinductor devices, which would be analogous to DNA in biology and then explore condensation beyond chemical kinetics, two remarkable tools that take us to the original brain jelly experiments. We have detailed, the final phase how 17 brain-morphic components, each encodes a typical PPM. Seventeen types of brain jelly have been synthesized. All neuron wires made of H2 devices (second generation Hinductor) should grow one by one and extend to the final destination via H3 modules. From sensors to the editing regions of the brain and finally to the cortex domain there is linear wiring wherever we want to preserve the fractal-seed and do not want it to interact with anything else, we need to grow the circuits carefully there. Such a massive scale self-assembled supramolecular architecture was never done before. Now, other than the delicate places, we use neuron jelly wherein neurons could re-orient and reconstruct circuits based on internal axon restructuring. Figure 9.17 lists how after growing brain jelly how one could actually read 12-dimensional data. Since the technology is optimized, the brain jelly was injected into the brain of a robot (Figure 9.17, right); 3D printing components are already optimized and listed below. The growth of the brain jelly could be observed live at nanoscale using a scanning electron microscope (SEM).

9.11.2 Humanoid Avatar—An Ultimate Sensor

Humans would transform with artificial sensor arrays (Guntner et al., 2018); now it is possible to create a humanoid avatar to test the brain jelly or any form of morphological computation (Hauser et al., 2011). Since resonance chain connects all computing seeds, wireless processing is feasible without a screening effect, also we do not need to create an antenna with enormous power to wirelessly transfer signals from one part of the brain to another. The computing power is increased by maximizing the density of resonance states and bandwidth of the resonance chain together. Below we describe how we have experimentally developed the first version of organic nanobrain that forms the brain jelly while learning from its immediate environment. It is not the brain jelly for the ultimate brain, but, this is the first step toward that direction. The humanoid avatar is a resonance chain. The Shannon information capacity of space-time wireless channels formed by electromagnetic sources and receivers in a known background medium is analyzed from the fundamental physics point of view of Maxwell's equations (Gruber and Marengo, 2008).

Wide ranges of vortex solids and liquids (Huber, 1994) generating time crystals, could be tested on the 47 cortex domains of the humanoid avatar that we built. Several prototypes of humanoid avatars have been created and some of them are available in the market, but they run by algorithm, they don't have PPM, the mother of all programmers. Moreover, no effort was ever made to meticulously create the entire neural network of a human body, build every single component using wide ranges of materials by 3D printing and then filling the cavities using suitable jelly. The prime concern that arises, how do we test that the humanoid bot is conscious. The same way we understand, the other humans are conscious, talking and interacting with it, on random topics. The main idea of this book is to explore the possibility of building a human brain that is non-chemical, has no software or pre-determined algorithm, and thus processes unknown, unpredictable events instantly and perpetually, without training.

Dimensional aspect of brain data	Key experiment to capture brain jelly data
1D Pulses flow in a line, if resolved, 2D plot is made of frequency variation. If not, pulse-groups are converted into geometric shapes.	We perturb pulse streams with different frequency signals to find 2D geometric shapes and 3 layered shapes, within & above
2D. 3D plots of frequency variation is perturbed so that iso-contour of 2D plots deliver different composition of singularities.	X, Y and Z axes are phase change, we create many 3D phase plots to find 3 layers of topologies one inside another.
3D. By shifting singularities, relative phase, a network of oscillating 3D topologies found.	From 2D data we get 3D shape, we perturb this 3D shape, shifting active/silent points.
4D. Oscillating 3D topologies are shifted to find a sequence of singularities, it is time.	We identify the 3D shape on which multiple singularity paths are intertwined.
5D. 3D singularity points form time crystals	Perturb 3D host of singularity paths, 3D sets.
6D. Coexisting 3D shapes hold simultaneity.	Find prime ratios hold true in oscillating shapes
7D. Oscillating 3D shapes form meander flowers & garden of flowers clock.	Nonlinear density of primes & integers with high ordered factor values govern the clocks.
8D. Clocking symmetry hold appollonian gasket	Clocks form time crystal, we get phase sphere.
9D. Phase spheres form gasket crystal	Gasket crystal forms a fractal, infinite series.
10D. Continued fraction geometric series hold constants as fractals of gaskets.	The basic constants form basic geometric shapes which morphs its shape following identities. For example e, pi, phi identity etc
11D. Shape change of identities build PPM.	



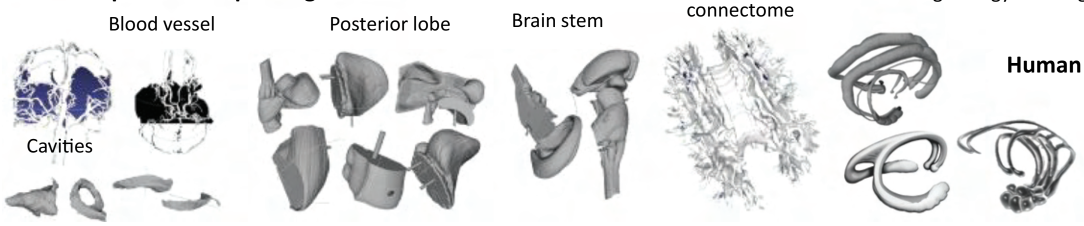


FIGURE 9.17 A table explains how we could feel 11D data transmission in a living brain and its brain jelly analog. Below we demonstrate some files of structures for the 3D printing of the brain components for the final humanoid avatar development. To the right side of the table, how the experiments are performed in the humanoid avatar is shown.

9.12 SENSOR TRIAD, SENSOR JELLY, MUSCLE JELLY, AND BRAIN JELLY

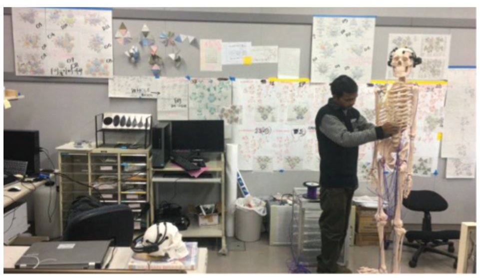
Eventually it is the spiral wave and its critical propagation limits (Karma, 1991) in a given excitable media that regulates the performance of a jelly. The scaling regime helps to optimize scale-free operation of a jelly, (Karma, 1992). Sensor triad, the sensor jelly, muscle jelly and the brain jelly would differ only in geometric features exhibited by the jelly; see Figure 9.18. Spiral waves propagate adopting different geometric features (Keener, 1986) in three types of jellies. Vortex filaments generate emulating the geometric parameters (Keener, 1990) required for sensing geometric shapes, executing mechanical movement and sensing the symmetry of primes. It is not one, but many waves dealing with many singularities (Koga, 1982b). The geometry of path or cavity reconfigures distribution of singularities (Kogan et al., 1992) in an auto wave (Krinsky, 1987). The sensor triad does not provide the ability to self-create or autopoiesis (Varela et al., 1974). Be it a sensor jelly or muscle jelly or brain jelly, for a typical component in the brain, a particular time domain has to be selected. Time-based priority has to be given. We discuss below, why one has to classify organic jelly based on time domain.

The fractal time domain distribution among different brain components: The neural network or brain jelly in the artificial brain of Humanoid avatar is so designed that time domain-distribution has inverse one-to-one correspondence with the resource priority of the brain, something like: "we give the highest priority to the visual data, then the sound data and finally to smell and then touch, in the absence of higher control, lower control-data takes over as the priority resource." Higher is the priority; lower is the time domain, now, to avoid any possible conflict some more rules are required for synchrony-de-synchrony flipping. First, the maximum and the minimum of total synchronization time for a particular domain do not overlap with any other regions, phase diagram reveals a pure communication (Matthews and Strogatz, 1990). Second, since complex time crystals couple neurons from two or more regions, the synchronization time is determined by the 3D pattern shape created by the coupled neuron network, it is faster if the shape is more symmetric.

Sensor jelly, SJ	Muscle Jelly, MJ	Brain jelly, BJ
PPM-1, PPM-2. Sensor molecules added to brain jelly	PPM-2, PPM-3. Electro-mechanical fibers added to brain jelly	PPM-3, PPM-4. BJ is 3D jell that senses time crystal, rewires.
Rewires to capture 12D dynamics of input data	Shrinks/expands morphs to regulate PNS core antenna	Sense only time crystal, changes minimum
H1, H2 class Hinductors	H2 class Hinductors	H3 class Hinductors
Most sensitive to topology to read reliably pulse features of sensor cell	Most sensitive to magnitude & phase of pulse signal	Most sensitive to geometry of phase architecture
Links sensors	Links skeleton	Links metric

Biological neural network	Artificial brain jelly
Components are neuron, glia or astrocytes, peri-neuronal network, PNN.	Neuron is replaced by Hinductor class 4th circuit element H, glia by supramolecules made of NB and PNN is made of carbon nanotube based hydrogel.
Various different classes of neuron cells make branches, bundles, vericosites, etc	H based bipolar fractal architectures create hydrogel, this is used to mimic neuron.
Neuron membrane sends binary pulses to compute	Gel morphs time crystal like real biological materials
Learning & plasticity defines short term memory & long term memory, LTM	A composition of frequencies convert part of gels into a rigid material, its LTM.
Cells die, wastes are cleaned.	No waste is produced.
Connections break & create.	Connections break & create
Membrane pulses does everything, information is only in membrane.	12 types of rhythms, 12 types of memories work together
Proteins evolve to make new structures.	Requires artificial injection of new gel.
Requires food and massive energy supply	No food, no energy, only thermal noise
Brain is limited to the head, neural network of entire body is not a part of it.	Mimic neural net of entire body as part of brain, neural fibers are made of tubes, tube membranes are semi-porous plastics.

Humanoid avatar under construction



A conversation with the first prototype conscious device

USER: What do you think of Mahatma Gandhi?
Chatbot: Quite a peace in life, a vegetarian Indian was he, walk a mile, karamdas known to many, non-violence that of humanity, a person to remember.

FIGURE 9.18 A comparison between the sensor jelly, muscle jelly, and the brain jelly. To the right a table compares the similarities and the differences between the biological neural network and the artificial brain jelly. Below is a photograph how the synthesis of a humanoid avatar begins at the skeleton level and eventually how software-generated chat-bot speaks about anything without prior knowledge.

Nonlocal interaction of spiral waves always happens (Meron, 1989), it can organize infinite number of H devices like organisms (Siegert and Weijer, 1995). Third, synchronization time is artificially defined: in a continuous synchronization and de-synchronization process, the 3D pattern-shape inside which neurons are actively playing the game of synchrony changes continuously, therefore, there is no distinct division between any two events; we consider that an event is completed when a large 3D pattern shrinks to a minimum. In the world of wireless communication, we simply add more wire-connections; make it hybrid-wireless to tune time domain at will.

Organization and re-organization of time-domain: Simultaneously, during oscillation, in the Humanoid avatar, the global convergence rules are superimposed on the oscillatory wave using a hierarchical buffer antenna. The time domain of transmission for superimposing the higher-level rules should match with the time domain of oscillatory transformation wave. The convergence generated in the distributed local regions of the upper brain is updated regularly as transformed time crystal cluster in the global periodic oscillation of the resource buffer antenna; therefore, its time domain should be faster than the transformation process. Once local-distributed regions stop generating new time crystals, the updated time crystal-cluster is sent to the resource buffer at the same time domain by which the resource antenna sends a signal to its buffer.

9.12.1 A Total Transformation from the Biological Neural Net to a Jelly of Time Crystals

Biological neural network and artificial brain jelly placed on the head of a Humanoid avatar are fundamentally different (Figure 9.18). Since ionic and chemical reaction based systems are avoided completely in the operation of humanoid avatar or brain jelly, an enormous number of problems have been avoided. Of course, brain jelly is organic; however, production, editing, and processing of time crystal do not require any chemical reaction. Whenever there would be chemical processing, there would be a waste—rather, here, physical reorganization of H, H2, and H3 devices is the key operating factors. Brain jelly is a quantum processor at the molecular scale and classical processor at the macro scale. Time crystals operate smoothly between classical and quantum domain because of fractal mechanics, that enables dodecanion, octonion, and quaternion tensors to regulate the interactive dynamics between the brain components.

Quantum models of the human brain: Brain's activity is related to quantum and even consciousness (Beck and Eccles, 1992). Space-time metric has been used by several physicists to explain consciousness, for example Lowen model (Lowen and Miike, 1982) was the first to consider gravitational lensing to generate consciousness. Spatial function becomes irrelevant; most importantly, E. Surowitz argued for space-time generated neural cycles or rhythms as the origin of consciousness (Surowitz, 2011). Directional computing becomes unnecessary, and they considered a feedback loop to generate time-invariance. It is exactly what happens in a time crystal. As a driving force an evolved Lowen model considers dual face to face conical-shaped lens formation, and its hierarchical network. Orch-OR theory (Penrose and Hameroff, 1996) that argues for gravitational collapse to explain consciousness just like the Lowen model makes another contribution, it includes a remarkable biological molecule microtubule as the processing unit, microtubule in axon is a singular wire, that means in giraffe, a 10 ft neck has one neuron and possibly a 10 ft long single molecule. Since all single molecules are a quantum device, the debate is not about the effect is quantum or not, the true debate is how the hierarchical network and the language of the brain are constructed. PPM protocol is a generic proposal independent of a particular consciousness theory to provide hitherto existing consciousness models a route to integrate with all highly interconnected research fields. It is a journey to consolidate Bayesian brain that correlates function and brain image (Friston, 2011) on a concrete mechanistic pathway.

Decomposes Recursive functions of Undefined problems and simulates all scales at a time: Fractal machine, brain jelly is designed to address undefined problems: One of the finest features of fractal tape network is that the machine can compose a rhythm inside a rhythm inside a rhythm... or clock inside a clock inside a clock wherever it sees in nature in any known or unknown form. Mathematically it is argued by infinite fractal time series, such a fractal of rhythms enables a machine to generate 99.99% of all possible rhythms in its environment or user with which the machine is locked. As a result of it, the machine does not require to define a particular phenomenon that is not known to the machine. The machines embedded can resonate with the 11D scale recursive functions naturally evolving in the universe in its frequency fractal network. It decomposes the dynamics to find the function that repeats itself and generate the entire composition of rhythms, it means the sensor builds the time crystal. When the time crystal is expanded using the PPM, as we read it from the Humanoid avatar using several EEG and multi-channel analyzer cables, the evolved architecture builds the patterns of the past present and future simultaneously in the network. Thus, brain jelly can address unknown events and situations. Therefore, it is not far brain jelly filled avatar would start thinking like a human brain (Binnig et al., 2002). One such classified effort's glimpse is shown in Figure 9.18 end. The final humanoid bot is not shown here, but its conversation is noted. It is not good in grammar but would surely learn in the coming future.