

VIBRATIONAL FOUNDATIONS OF MENTAL MORPHOGENESIS¹

Aamod Shanker, Kirill Popov, Cale Madsen and Debanjan Bhowmik

“at its most coherent the mind flows like a fluid, and hence follows the principles of hydrodynamics, electro-magnetics, or most generally, of wave mechanics” DB

ABSTRACT: Morphogenesis, the generation of form, is closely related to the mathematical field of topology, the study of the qualities of shape. Since cerebral thought distils itself into shapes, seen and felt, and their subsequent transformation, the study of the emergence and comprehension of shapes is central to address questions of consciousness, emerging at the apparent juxtaposition of the internal world of the mind, and the external world of physical objects.

Since light is a vibrating electromagnetic wave, we use principles derived from measurements of coherent speckle in light, where energy unfolds out of singularities in the field, to draw analogies with the emergence of the material universe from centers of conscious experience. The vibrational basis of understanding consciousness is additionally complemented with ancient shaivik literature of south asia - the spandakarika (vibration chronicles).

KEYWORDS: Morphogenesis; Phenomenology; Vibration; Coherent optics; Speckle; Sounds; Om

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Kali Yantra (Kali's instrument): focusing attention of the central dot brings in and out of relief various dimensions within the symmetry of the mandala which surrounds it.

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MORPHOGENETIC APPROACH TO THE EMERGENCE OF MIND

Morphogenesis has been explored as a universal concept by many contemporary phenomenologists – such as Rene Thom’s [Thom, 69] description of shape and form in biology and complex systems. Thom describes structural expression in biology moving through epigenetic landscapes, traversed as organisms evolve by means of minimizing the Lagrangian in this epigenetic landscape. Similar to Lagrangian mechanics of wave propagation, this gives rise to wave-fronts as organisms evolve through scales, characterized by the unfolding about the catastrophic or singular points in the wave-field. Hence local structure at the smallest scales define the unfolding of singularities in the global space. This is analogous to how an embryo, or a seed, reflects upwards to form the whole organism.

Fig.1 Thom’s description of a cusp type singularity, as a projection of a higher dimensional fold. The unfolding of the singularity fills the global space.

Another morphogenetic approach to growth and form, is Rupert Sheldrake’s theory of morphic resonance [Sheldrake, 09]. Morphic resonance explains the laws of nature as repetition with variation – new forms emerge based on the past memories, forms or events that have already occurred. Sheldrake started his academic life as an established biologist at Cambridge, before his disillusionment with the fundamentalism of science led him to explore the consistency of physical and mental laws themselves, as well as challenge the assumptions of modern science. He also journeyed through various eastern traditions in his spiritual quest. To quote Sheldrake –

“while thinking about the mind, there is handier way of thinking of the past, since there are memories in mental fields. One can extend this memory [of mental fields]

if one thinks of the whole universe as essentially thought-like.”

– R. Sheldrake

David Bohm equates this to his implicate order, the universal whole that spontaneously creates (projects) and swallows (injects) all reality or form, hence

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connecting events and their causal influence across space-time. [Bohm, 83]. This is the purpose of the Schrodinger’s equation, to describe how this reinjection happens in the form of probability waves that locate quantum particles in space-time. Bohm, however, is critical of the modern formulation of quantum mechanics, since causality is beyond its scope, and hence of paradigms of modern physics. Since the ‘collapse’ of the wave function is extrinsic to the Schrodinger’s equation, all memory of the past is lost as soon a measurement is made. A holistic understanding of phenomena and form, must include descriptions of causality and interconnectedness over space-time.

The Shiva cosmology

omkar bindu sanyuktam, nitah dhyayani yoginah,
tramad mokshadam, chaiv omkaray namonamah.

in the om dot contained, by concentration revealed, for
those is moksha, that into the om submerge

The philosophy of Shiva, as the cycle completing, revolution creating energy of the cosmos is interspersed through south-asian folklore and ancient texts, the origins concentrated around the Indus valley civilization of ~2000BC (modern day Pakistan and Kashmir). Shiva is also the image of the ideal yogi, the swallower of darkness, the dancer that brings into rhythm the endless intertwined cycles of the revolving cosmos.

In the Shaivik tradition [Flood, 93], consciousness emanates from the primordial null, emanating as vibrations that permeate the cosmos as they diffuse, much like a turbulent fluid. The initial condition, or the primal emanation, reflects and repeats through boundaries and nodes in the subsequent vibrational fields that once set in motion constantly create and recreate the boundaries in the material universe. Consciousness, an emergent process of this field, permeates through the human body at various levels.

The classic Indian text, the Mundaka Upanishad, equates the process of

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manifestation with the auditory symbol 'AUM', where the syllables span the bridge between the cosmic essential and the cosmic manifest, or from the subtler to the more gross. 'A' is the opening of the sound, arising of the stillness, 'U' is the rounding of the first sound, and 'M' is the meeting of the boundary, or closure, where the source reappears. At the levels of physiology of the practitioner, the 'A' originates at the root of the torso and is polydimensional, or most open. It rises upwards through the spine (*kundalini*) and loses dimensionality, by being closed, but gains more specificity as it is rounded and channeled. Finally, this open sound hits the closure of the lips, to reach 'M', the manifestation at the repeated node.

Within the psyche and its movement from the subtle to the manifest, these are equated with the three concepts of *mandala*, *mantra* and *mudra*. The *mandala*, is essentially optical, visual, describing shapes as visible symmetries. The human cerebral cortex, arguably an extension of the optical nerve, is particularly adept at imagining and representing forms, trees, shapes and lines (topology), which is much of the analysis here since our primary experimental approach utilizes the mathematical structure of visible light. The next is the *mantra*, or spoken sound – symbolizing the connection of the auditory system to the emotional centers, where the primordial silence creates the manifest sound. Mathematicians and artists are often adept musicians, channelling the source through the temporal vibrations in the body as well as through the envisioning of shapes and their relations. The *mudra*, or mood/action, is the most manifest, as it refers to willed movements of the body, which arrest the subtler levels by limiting the interactions of the body with the external world. It is also represented in Buddhist texts as hand gestures, that focus the mind (*ekagra*) of the Buddha, by establishing firmly the conditions of the body in symbolic postures.

A thermodynamic description would entail moving from high entropy, greater dimensional state space, through the realm of possibilities, to manifest as a collapse, or entropy lowering in a lower dimensional projection. The collapsing of dimensions allows possibilities to manifest themselves and take form, much like the wave-function collapse of quantum mechanics.

AUM, THOM, BOHM & SHELDRAKE

Since the primary question of conscious experience is the emergence of body from the mind and vice versa, many relations already present themselves between the mathematical ideas of morphogenesis and the shiva cosmology of vibrations as manifestation.

The singularity unfolding of Thom, or the emergence of the global shape from the nodes in the derivatives of a topological function, is the *omkar bindu*, the nulls that

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higher dimensions thread through to acquire their manifest form. An analogy is to the nodes of a vibrating string, where the boundaries repeat themselves at the positions of the nodes of the standing wave, the unfolding of the null fully determining the the energy distribution along the string.

Bohm's implicate and explicate order is the shaivik description of essential and manifest cosmic bodies, also embodied by the symbolism of shiva-shakti. The shiva- shakti duality can very crudely translated to masculine-feminine, or yin-yang. The shaivik calls the process of projection as Shakti (literally translating to *power*), meeting Shiva to give body to the explicate form. Injection, the subsequent absorption back into the implicate order, is the dance of *tandava* - rhythm generation and propagation at the feet of Shiva.

Thom's morphic resonance is the temporal dimension of emanation (*mein samay hoon*?, or '*i am time*'). The quality of the universe is the quality of the mind, vibrations being felt as *spanda* (sound), the rhythmic beating of an alive heart, the steady respiration that cycles air in and out. The relative shapes of vibrations upon interacting, manifest form - the process of *projection* (by its mathematical definition, as well as Bohm's projection onto the explicate order). In Sheldrake's own words when paraphrasing a hindi mythical tale, the universe is a dream of Vishnu, and since Vishnu sleeps for a little while, there is a memory in the cosmic process. The source however repeats itself in singularities. Rigorously, a function is singular where it or its derivatives go to zero or infinity. The personality of shiva, is conveyed as singularity embracing – the odd ones are welcome, similar to analysis of fractures in concrete or ice, where the cracks appear first in lower dimension, then thread upwards as a sequence of points, lines and cracks. Looking for exceptions in the current dimension give a clue to the projective nature of the higher dimensions, allowing access ultimately to *paramsiva*, the most subtle, most supreme nature of being.

THE WAVE EQUATION AS A PHASE-SPACE – PROJECTION

Fig.2 Vibrational modes of an electromagnetic wave with electric and magnetic fields and zero boundary conditions (E,B), or of the probability amplitude of quantum mechanical particle in a box ($u(x)$).

The dualism of injection-projection that gives rise to dynamics, is encapsulated in the propagation equation for diffusive waves. Arising as minimal of the Hamilton equation, waves effectively need two conjugate quantities to exchange informational energy and propel each other forward. These could be the electric /magnetic equations of 3D space for light and radio, or the position/momentum dual for the space of particles. Even more generally the two quantities for coherent waves are the amplitude, and phase, one which is explicate and the other is implicate.

Electric field

$$E(x) = a(x)e^{i\varphi(x)}$$

Fourier Transform – space to spatial frequency

$$E(u) =$$

$$\int E(x) e^{i2\pi u x} dx$$

Phase space: space and spatial frequency together

$$W(x, u) = \int E(x) e^{-i2\pi u x} E^*(x + \tau) e^{i2\pi u \tau} dx d\tau$$

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Hence a primary duality first creates two poles, then a circular connection between them. On this circle the wave can cycle and propagate to fill the rest of space. In this sense of filling up the rest of space, or the generation of time, is the process of emanation (*sphurtha*) of vibrations (*spanda*) in the Shaivik terminology, or projection in Bohm's explication of the implicate order. In the case of light propagation, for instance, the forward diffusion of light normal to a stack of 2D planes is the rotation and projection of a 4D phase-space. The 4D phase space has two dimensions of space, and two of spatial frequency. As time proceeds, this volume turns, its marginal (or sum) along the spatial frequency dimensions projecting into the conjugate variable, or energy distribution in the spatial dimensions. Along the direction of propagation, the volume turns a little for each step, and then projects again. At infinite propagation distance, this phase space collapses to a Fourier Transform, or a rotation by 90° – then the energy distribution in space corresponds exactly to the spatial frequencies at the start of the scattering process.

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Fig.3 Propagation is rotation and projection in phase space, as seen in this x-z cross section of a periodic grating and its fractal unfolding with propagation as a coherent light wave diffracts from the grating in the z direction. The left figure shows the cross sections of the intensity of the coherent optical wave as it diffracts off a periodic grating. The right shows the phase space of the grating, two dimensional (space vs spatial frequency) since the grating is one dimensional. Along the propagation direction, the intensity along x for any z is a specific rotation (for that specific z) and vertical summation to project to the intensity in space, I(x).

FORM IN LIGHT: SINGULARITIES AND MORPHOGENESIS IN LASER SPECKLE

Flowing light demonstrates momentum – translational symmetry in time as linear momentum, rotational symmetry as angular momentum. And so does the mind, especially in coherent states, where continuity (or time translation symmetry) gives rise to *flow* states. Interference requires the triad of object (*prameya*), medium (*pramana*), and subject (*prakriti*) – optically this can be thought of as the wave of interest (object) whose internal structure is invisible till it interferes with the wave that probes it (subject), creating an interference pattern on the screen (medium). The tangible energy has a quadratic dependence on the wave field

$$\text{Energy } (a) = a^2$$

$$\text{Energy } (b) = b^2$$

$$\text{Energy } (a+b) = (a+b)^2 = a^2 + b^2 + \mathbf{ab+ba}$$

This gives rise to the sum being greater than the parts, or mathematically speaking, cross terms arising between the interfering waves (shown in bold). Hence it is natural to find

fractals in diffraction patterns, since the coupling between fields allows information to flow between various spatial and temporal scales. Relativistically, Einstein's $E=mc^2$ hints at the same bilinearity in going from light to matter, or from the essential form to the manifest. The exponent '2', symbolizes the relative nature of manifestation, where a field has to be seen in relation with another field to give meaning, or substance.

Studying fluid flow in optics is hence an insightful experiential process to understand the dynamics of wave propagation. Similar behavior is seen in any soft medium, such as in air during combustion, or liquids during laminar and turbulent flow. As a general optical experiment then, consider measuring a random, fully coherent optical pattern, after it has been scattered and propagated some distance, to create optical speckle (figure on next page).

The creative potential of singularities can be observed in a coherent speckle field,

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where the electromagnetic energy is randomly scattered from a surface and propagates to some finite distance. It is observed that the seemingly random energy distribution hence obtained has within it dark singularities [Berry, 74]. Each point of infinitesimal darkness threads through the optical volume, channelling information over an infinitely extended spatial frequency range, acting as the source and sink of constant phase contours in the wave field that determine the distribution of light in this seemingly random pattern. Thus, for the holographer or optical engineer, the energy distribution within the flow is completely solved once the nulls are characterized.

Fig.4 Generation and measurement of a coherent speckle field, where a rough Gaussian surface, the phase diffuser (with perfect transmission), gives rise to a speckle pattern. This speckle pattern

is interspersed with nulls after some propagation distance.

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Fig.5 Optical vortices are singularities where null lines thread the plane. The intensity spirals around the vortex, corkscrewing out of the plane into the third dimension, being zero in the center. The phase, starts and ends at vortices, wrapping by multiples of $\pm 2\pi$ around each null – notice adjacent nulls have opposite handedness since the phase lines are continuous between them. The

structure of the optical energy distribution arises in the spaces between singularities. Interestingly, around each of these singularities, the phase of the wave forms vortices, similar to the air swirling around the eye of the tornado. The vortices in waves in three-dimensional media are well studied in theories of turbulence, where qualitative ideas are used to get a handle on complex systems, such as flows in weather patterns or oceans. The primary challenge in turbulence theory is to explain stability in form despite rapid fluctuations in the smaller scales of a fluid, within certain spatio-temporal boundary conditions. Vortices thread through the three-dimensions of a turbulent fluid, interlocking and exchanging energy between scales, from large to small. This interlocking gives the structure self-similarity, and hence pseudo-stasis through time, despite their sensitivity to initial conditions (chaotic nature). Singularities, roughly speaking, are the centers of the vortices, since all transformations (including translation) are overlapping rotations about a family of points. Much like the 12 spoked wheel of Kali, turning with time, centered about the spike of Shiva, the universe marches on, creating constantly with overlapping, turning wheels..

Fig.6 Intensity of the laser speckle, and its phase on interfering with a plane wave. The phase guides the propagation of intensity, and intensity gives the phase an envelope to propagate. Near generative centers, the phase contour lines emerge (are projected into the plane), their local topography defining how they connect to other vortex centers and boundaries of the volume. The intensity circles around nulls, before disappearing completely at the singularity (to be injected out of the plane).

Fig.7 The simplest vortex, with isotropic emanation, creates intensity in a donut shape. Small fluctuations in the wavefront phase near the center cause symmetries to break and redistribute. The emanations then have specific symmetries, similar to the *mandalas* in yogic and Buddhist art.

Fig.8 Nulls are eyes of vortices threading an optical volume, shown in this 3D speckle pattern. The nulls (0D) form a dendritic tree, rising through 1D and 2D to fill the 3D volume.

In the optically turbulent flow of specular coherent fields, nulls can only appear after propagation, since they must include field interactions at the global scale i.e. the entire aperture. Hence global effects are concentrated into the singularity, due to the mathematical nature of the fractional Fourier transform that the propagation entails – analogous to the ability to wrap around a very small hole (singularity) starting very far away along the arm of a spiral (globality).

Additionally, the nulls have inertia, acting as stable nodes that provide a skeleton to the body of the light. Since they are collapsing the information flow to lower dimensions, they retain their characteristics through the 3D optical volume, obeying a rotational-invariance-in-a-plane inspired angular momentum, that is resistant to the chaotic nature of the initial conditions, or fluctuations in the boundaries. It is tempting here to draw an analogy with the mind of a conscious individual, as it preserves some essential characteristic (identity) while threading through the chaotic forces of time and space.

MENTAL MORPHOGENESIS

The connection of conscious experience, as a localized phenomena of experience related to mental and ancestral memories, to dimension reducing nulls and lower dimensional hypersurfaces can be commonly encountered at many levels of mental and physical experience that comprise life, awareness, attention and consciousness. As a plane is threaded by a rotating screw, an optical field by dark vortices, the same way the double helix threads through an empty, pseudo-static core at the smallest scale of life, in the

DNA.

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Fig.9 At localized scales, such as at synaptic junctions, the spectral transform spans the entire global domain, connecting the large scales to the small scales.

Neural circuitry, for instance, has a strong physiological correlate to experience. At the purely mechanistic level, neural circuitry is an effective conductor of reality since dimensions collapse and information increases within the volume – the 3D space is filled with line like dendritic neural networks, their own dynamics governed by positions of bifurcation, and singular points of contact, the synapse. Much like antennae that use the capacitance between closely spaced conductors to emanate and receive electromagneticicity, the neural networks in the body are local concentrators of causality and energy, the uncertainty principle (or the conjugate domain universality for real domain locality) allows access to large range phenomena in space time, enabling the strong sense of intuition in humans as spiritual beings. If only computers could access the same!

At a larger, more emergent physical scale, the umbilical chord that threads through bodies of the mother to the child, splitting at each generation ad infinitum. This pseudo-stasis that could be related to identity, or family name, or familiarity of the progeny to the parents, is analogous to the inertia of the null networks in specular fields, that have inertia due to their selectivity of lower dimensions to project through larger ones. Each piercing of a pair of dimensions requires a rotation in that plane to access the third, and so forth. By an

interlocking network of vortices, the final

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projections are zero dimensional points in the projected space, with strong stasis due to the interlocking.

Fig.10 Interlocking vortices in a turbulent fluid give rise to morphological stability over large scales, despite rapid dynamics at small scales. [**Davidson, 2004**]

At one level, any seeming stasis could be defined as identity possessing - and could thence be attributed consciousness. However due to our relative position as endlessly active, moving and flowing entities, for minds and bodies it is conventional to define the static envelope that encompasses dynamics as the identifiable, conscious being. Hence a rock is less conscious in this perspective, than a redwood tree, without the same metabolism and internal machinery. However, the conscious experience and properties of time and space are very much scale dependent. Humans operate at closely coupled collective scales with each other, due to their common ancestry, and colocation in time and space, and at much deeper levels with related life-forms, green trees, bird calls. And yet the deepest level is the relationship to shapes, forms, sounds, smells – the elements that bear our beings, the most initial of the initial conditions, the building blocks of existence that flow through and into each other, eternally.

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APPENDIX: AUM AND THE EXPERIENTIAL NATURE OF TRUTH

The mental processes that are so capable at replicating the nature of fluid flow and hence construct the whole doctrine of bilinear wave mechanics, occur also in pure states during deep meditation, when the singularity (the *omkar bindu*, or the OM dot) is focused on. In EEG measurements of meditating subjects, these correspond to the 40Hertz oscillations of the brain. The central creative spike of the *kundalini* rises through the spine of the yogi and unites him in perfect harmony with the external and internal, the boundaries of the body dissolving away. Intention, or focus, hence is the creation spurning essential force around which the wheel of *Kali* (12 spoked manifestation of *Shakti*), dances the cosmos into existence. The extension of achieving this harmony through mental practice is described also in yogic traditions as *Gyan Yogi* (union using knowledge), *Karma Yoga* (union using action), and *Bhakti Yoga* (union using love), respectively representing the inflow of knowledge, the outflow of action, and the bidirectional identity-nulling ultimate creative force of love. The final utility in synthesizing the external and internal worlds, mystic and scientific traditions, or eastern and western philosophies lies in communicating a coherent narrative that allows access to states of heightened spiritual sensitivity.

Example of a *mantra*, with specific meter and syllabic structure:

‘Om bhur bhuva svaha Tat savitur varenyam Bhargo devasya dhi mahi
Dhiyo yonah prachodayat. Swaha.’

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