How the universe listens to itself:spherical music

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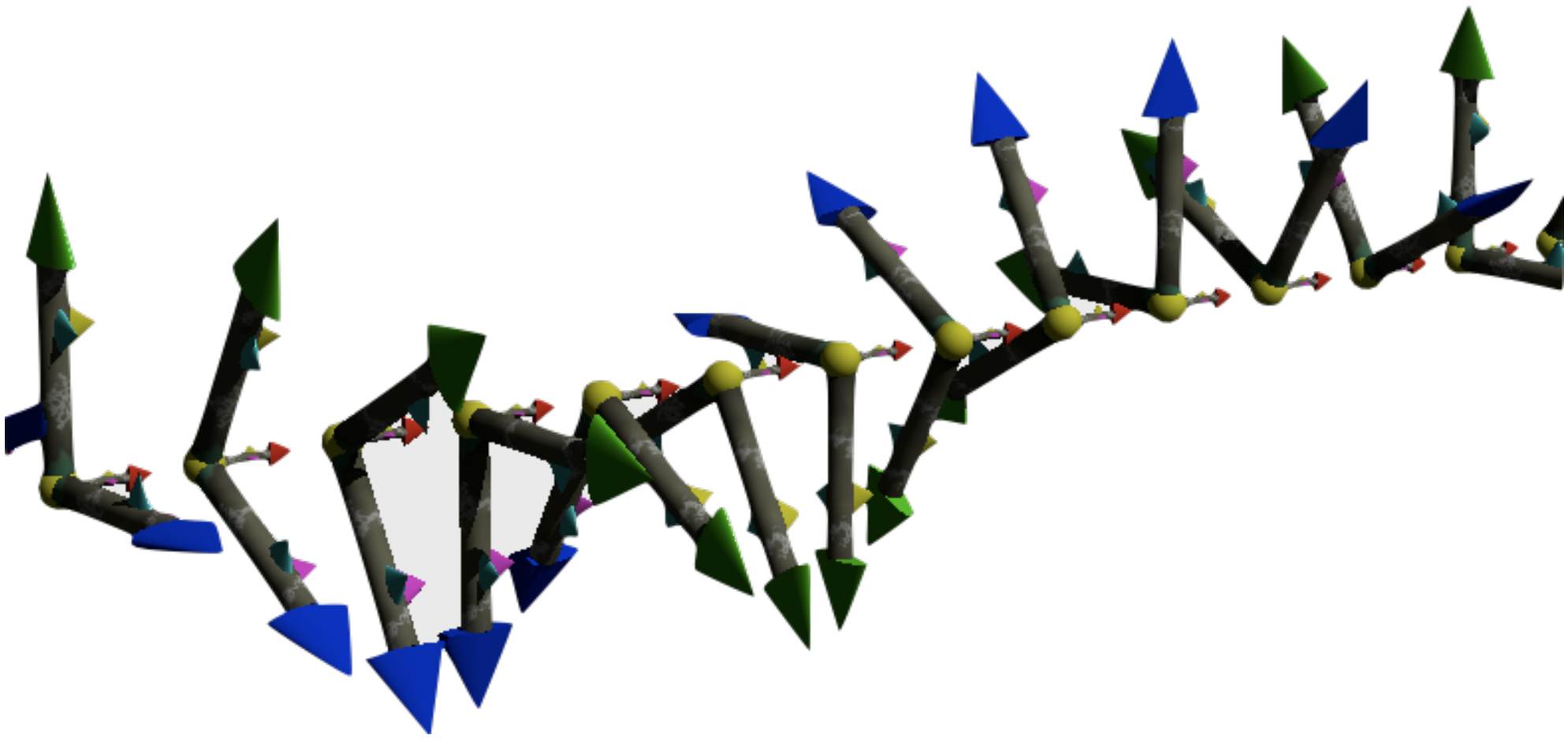
The nature of light, matter and the universe itself from a musical perspective

After images

- Extending music to the octave of colour
- The universe: intimately small to light
- Light: A pure note struck through space
- The harmony of phases
- The electron a (hyper)spherical bell
- Singing crystals: fundamental and harmonics

A picture of light



An electromagnetic note struck across space and time.
Colours span (roughly) an octave.
In the rainbow: G is red, C is Green and E violet.

Model of Electric field, Magnetic field and momentum for one wavelength of a photon.

Paradoxical light

- Ultimate speed: nothing faster
- The more you put in (energy-momentum) the smaller it gets (wavelength = (Plank's constant)/momentum).
- It crosses the universe, but sees it smaller than a grain of sand (Einstein's relativity)

None of the paradoxes are real: all provide insight.

Where am I?

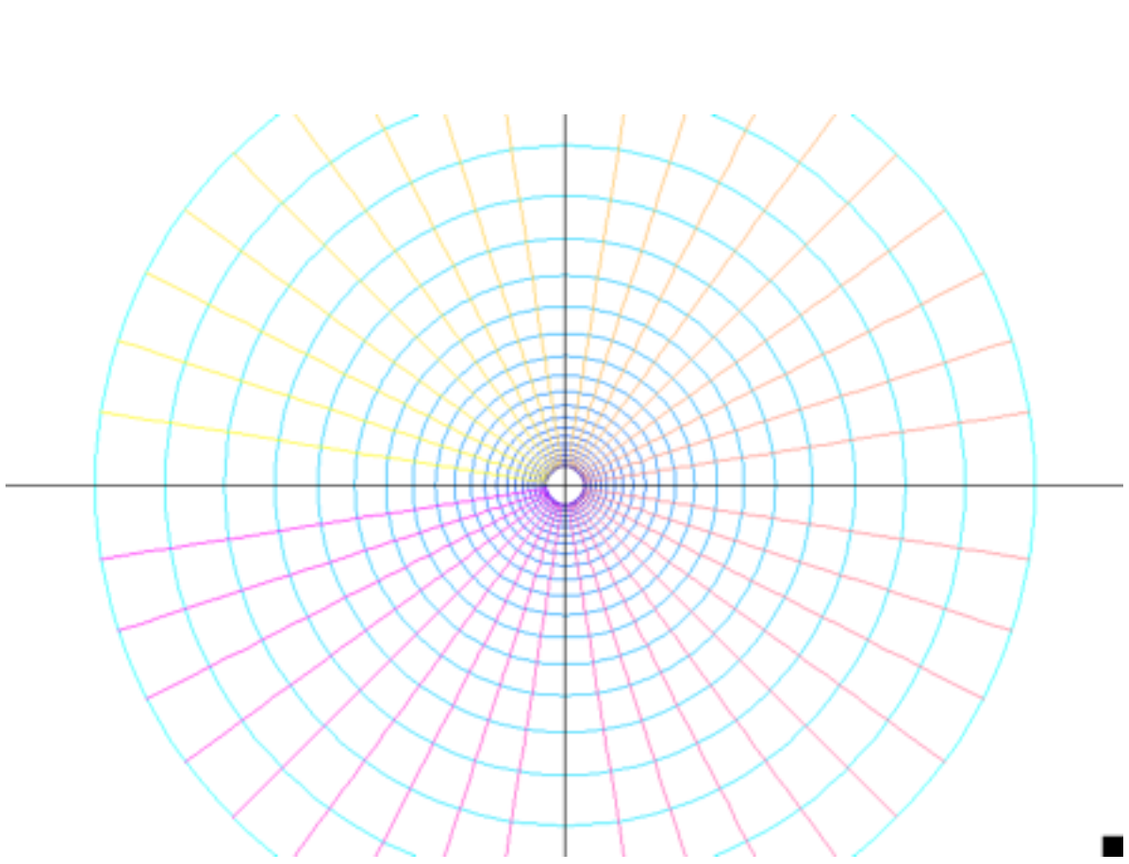
Here and now

- Perceivable universe series of concentric spherical shells centred on the observer
- Characterised by lightspeed, soundspeed …
- Einstein: as one approaches the speed of light space shrinks and clocks slow down
- Simultaneous immediate locality (few ns ago) Sun (8 mins ago), Alpha Centauri (4Yrs ago) ...edge of universe (15 billion yrs ago)
- For Light the whole universe seems tiny

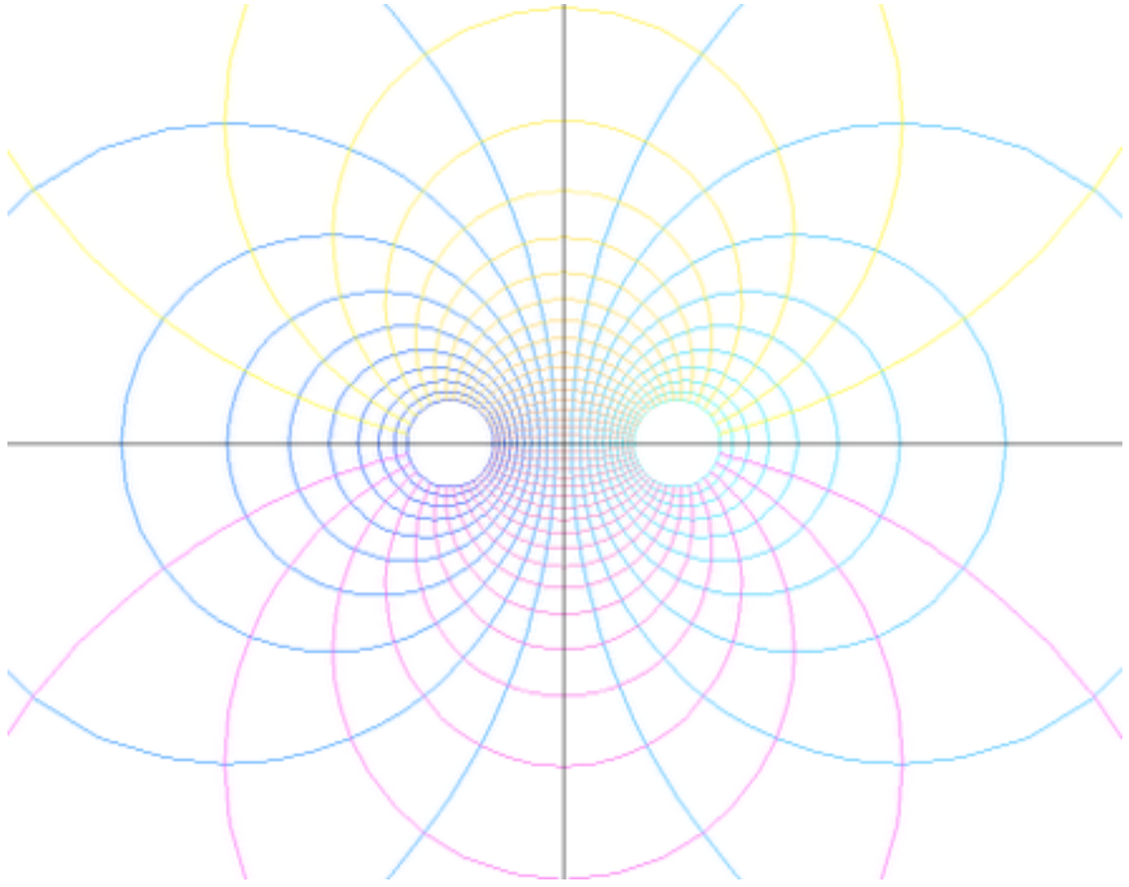
A pure note struck through space
(how the universe listens to itself)

- From the perspective of the note itself, player and listener at same time and place
- Energy transferred from one point in space to another far away and in the future. Multiplicity of exchanges paints our world.
- For transfer, the listener must (quantum) collapse the large from the past and contain it in the small of the present
- How?
- Need a proper extended inverse for the whole distribution

Cancellation of a whole distribution to a point



Slice through a radial (spherical) polar field. Large (can be universally large). This is the emitter (the player).



Its conformal inverse: Bispherical or Toroidal (This is small (picometres). This is the absorber (the listener). The larger the absorbed part, the smaller the absorber.

The Harmony of Phases
Louis de Broglie

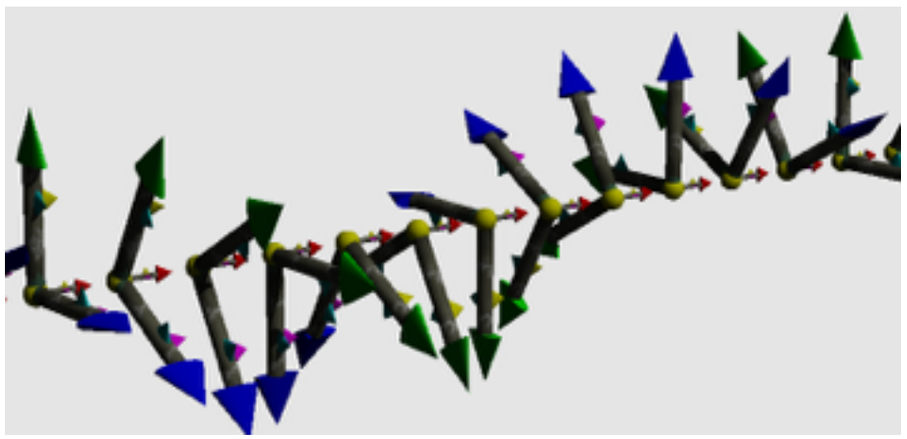
- Proposed to remove apparent paradox in relativity
- Absolute harmony. Two different notes everywhere (and for all time) precisely in phase with one another
- Called when first proposed “The French madness”
- Now called “Quantum Mechanics”

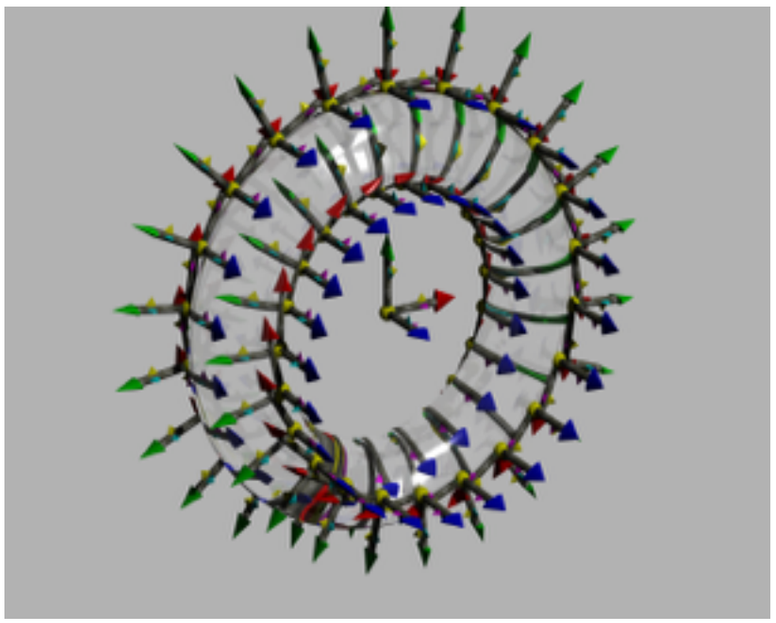
No longer taught. Now start from maths. Part of insidious tendency to mistake maths (a mere language, if a powerful one) for reality.

How does it work?

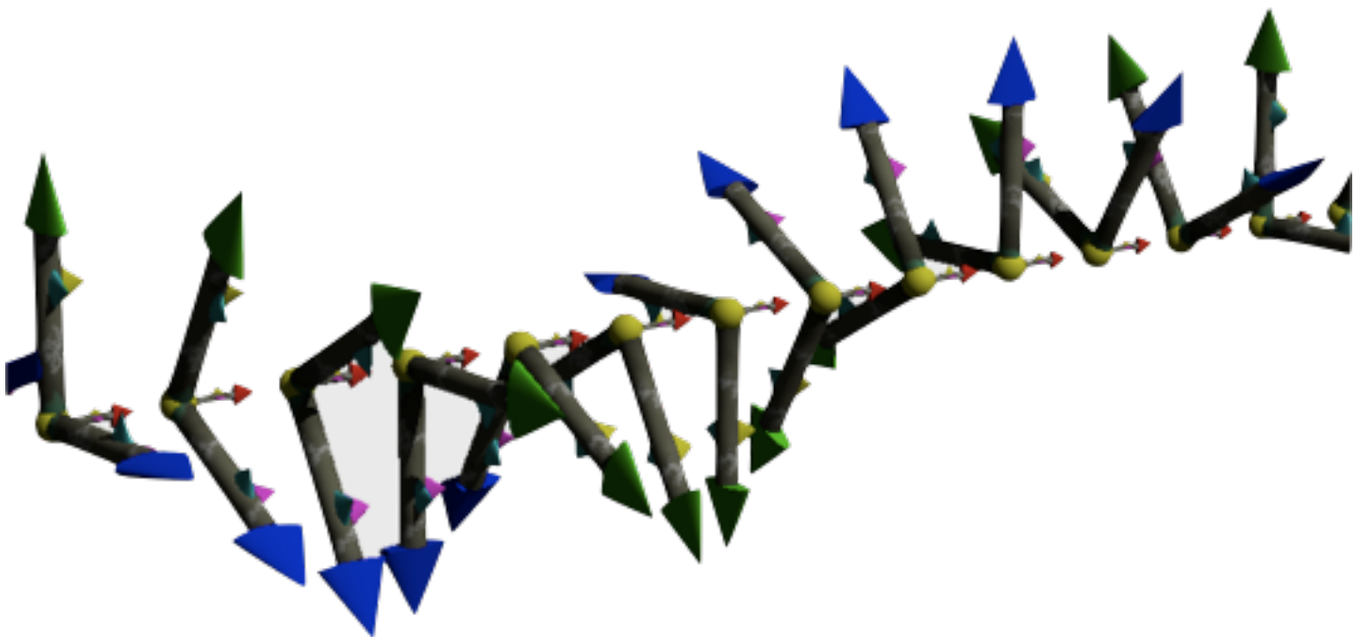
(Relativistic quantum mechanics that is)

- For each particle two notes, perfectly in phase, each lightspeed at rest. Same Pitch. (Electron an A)
- In motion one appears (from the outside) sharper the other flatter, but relativistic transformations keep both in perfect harmony internally
- Externally, beat oscillation is the de Broglie wavelength





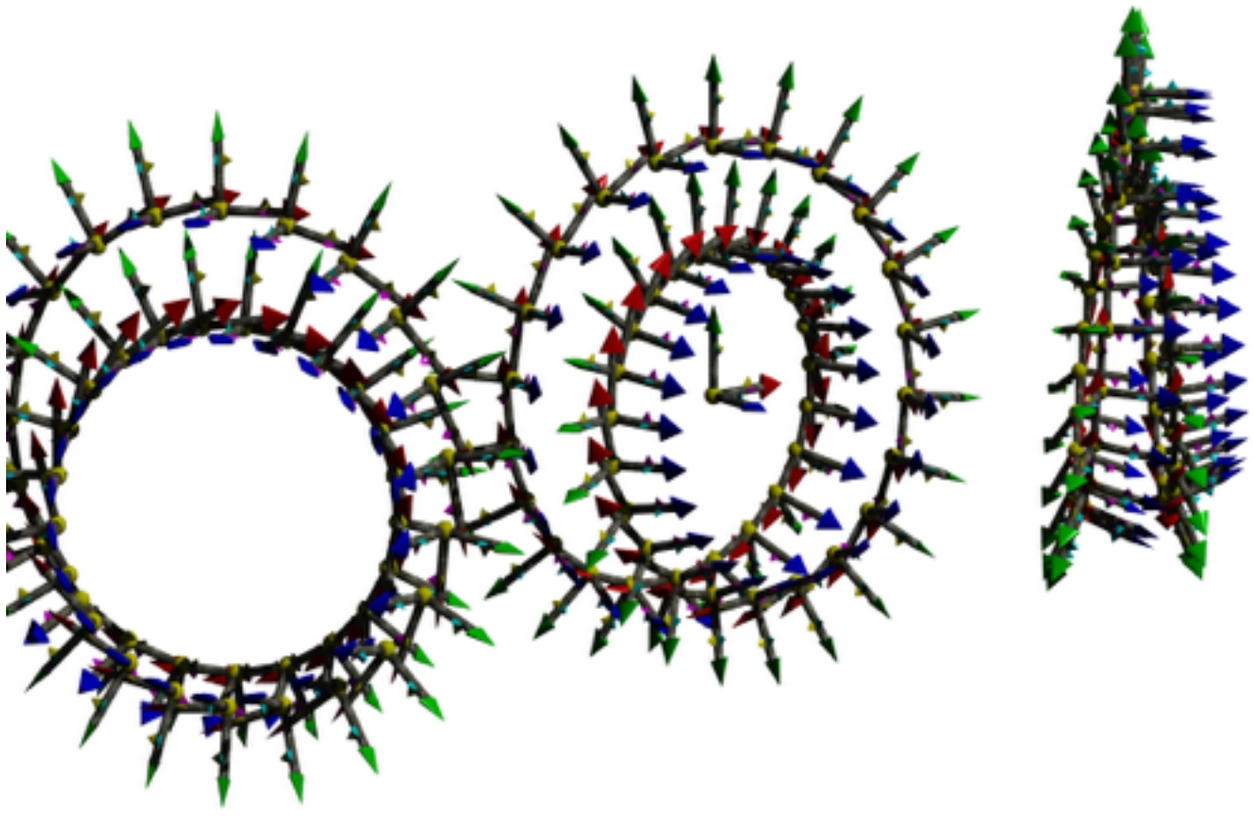
Rings like a perfect (hyper)spherical bell (Eigenmodes of a struck 4-D string)



Eigenstate of angular momentum of a photon. Two perpendicular vibrations.

One stereographic projection of a hypersphere is toroidal. Others are spherical.

Visualise as spinning, vibrating torus, or self-enfolding sphere.



Singing crystals

- In a crystal (or any matter), the electron wavefunction expands to fill the whole crystal in harmonic modes (see e.g. J.G. Williamson et al., Phys. Rev. B 1990)
- The smallest energy electrons are the largest (twice as big as the crystal itself into which they are folded), the largest energy electrons the smallest
- The states are a harmonic progression maintained eternally

Conclusions

- For light the universe is very small
- Player and listener intimately connected through space and time
- Harmony, resonance and synchronicity are key to interactions, key to the underlying nature of particles and key to the quantum states of matter
- Inescapably: the foundations of Natural Philosophy are musical in nature

A mystery for scientists …
The electron is for the:

- particle physicist-smaller than attometres
- classical field theorist-bigger than femtometres
- solid state guy-hundreds of nanometres (e.g. J.G. Williamson et al., PRB 1990)
- Superconducting engineer-twice as big as the new mag-lev line from London to Tokyo

Who's right? All are, but how?

Expand Einstein FJ to pure field FdF - generalised Lorentz force density. Both object and observer. Write,1024 terms like dA.d(dA), though P may be external (Coupling!).

$$(F+P)d(F+P)=0=$$

$$\gamma_0(\vec{E}\cdot\vec{J}+\vec{B}\cdot\vec{J^m}+P(\nabla\cdot\vec{E}+d_0P)) \qquad \text{(our “F=ma”)}$$

$$+\quad \gamma_{123}(P\nabla\cdot\vec{B}-\vec{B}\cdot\vec{J}+\vec{E}\cdot\vec{J^m})$$

$$+\quad \begin{pmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\end{pmatrix}(-\vec{B}\times\vec{J}+\vec{E}\rho+\vec{E}\times\vec{J^m}+\vec{B}\nabla\cdot\vec{B}+P\vec{J})$$

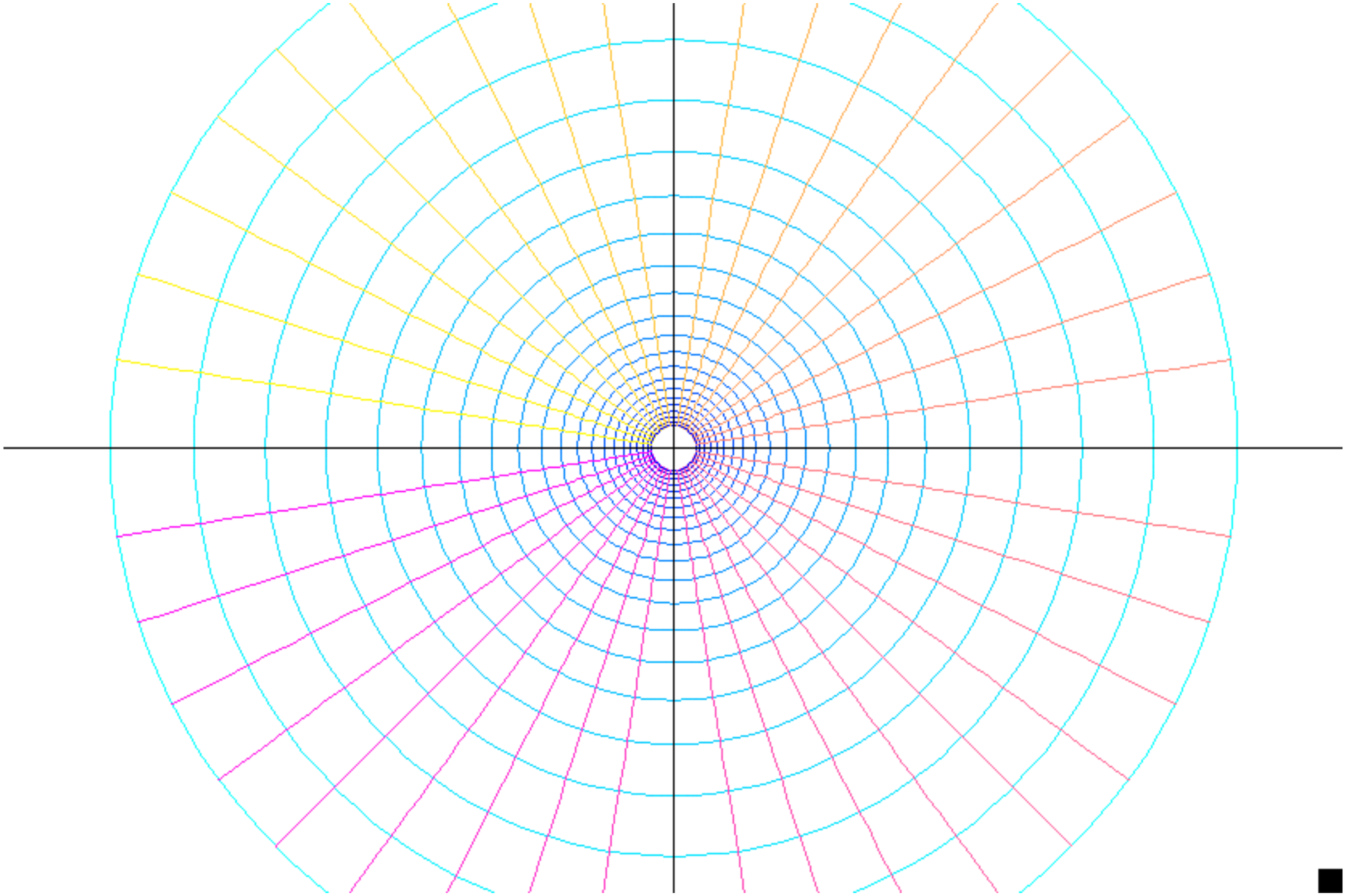
$$+\quad \begin{pmatrix}\gamma_{023}\\ \gamma_{031}\\ \gamma_{012}\end{pmatrix}(-\vec{E}\times\vec{J}-\vec{B}\rho-\vec{B}\times\vec{J^m}+\vec{E}\nabla\cdot\vec{B}+P\vec{J^m})$$

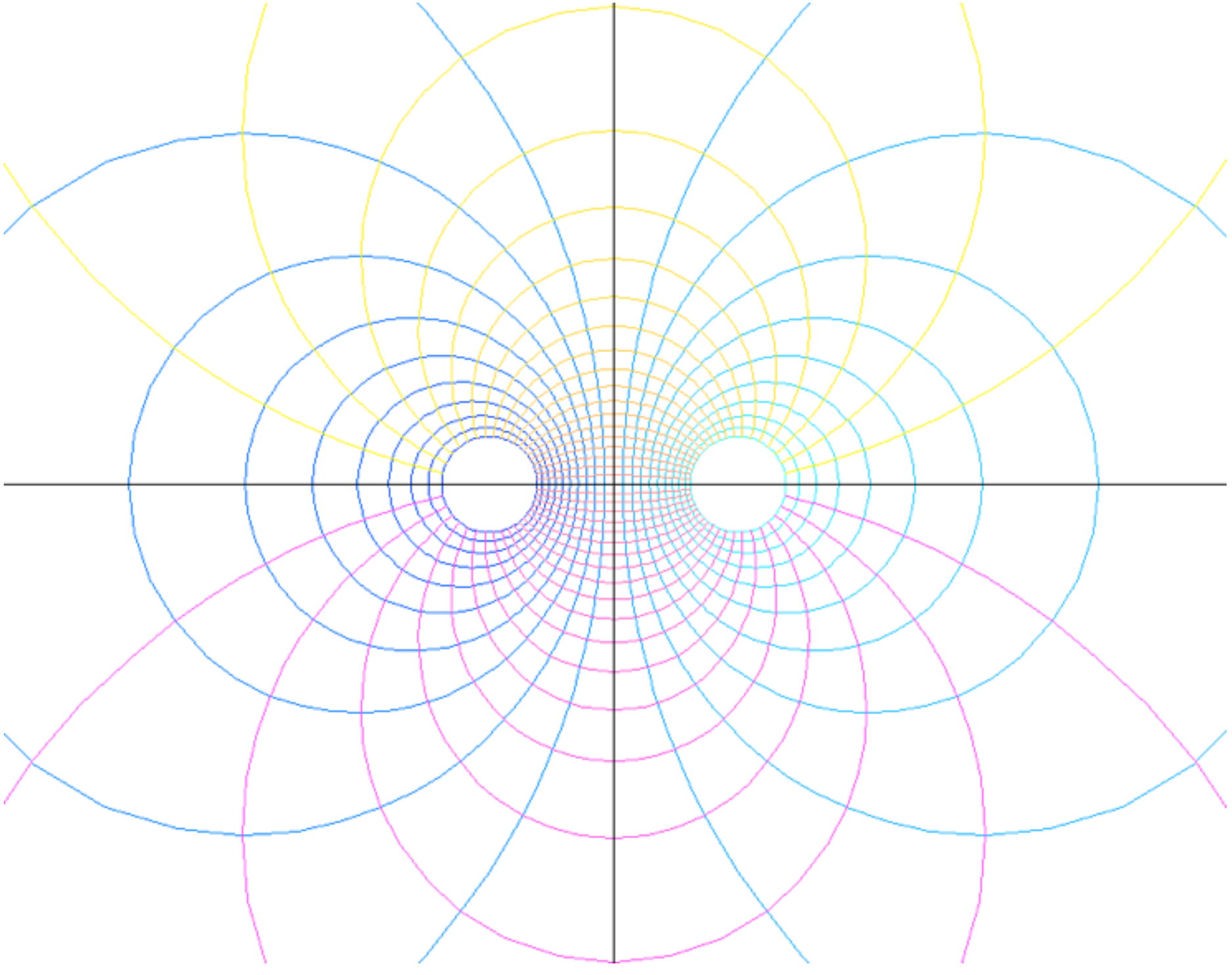
$$\vec{J}=\nabla\times\vec{B}-\partial_0\vec{E}+\nabla P \text{ and } \vec{J^m}=\nabla\times\vec{E}+\partial_0\vec{B}$$

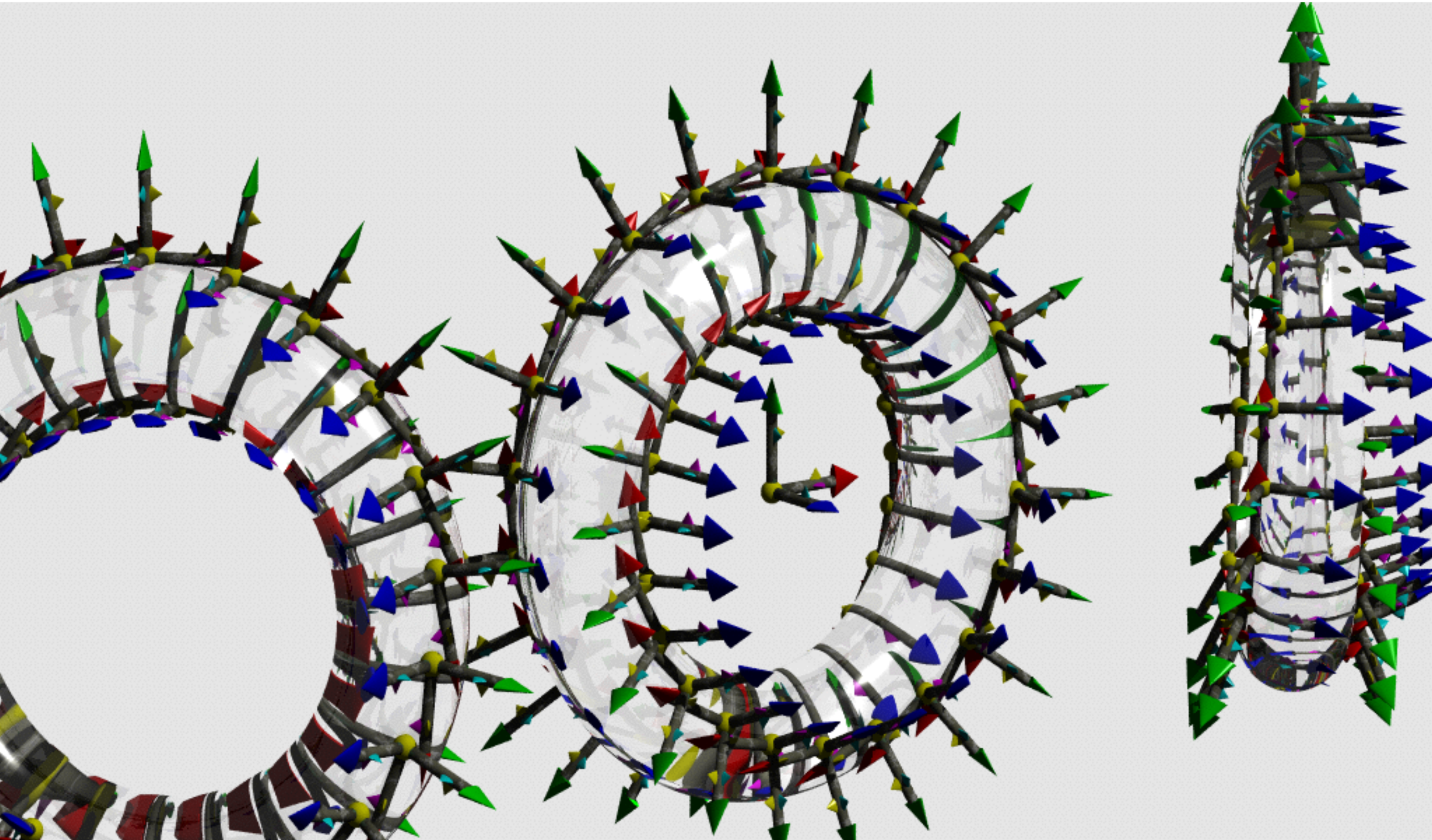
Each short for 2 Maxwell eqs. Also $\rho=\nabla\cdot\vec{E}+d_0P$

How can it be both toroidal and spherical?

- Hyperspherical: both are projections
- Rotations in multiple planes in multiple spaces (at least 3)
- Momentum and angular momentum conserved: tumbles
- Harmony of phases between oscillations







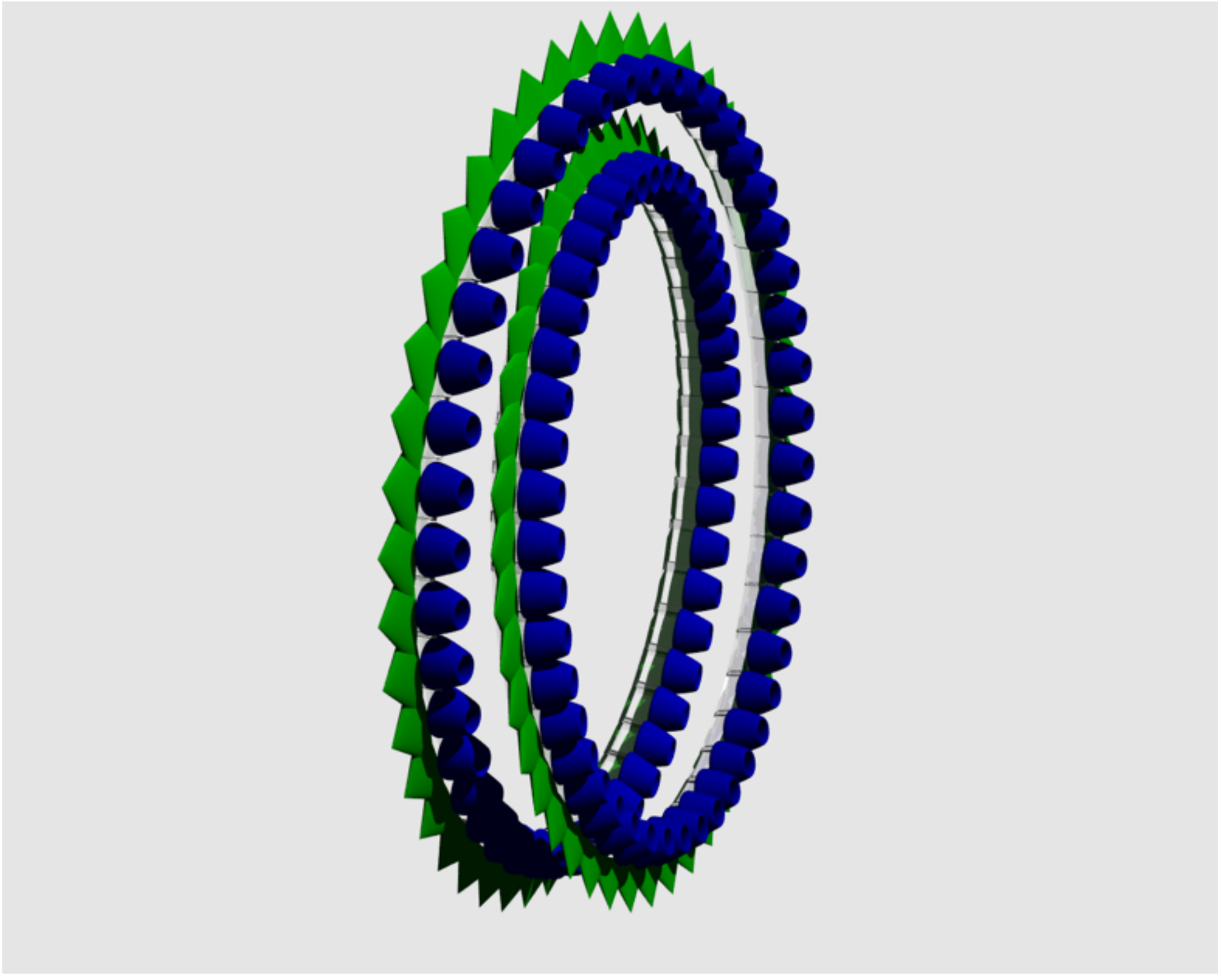
3 views of the same field wrapped in a torsioned loop. Electric monopole, magnetic dipole.

Where is the spin? Look at extremal paths

Spin in the twist through the hole in the torus

Uncertainty principle

- The phase(s) of the electron are unknown
- Varies ± c at twice Compton freq
- Reproduces all features of standard uncertainty relation except energy uncertainty limited to electron mass (see Hestenes “Zitterbewegung interpretation of quantum mechanics”)



Positron field snapshot, blades electric, hollow cones magnetic phase direction space-time bivector

electron/positron creation/annihilation

This is no surprise, its the twisted strip. Its a path in 3-momentum space, under the assumption that the momentum is fixed somehow.

In fact its a lot more complicated than this .. really need to look at J space, E space and B space at the same time. Eventually need to keep track of at least 9 and eventually 16 modulo the quantum bicycle and momentum conservation.

Not too bad: each one can only be in one direction at once!

The reason it all appears to work in 3D is because of the remarkable projections properties of (true) 4-space, onto 3-space. (Hopf maps, Vilarceau circles, toroidal sectioning of hyperspheres and all that stuff). The different 3D sub-spaces behave the same translationally and under simple rotations, but do not behave the same under boosts or rotations of rotations. This may be the underlying reason why the quantum world has looked so weird for so long. Note also that, while the scalar 1D space is defined at a point, the other spaces are defined over a characteristic length (v), area (b,r), or volume(t), or hypervolume(q). They are all simply related to the (Compton) wavelength of the object under study, but lead to relationships between the so-called fundamental constants (see, Williamson, van der Mark 1997).