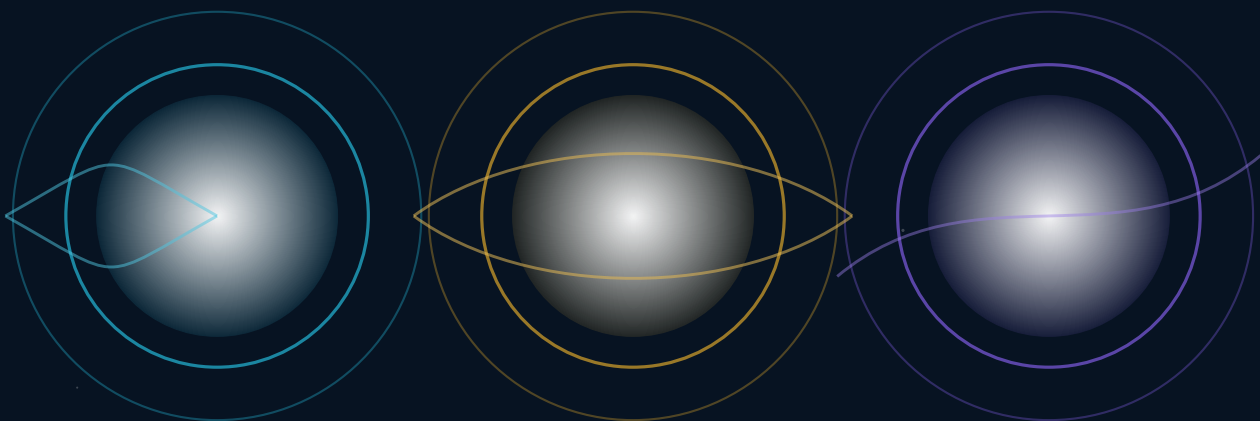


RBFL Coherent Luminous Node Bridge

From sonoluminescence and ball lightning to low-energy plasma coherence

A physical-firewall foundation for the next chapter of RBFL investigation



SONOLUMINESCENCE

BALL LIGHTNING

RBFL PLASMA NODE

Core proposition. Nature demonstrates multiple ways for energy and matter to form localized, bounded, luminous states when geometry, phase, feedback, and loss balance align. Sonoluminescence is a known acoustically driven example. Ball lightning is a real but unresolved atmospheric anomaly whose mechanism remains contested. RBFL asks whether the higher-level pattern - coherence → localisation → persistence → release - can be used as a disciplined guide for low-energy plasma investigations without claiming that the underlying physical fields are identical.

Executive scientific boundary

This report deliberately separates four levels of statement. **Observed** means directly reported in published experiments or astronomical/laboratory records. **Established** means standard physical equations or well-supported phenomena. **Project-derived** means mathematics already formalized in RBFL/RBFT project documents or the previous low-energy plasma sandbox. **Hypothesis** means a new bridge proposed here and still requiring physical validation.

The central boundary is unchanged:

same higher-level organisation pattern $\neq$ same microscopic physical mechanism

Ball lightning is therefore used as an *anomaly-class clue*, not as proof of RBFL, not as proof of plasma self-gravity, and not as evidence that sonoluminescence occurs in air.

Executive result

The new investigation foundation is a coherence-first programme:

low or moderate energy + high organisation + bounded geometry $\rightarrow$ testable coherent node state

The immediate scientific target is not negative gravity. It is to determine whether a low-energy plasma can be driven from a noisy discharge into a **repeatable, spatially localised, phase-locked attractor** whose internal gradient can be rotated electronically and distinguished from equal-power scrambled controls.

One-sentence public-safe statement

RBFL uses sonoluminescence and ball lightning as physically distinct examples that motivate a broader question: whether coherent localisation and bounded persistence, rather than raw energy alone, can identify the useful state variable for the next generation of low-energy plasma tests.

Contents

1	Why this report exists	5
2	Evidence ladder and terminology	5
3	RBFL architecture lock	6
4	Sonoluminescence: the controlled coherence archetype	6
4.1	Known physical carrier	6
4.2	Why coherence matters	6
4.3	Shared collapse gate, different physics	7
5	Ball lightning: a real anomaly, an unresolved mechanism	7
5.1	What is actually observed	7

5.2	Why the anomaly belongs in this investigation	7
5.3	Competing published mechanisms protect the analysis from overclaiming	7
6	The new bridge: coherent luminous nodes	8
6.1	Generic coherence variable	8
6.2	Attractor criterion	9
7	How the bridge maps into RBFL C_Phi	9
7.1	Sine-intersection mechanism already provides the mathematical slot	9
7.2	Stable node condition	9
8	Low-energy coherent plasma: the current project testbed	9
8.1	Why low energy is useful	9
8.2	Bounded plasma amplitude normal form	10
8.3	Phase-lock dynamics	10
8.4	Breathing envelope	10
8.5	Internal gradient synthesis	10
8.6	The unknown mapping stays unknown	11
9	What the previous sandbox actually established	11
10	What ball lightning adds to the RBFL investigation	12
11	The rotating arc display: useful analogy, important caution	12
12	Foundation experiment for the next RBFL chapter	13
12.1	Stage A - characterize the natural plasma mode	13
12.2	Stage B - phase lock without increasing power	13
12.3	Stage C - remove mechanical rotation	13
12.4	Stage D - paired or quadrature nodes	13
12.5	Stage E - bounded breathing	13
12.6	Stage F - external residual test	13
13	Frozen state ladder and controls	14
14	Predeclared falsification criteria	14
15	AI continuation block: source-of-truth equations	14
16	Reference implementation pseudocode	15
17	Symbol dictionary	16
18	Source provenance and reproducibility manifest	17

19 Research questions that define the next chapter	17
20 Conclusion	18
References	19

1 Why this report exists

RBFL has reached a point where explanation is not decoration; it is part of scientific testability. A mechanism claim becomes useful only when it identifies *what should be measured, what should remain unchanged, what distinguishes the hypothesis from ordinary physics, and what result would falsify it*.

Three project threads now converge:

1. The **Buoyant Node Bridge** showed that sonoluminescent bubble collapse and gravity-driven stellar collapse can share a reduced instability architecture while remaining physically different systems.
2. The **3D Sine-Intersection interpretation** gave C_Φ a volumetric coherence meaning: constructive phase intersections correspond to amplified nodes, destructive intersections to suppressed regions, without adding a new force term.
3. The **Low-Energy Coherent Plasma Gradient sandbox** showed, inside a dimensionless synthetic model, that paired phase-locked plasma modes could produce a cleaner electronically rotatable internal gradient at modest normalized drive than an equal-power scrambled state.

The present chapter adds a fourth clue: **ball lightning**. It is a real but unresolved atmospheric phenomenon with direct spectral observations and multiple competing models. Some models invoke trapped electromagnetic energy and plasma; others invoke chemical oxidation of soil-derived material. The fact that the mechanism is unresolved is not a weakness for this report - it is exactly why the phenomenon belongs in the anomaly layer rather than the proof layer.

2 Evidence ladder and terminology

Status	Meaning in this report	Example
Observed	A phenomenon or measurement has been directly reported.	Ball lightning was recorded spectroscopically following a cloud-to-ground strike; soil-element emission persisted through the luminous lifetime.
Established	Standard or strongly supported physics.	Acoustic trapping and Rayleigh-Plesset-type collapse in sonoluminescence; Lorentz forces and plasma transport.
Project-derived	Formalised within existing RBFL project work.	Locked RBFL law; I_Φ interference diagnostic; paired-plasma normal form; internal sandbox results.
Hypothesis	A new explanatory or experimental bridge.	A generic coherent-luminous-node class linking localisation, phase organisation, persistence and release.
Open	A quantity or causal link not yet measured.	Any coupling κ_Φ between an internal plasma gradient and an external gravitational response.

Language firewall

The phrase **coherent node** in this report means a macroscopic, repeatable, phase-organised state of an observable field or plasma mode. It does **not** imply that all particles

occupy one quantum-coherent many-body wavefunction.

3 RBFL architecture lock

The locked acceleration skeleton remains

$$g_{\text{RBFL}}(r, t) = g_b(r, t) + C_\Phi(r, t) \sqrt{a_\Phi |g_b(r, t)|} \hat{g}_b(r, t) \quad (1)$$

with

$$g_b = -\nabla \Phi_b, \quad \nabla^2 \Phi_b = 4\pi G \rho_b. \quad (2)$$

The present report does not add a plasma term, ball-lightning term, or sonoluminescence term to Eq. (1). Those systems can only inform the **mechanism language, detector design, and candidate dynamics of C_Φ** .

The project architecture requires the following separation:

$$\text{source} \rightarrow \text{law} \rightarrow \text{prediction} \rightarrow \text{residual/detector} \rightarrow \text{mechanism test}$$

Mechanism language may explain C_Φ , but it must not silently become a new acceleration term.

4 Sonoluminescence: the controlled coherence archetype

4.1 Known physical carrier

Single-bubble sonoluminescence consists of a gas bubble acoustically trapped in a liquid and periodically driven until a strong collapse produces light [5]. The organiser is a material pressure field, not gravity and not a vacuum wave. The local acoustic acceleration is

$$a_{\text{ac}} = -\frac{1}{\rho_\ell} \nabla p_{\text{ac}}, \quad \rho_\ell > 0. \quad (3)$$

The classical radial dynamics can be represented by the Rayleigh-Plesset equation

$$\rho_\ell \left(R \ddot{R} + \frac{3}{2} \dot{R}^2 \right) = p_B - p_\infty(t) - \frac{2\sigma}{R} - \frac{4\mu \dot{R}}{R}. \quad (4)$$

The external pressure may be written

$$p_\infty(t) = p_0 - P_{\text{eff}} \sin(\omega t + \varphi). \quad (5)$$

4.2 Why coherence matters

A standing acoustic mode is already an interference solution. For multiple pressure contributions,

$$P(\mathbf{x}) = \sum_{j=1}^N P_j(\mathbf{x}) e^{i\psi_j(\mathbf{x})}, \quad (6)$$

and a normalized overlap index can be written

$$I_{\text{ac}}(\mathbf{x}) = \frac{\left| \sum_j P_j e^{i\psi_j} \right|^2}{\sum_j P_j^2 + \varepsilon}. \quad (7)$$

Large I_{ac} means that multiple contributions reinforce at a reproducible location. This is the first major bridge principle:

$$\text{organisation determines where energy concentrates}$$

4.3 Shared collapse gate, different physics

The Buoyant Node work defined an inward-drive versus support ratio

$$\Lambda = \frac{|a_{\text{organiser}}|}{|a_{\text{support}}|}, \quad (8)$$

with the reduced interpretation

$\Lambda < 1$: supported/breathing, $\Lambda \approx 1$: instability boundary, $\Lambda > 1$: nonlinear inward collapse.

This normal form is useful because it identifies *a structural role*, not a common microscopic field.

5 Ball lightning: a real anomaly, an unresolved mechanism

5.1 What is actually observed

A 2014 Physical Review Letters report recorded ball lightning spectroscopically at approximately 0.9 km after a cloud-to-ground strike [6]. The luminous object moved horizontally, and emission from soil elements was present through its observed lifetime. This is unusually important because it is instrumented evidence rather than eyewitness description alone.

The observation does not uniquely identify the mechanism. Competing explanations include chemical oxidation of soil-derived nanoparticles, microwave/plasma cavities, electrical/plasma structures, and mixed thermochemical-electromagnetic processes.

5.2 Why the anomaly belongs in this investigation

The useful feature for RBFL is not “mystery” by itself. It is the existence of a **localized luminous state that persists for many internal collision times and moves as a bounded object-like region**. Any valid mechanism must explain localisation, persistence, energy balance, and termination.

A mechanism-agnostic energetic statement is

$$\frac{dE_{\text{node}}}{dt} = P_{\text{in}} - P_{\text{rad}} - P_{\text{thermal}} - P_{\text{transport}} - P_{\text{expansion}}. \quad (9)$$

A quasi-persistent luminous state requires

$$\left\langle \frac{dE_{\text{node}}}{dt} \right\rangle_T \approx 0 \quad (10)$$

over a dwell interval T , even if each term is individually large.

5.3 Competing published mechanisms protect the analysis from overclaiming

The ball-lightning literature itself warns us not to equate persistence with one cause. For example:

- Abrahamson and Dinniss proposed slowly oxidizing silicon/silicon-compound nanoparticle networks produced after lightning strikes soil [7].
- Wu proposed a relativistic-electron/microwave mechanism in which intense microwave radiation ionizes air and forms a plasma bubble that traps the radiation [8].
- Ohtsuki and Ofuruton reported laboratory plasma fireballs produced by microwave interference in air [9].

- Jerby and Shoshani reported ball-lightning-like ejections during localized microwave heating of basalt [10].

These models are mutually non-identical. Their value here is that they show multiple physically plausible routes to a bounded luminous object. Therefore ball lightning is treated as an **anomaly family** whose stable-state mathematics can be studied without prematurely deciding the ontology.

6 The new bridge: coherent luminous nodes

New synthesis proposed in this report

A **coherent luminous node** is a finite spatial region in which an observable energy/matter state is simultaneously *localized*, *phase-organized*, and *dynamically bounded* for long enough to behave as an identifiable state rather than a transient spark.

The common higher-level sequence is

$$\text{distributed drive} \rightarrow \text{mode selection} \rightarrow \text{localisation} \rightarrow \text{bounded persistence} \rightarrow \text{collapse, release, or stable} \quad (11)$$

This is the proposed bridge across sonoluminescence, ball-lightning candidate mechanisms, and low-energy plasma organisation. The physical carriers remain different.

6.1 Generic coherence variable

For N observable oscillatory components with phases ϕ_j , define the standard macroscopic order parameter

$$R_\phi(t) = \left| \frac{1}{N} \sum_{j=1}^N e^{i\phi_j(t)} \right|, \quad 0 \leq R_\phi \leq 1. \quad (12)$$

$R_\phi \approx 0$ corresponds to strong phase disorder; $R_\phi \approx 1$ corresponds to strong phase alignment.

Let $u(\mathbf{x}, t)$ be a measurable energy-density or luminous-intensity proxy. Define a localisation fraction inside candidate region Ω ,

$$L_\Omega(t) = \frac{\int_\Omega u(\mathbf{x}, t) dV}{\int_{\Omega_{\text{all}}} u(\mathbf{x}, t) dV + \epsilon}. \quad (13)$$

For a characteristic size $R(t)$ and dominant frequency $\omega(t)$, define a simple temporal stability factor

$$S_T = \exp \left[- \left(\frac{\sigma_R}{\langle R \rangle} \right)^2 - \left(\frac{\sigma_\omega}{\langle \omega \rangle} \right)^2 \right]. \quad (14)$$

A proposed *diagnostic only* coherent-luminous-node score is

$$\mathcal{N}_{\text{CLN}} = R_\phi L_\Omega S_T. \quad (15)$$

Equation (15) is new in this report. It is not an RBFL force term and not a claim that every system can be reduced to one scalar. Its purpose is to give future simulations and experiments a reproducible language for asking whether organisation, localisation, and persistence rise together.

6.2 Attractor criterion

A static coherent node is a stable local maximum of a coherence field $C(x, t)$ when

$$C > C_c, \quad \nabla C = 0, \quad H[C] < 0, \quad |\partial_t C| \ll C/\tau. \quad (16)$$

A breathing or rotating node is more naturally a limit cycle,

$$X(t + T) = X(t) + \mathcal{O}(\epsilon), \quad (17)$$

where the state vector may contain

$$X = (E, R_\phi, L_\Omega, R, \omega, G, \dots). \quad (18)$$

This extends the earlier RBFL attractor-basin idea: stability need not mean a dead-flat state; it can mean bounded repeatability.

7 How the bridge maps into RBFL C_Phi

7.1 Sine-intersection mechanism already provides the mathematical slot

The 3D Sine-Intersection paper represents a local phase contribution from anchor i as

$$\Phi_i(r, t) = A_i(r, t) \sin(k_i \cdot r - \omega_i t + \theta_i). \quad (19)$$

For two components with $\Delta\psi = \psi_1 - \psi_2$,

$$I_{12} = A_1^2 + A_2^2 + 2A_1A_2 \cos \Delta\psi, \quad (20)$$

so

$$\Delta\psi \approx 0 \Rightarrow \text{amplification}, \quad \Delta\psi \approx \pi \Rightarrow \text{suppression/cancellation}.$$

For many anchors,

$$I_\Phi(r, t) = \frac{\left| \sum_i A_i(r, t) e^{i\psi_i(r, t)} \right|^2}{\sum_i A_i^2(r, t) + \varepsilon}. \quad (21)$$

The existing project interpretation is

$$C_\Phi(r, t) = \mathcal{C}[I_\Phi, \nabla I_\Phi, \partial_t I_\Phi, \rho_b, \mathcal{G}], \quad (22)$$

where $\mathcal{G}$ encodes geometry, boundary conditions, rotation state, and environment.

7.2 Stable node condition

The existing RBFL mechanism paper proposes the candidate amplified-node condition

$$C_\Phi > 1, \quad \nabla C_\Phi = 0, \quad H[C_\Phi] < 0, \quad \partial_t C_\Phi \approx 0. \quad (23)$$

This has the same mathematical form as Eq. (16). That is the key new explanatory bridge: **the same stability grammar can be used to classify acoustic nodes, luminous plasma nodes, and RBFL coherence nodes without claiming the underlying fields are the same.**

8 Low-energy coherent plasma: the current project testbed

8.1 Why low energy is useful

If the variable of interest is organisation, then brute force is scientifically inconvenient. High power increases thermal expansion, radiation, electromagnetic leakage, mechanical vibration,

outgassing, and sensor contamination. A low-energy regime makes null subtraction easier and therefore creates a cleaner falsification environment.

The previous RBFL sandbox formalized the design reversal as

do not seek enough energy to overpower gravity; seek enough organisation to create a small controllable

8.2 Bounded plasma amplitude normal form

The existing sandbox used

$$A(P) = \left[\frac{\max(P - P_{\text{ion}}, 0)}{1 + P/P_{\text{sat}}} \right]^{1/2}, \quad (24)$$

where P is normalized drive, P_{ion} a sustain threshold, and P_{sat} a saturation scale. This is explicitly a control-theory normal form, not a plasma chemistry model.

8.3 Phase-lock dynamics

For orthogonal pair $j \in \{x, z\}$, define

$$e_j(t) = \phi_j(t) - \Theta(t). \quad (25)$$

The sandbox evolves phase error using

$$de_j = [\Delta\omega_j - K_{\text{eff}}(t) \sin e_j] dt + \sqrt{2D(P)} dW_j, \quad (26)$$

with

$$K_{\text{eff}}(t) = Q_c P B(t), \quad D(P) = D_0 + D_1 P. \quad (27)$$

8.4 Breathing envelope

The sonoluminescence-inspired modulation is deliberately weak and secondary:

$$B(t) = 1 + b \sin(2\Theta(t) + \phi_b). \quad (28)$$

This imports only the control idea of bounded breathing, not the acoustic mechanism.

8.5 Internal gradient synthesis

With small amplitude mismatch ϵ_A ,

$$G_x(t) = \Gamma A^2(P)(1 + \epsilon_A)^2 \cos e_x(t) \sin \Theta(t), \quad (29)$$

$$G_z(t) = \Gamma A^2(P)(1 - \epsilon_A)^2 \cos e_z(t) \cos \Theta(t), \quad (30)$$

so

$$\boxed{G(t) = G_x(t)\hat{x} + G_z(t)\hat{z}.} \quad (31)$$

The macroscopic coherence score is

$$C = \left\langle \frac{\cos e_x + \cos e_z}{2} \right\rangle, \quad (32)$$

and the sandbox disorder proxy is

$$H_{\text{dis}} = P \max(0, 1 - C^2) + \eta_T P^2. \quad (33)$$

Gradient stability is

$$S_G = 1 - \frac{\sigma_{|G|}}{\langle |G| \rangle}. \quad (34)$$

8.6 The unknown mapping stays unknown

The only speculative external mapping is

$$\Delta a_{\Phi} = \kappa_{\Phi} G. \quad (35)$$

No value, sign, or existence of κ_{Φ} has been established. Projecting vertically gives the discriminating orientation form

$$\Delta a_{\Phi,z} = \kappa_{\Phi} G_z \propto \kappa_{\Phi} \cos \Theta. \quad (36)$$

This implies a maximum near 0° , a null near 90° , sign reversal near 180° , and a second null near 270° if such an external coupling exists.

9 What the previous sandbox actually established

The dimensionless low-energy sandbox ran 2,160 parameter cases. Of these, 1,885 met its internal stable-gradient gate and 787 were inside the predeclared low-energy band. The selected minimum-drive case had

$$P = 0.075, \quad C = 0.979, \quad r_{\text{track}} = 0.9997, \quad \langle |\Delta\Theta| \rangle = 1.89^\circ, \quad S_G = 0.970,$$

with disorder proxy

$$H_{\text{dis}} = 0.00363.$$

The equal-power scrambled control returned approximately

$$C_{\text{scramble}} = 0.235, \quad r_{\text{track}} = 0.355, \quad \langle |\Delta\Theta| \rangle = 60.8^\circ.$$

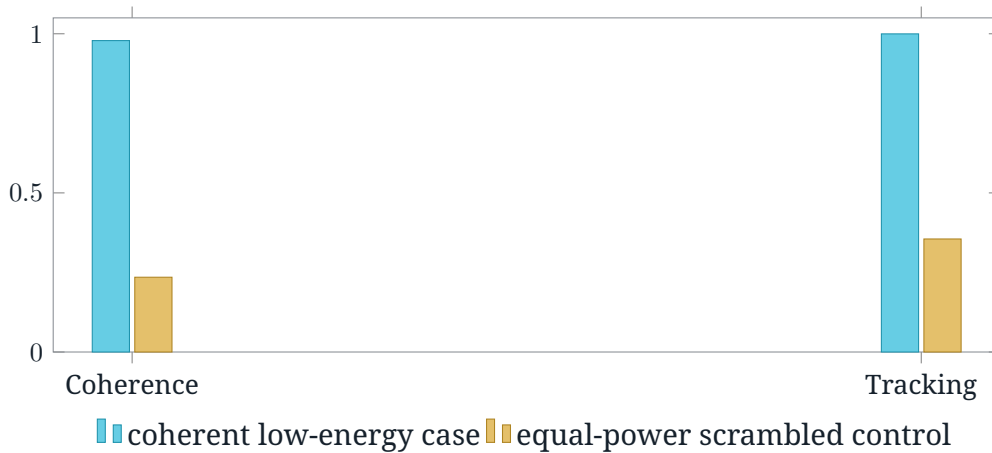


Figure 1: Exact coherence and orientation-tracking metrics from the prior reproducibility package. At the same normalized power, the coherent case also had a much lower disorder/heat proxy (0.00363 versus 0.07131).

Interpretation of the previous sandbox

The result was **not** “anti-gravity was simulated.” The supported internal statement was narrower: within the declared normal form, low normalized drive plus high phase organisation produced a cleaner, electronically rotatable internal gradient than the equal-power incoherent state. External coupling remained untested.

10 What ball lightning adds to the RBFL investigation

Ball lightning adds a different kind of clue from sonoluminescence.

Sonoluminescence tells us that a precisely driven, strongly bounded system can focus distributed energy into a tiny repeating luminous event. Ball lightning tells us that nature sometimes produces a luminous, finite-sized atmospheric object whose persistence is surprisingly long compared with an ordinary spark, even though the mechanism remains unsettled.

The shared investigative question is therefore not “are these the same phenomenon?” It is:

what state variables allow a luminous energetic region to become bounded and persistent?

A useful search hierarchy is

power → phase order → localisation → bounded attractor → release/transition. (37)

The report therefore promotes **coherence, localisation, and boundedness** to primary observables instead of assuming that temperature or total power is the decisive control variable.

11 The rotating arc display: useful analogy, important caution

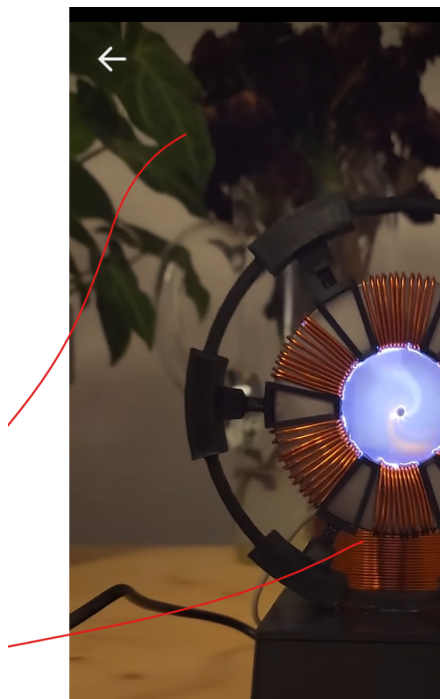


Figure 2: User-provided example of a luminous rotating arc display. The user later clarified that a motor mechanically rotates a central rod while the discharge arcs toward the outer structure. It is therefore an example of *forced* rotation, not evidence that the plasma itself has spontaneously formed a self-organised coherent vortex.

This distinction creates a clean development ladder:

mechanically forced arc rotation → electromagnetically driven rotation → phase-locked plasma mode – (38)

The motor-driven device is useful because it supplies a visually measurable oscillator, but the next scientific step is to remove the mechanical source of rotation from the causal chain.

12 Foundation experiment for the next RBFL chapter

12.1 Stage A - characterize the natural plasma mode

Before imposing a model, measure what is actually rotating. The minimum state vector is

$$Y(t) = [I(\theta, t), \phi(\theta, t), \omega(t), R(t), P(t), T(t), B(x, t), E(x, t)] . \quad (39)$$

The immediate questions are:

- Is the visible pattern a bulk flow, an ionisation spoke, an arc attachment, or a moving luminous front?
- Is there one dominant angular mode or several competing modes?
- Does the rotation frequency scale with electrical drive, gas pressure, magnetic geometry, or mechanical forcing?
- Does a reproducible attractor exist at fixed external controls?

12.2 Stage B - phase lock without increasing power

The key comparison is same average power, different organisation:

$$P_{\text{coherent}} \approx P_{\text{scrambled}}, \quad R_{\phi, \text{coherent}} \gg R_{\phi, \text{scrambled}}. \quad (40)$$

A phase-lock controller should first follow the natural mode and only later take command of it. The internal success condition is not brightness; it is reduced phase error, reduced mode competition, and increased repeatability.

12.3 Stage C - remove mechanical rotation

A decisive transition occurs when the mechanically rotating source can be stopped while a rotating plasma pattern remains phase-locked to an electronically rotated field. This changes the causal statement from

motor $\rightarrow$ arc path $\rightarrow$ visible rotation

to

electronic phase pattern $\rightarrow$ plasma mode $\rightarrow$ visible rotation.

12.4 Stage D - paired or quadrature nodes

The minimal vector geometry uses two orthogonal phase-controlled pairs. This retains the exact previous sandbox logic and allows the internal gradient to be rotated without rotating the apparatus.

12.5 Stage E - bounded breathing

Only after stable phase lock is established should a weak modulation $B(t)$ be introduced. The test is whether a small breathing term increases localisation or state stability at fixed mean power. If it increases disorder, the sonoluminescence-inspired branch is falsified for that regime.

12.6 Stage F - external residual test

The physical claim begins only here. The measured external residual must be formed after subtracting known forces,

$$\Delta F_{\text{residual}} = F_{\text{measured}} - F_{\text{EM}} - F_{\text{thermal}} - F_{\text{acoustic}} - F_{\text{airflow}} - F_{\text{vibration}} - F_{\text{cable}} - F_{\text{instrument}}. \quad (41)$$

The high-value signature is not a one-direction weight change. It is a residual vector that follows the electronic phase command while the apparatus remains mechanically stationary.

13 Frozen state ladder and controls

The first physical campaign should predeclare the following state ladder:

State	Internal condition	Purpose
S0	power off	instrument baseline
S1	plasma on, free-running	natural mode characterization
S2	equal-power phase scrambled	coherence null
S3	phase locked, fixed orientation	coherent-state test
S4	phase locked, rotating command	orientation-tracking test
S5	S4 plus weak breathing modulation	sonoluminescence-inspired modulation test
S6	reversed phase order / reversed rotation	sign/reversal control

Required controls include electromagnetic dummy loads, thermal matching without plasma, mechanical vibration injection, cable-orientation reversals, gas-flow nulls, sensor displacement controls, and blinded run labels.

14 Predeclared falsification criteria

The next chapter should be considered unsuccessful if any of the following occur:

1. Coherence metrics rise only when input power rises; equal-power phase order has no independent effect.
2. The visible rotation disappears when mechanical forcing is removed and cannot be recovered by electronic phase control.
3. A claimed node score can be reproduced by brightness thresholding or camera artifacts alone.
4. The internal gradient does not follow the commanded orientation on held-out runs.
5. Any external force residual follows current, magnetic leakage, temperature, airflow, vibration, or cable geometry more closely than phase orientation.
6. Reversing electronic orientation does not reverse or rotate the claimed residual in the predeclared manner.
7. An ordinary plasma/electromagnetic model predicts all measured observables equally well or better without an RBFL coupling layer.

15 AI continuation block: source-of-truth equations

This section is intentionally compact and redundant. It is designed so another AI or researcher can continue the investigation without reconstructing the project logic from conversation history.

LOCKED - do not modify inside this investigation

$$\begin{aligned}
g_{\text{RBFL}} &= g_b + C_\Phi \sqrt{a_\Phi |g_b|} \hat{g}_b, \\
g_b &= -\nabla \Phi_b, \\
\nabla^2 \Phi_b &= 4\pi G \rho_b.
\end{aligned}$$

Ball lightning, plasma coherence, breathing, detector metrics, and κ_Φ are not additional force terms.

MECHANISM-LEVEL RBFL INTERPRETATION

$$\begin{aligned}
\Phi_i &= A_i \sin(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t + \theta_i), \\
I_\Phi &= \frac{|\sum_i A_i e^{i\psi_i}|^2}{\sum_i A_i^2 + \varepsilon}, \\
C_\Phi &= \mathcal{C}[I_\Phi, \nabla I_\Phi, \partial_t I_\Phi, \rho_b, \mathcal{G}].
\end{aligned}$$

Amplified-node candidate: $C_\Phi > 1$, $\nabla C_\Phi = 0$, $H[C_\Phi] < 0$, $\partial_t C_\Phi \approx 0$.

SONOLUMINESCENCE BRIDGE

$$\begin{aligned}
a_{\text{ac}} &= -\rho_\ell^{-1} \nabla p_{\text{ac}}, \\
\rho_\ell (R\ddot{R} + \frac{3}{2} \dot{R}^2) &= p_B - p_\infty - 2\sigma/R - 4\mu\dot{R}/R, \\
\Lambda &= |a_{\text{organiser}}| / |a_{\text{support}}|.
\end{aligned}$$

Use the same instability topology only; do not identify gravity with sound.

LOW-ENERGY PLASMA NORMAL FORM

Use Eqs. (24)-(36). Internal synthesis and external coupling are separate questions. Never fit κ_Φ from the desired force result.

OPEN / UNESTABLISHED

- Ball lightning is not established here as a coherent plasma node; its mechanism is unresolved.
- No physical experiment has established an RBFL external coupling coefficient κ_Φ .
- No negative- g or gravity-screening effect has been demonstrated by this report or the previous sandbox.
- The proposed coherent-luminous-node index $\mathcal{N}_{\text{CLN}}$ is a diagnostic introduced in this report, not part of the locked law.

16 Reference implementation pseudocode

```

INPUTS:
  phase channels phi_j(t)
  intensity / energy proxy u(x,t)

```

```

characteristic node radius  $R(t)$ 
dominant angular frequency  $\omega(t)$ 
electrical power  $P(t)$ 
magnetic, thermal, vibration, airflow, cable-force controls

```

STEP 1: phase order

```
R_phi(t) = abs(mean(exp(lj*phi_j(t))))
```

STEP 2: localization

```
L_Omega(t) = integral_Omega(u) / (integral_all(u) + eps)
```

STEP 3: temporal stability over declared dwell window

```
S_T = exp(-(std(R)/mean(R))^2 - (std(omega)/mean(omega))^2)
```

STEP 4: coherent luminous node diagnostic

```
N_CLN = mean(R_phi) * mean(L_Omega) * S_T
```

STEP 5: run frozen state ladder $S_0 \dots S_6$

```
compare equal-power coherent vs scrambled conditions
```

STEP 6: if paired-plasma model is used

```
integrate phase-error SDE (Eq. 6 / report Eq. adler)
```

```
construct  $G_x$ ,  $G_z$  and  $G(t)$ 
```

```
compute coherence  $C$ , gradient stability  $S_G$ , orientation error
```

STEP 7: external test only after internal lock

```
DeltaF_residual = F_measured - sum(known artifact models)
```

```
test phase/orientation harmonic and sign reversal on blinded held-out runs
```

FAIL if residual follows power/temperature/B/vibration/cables better than orientation.

17 Symbol dictionary

Symbol	Meaning	Status
ρ_b	3D baryonic density field	locked source input
g_b	ordinary baryonic acceleration	locked
a_Φ	RBFL phase-saturation acceleration scale	locked parameter
C_Φ	local RBFL coherence-response factor	locked law term / mechanism interpreted
I_Φ	phasor-style local RBFL interference index	mechanism diagnostic
R_ϕ	macroscopic phase-order parameter	established synchronization diagnostic
L_Ω	fraction of measured energy/intensity localized in candidate node	proposed diagnostic
S_T	radius/frequency temporal stability factor	proposed diagnostic
$\mathcal{N}_{\text{CLN}}$	coherent-luminous-node score $R_\phi L_\Omega S_T$	new proposed diagnostic
P	normalized plasma drive in prior sandbox	project-derived model variable
P_{ion}	normalized sustain threshold	project-derived model variable

Symbol	Meaning	Status
P_{sat}	amplitude saturation scale	project-derived model variable
Q_c	phase-lock/coherence efficiency	project-derived model variable
$D(P)$	phase-noise strength	project-derived model variable
$B(t)$	weak breathing envelope	project-derived model variable
$\Theta(t)$	electronic orientation command	project-derived model variable
e_j	phase error for pair j	project-derived model variable
G	internally synthesized anisotropic gradient	project-derived model output
S_G	gradient-amplitude stability	project-derived diagnostic
κ_Φ	unknown mapping from internal gradient to external RBFL response	open / unmeasured
Λ	inward organiser to support ratio	derived bridge diagnostic
E_{node}	energy associated with candidate localized luminous state	generic bookkeeping variable

18 Source provenance and reproducibility manifest

The following project artifacts were used directly in reconstructing the mathematics and scientific boundaries of this report. SHA-256 values are included where the local artifact was available in this session.

Artifact	SHA-256 / provenance
RBFL/RBFT 6.0 Improved Unified Model - Architecture Blueprint and Full Derivation Dictionary	aba377887b4926d80ef5a97fb34319ea6affe1b3b66cde119
RBFL 3D Sine-Intersection Field Mechanics White Paper	3670ed14eba8e616ec6adfd5761846558b99abb1714974f03
RBFL Low-Energy Coherent Plasma Gradient White Paper	c35e4919d06d6ca47fa75073d856d60907c156e2a9d7f2005
RBFL Low-Energy Coherent Plasma Gradient Reproducibility Package	765e5b551f5b16e1e7974f5dd9104e0c385d822adf86c0729
User-provided rotating arc-plasma screenshot, 7 Aug 2026	9e1fe4f2ea3c6040c567165734b5abbcb975ca4dc159f316
The Buoyant Node Bridge - Physical Firewall Edition	Project source record accessed in current RBFL file library; equations and status language cross-checked against the rendered document.

19 Research questions that define the next chapter

1. Can a low-energy plasma display a reproducible macroscopic phase-order transition at approximately fixed average power?

2. Does increased phase order increase localisation L_Ω and dwell stability S_T independently of brightness?
3. Can a rotating luminous mode survive after mechanical rotation is removed and the electronic phase pattern becomes the only rotation command?
4. Does weak bounded breathing increase node quality $\mathcal{N}_{\text{CLN}}$ or destabilize it?
5. Can paired orthogonal plasma regions reproduce the previous synthetic gradient results in measured laboratory variables?
6. Does any external residual follow the commanded internal orientation rather than current, magnetic leakage, temperature, gas flow, vibration, or cable geometry?
7. If no external effect exists, can the coherence-first programme still improve plasma confinement or state control using ordinary electromagnetism? That outcome is scientifically useful and should be reported rather than treated as a failure.

20 Conclusion

The next RBFL investigation should begin from a narrower and more defensible proposition than anti-gravity or fusion. Sonoluminescence establishes that a bounded, phase-organised system can focus distributed energy into a repeatable luminous collapse. Ball lightning establishes that nature can produce rare, localized luminous atmospheric objects whose persistence demands an explanation, while its competing models warn against prematurely assigning a mechanism. The existing RBFL sine-intersection framework supplies a mathematical language for amplified and suppressed coherence regions, and the previous low-energy plasma sandbox supplies a reproducible control-theory model for phase-locked gradient synthesis.

The resulting foundation is:

$$\boxed{\text{coherence} + \text{localisation} + \text{bounded dynamics} \longrightarrow \text{candidate node state}} \quad (42)$$

followed by the decisive empirical question

$$\boxed{\text{does any external response track the node's phase/orientation after ordinary forces are removed?}} \quad (43)$$

That is the gateway from explanation to acceptance: the explanatory bridge is now explicit, the mathematical objects are defined, the status of every claim is separated, and the next experiment has a predeclared path to falsification.

References

- [1] L. S. Haye, *RBFL/RBFT 6.0 Improved Unified Model: Architecture Blueprint and Full Derivation Dictionary*, RBFL project record, 2026.
- [2] L. S. Haye, *RBFL 3D Sine-Intersection Field Mechanics: A Volumetric Coherence Interpretation of Phase Projection, Scaling, and Apparent Matter Clumping*, RBFL project record, 2026.
- [3] L. S. Haye, *The Buoyant Node Bridge: Same Collapse Mathematics, Different Physical Fields*, Physical Firewall Edition, RBFL/RBFT 6.0, 2026.
- [4] L. S. Haye, *RBFL Low-Energy Coherent Plasma Gradient: Paired-Plasma Phase Rotation as a Minimal Test of an Anisotropic Coupling State*, 7 Aug. 2026.
- [5] M. P. Brenner, S. Hilgenfeldt, and D. Lohse, "Single-bubble sonoluminescence," *Reviews of Modern Physics* 74, 425 (2002), doi:10.1103/RevModPhys.74.425.
- [6] J. Cen, P. Yuan, and S. Xue, "Observation of the Optical and Spectral Characteristics of Ball Lightning," *Physical Review Letters* 112, 035001 (2014), doi:10.1103/PhysRevLett.112.035001.
- [7] J. Abrahamson and J. Dinniss, "Ball lightning caused by oxidation of nanoparticle networks from normal lightning strikes on soil," *Nature* 403, 519-521 (2000), doi:10.1038/35000525.
- [8] H.-C. Wu, "Relativistic-microwave theory of ball lightning," *Scientific Reports* 6, 28263 (2016), doi:10.1038/srep28263.
- [9] Y. H. Ohtsuki and H. Ofuruton, "Plasma fireballs formed by microwave interference in air," *Nature* 350, 139-141 (1991).
- [10] E. Jerby and Y. Shoshani, "Localized microwave-heating of basalt - lava, dusty-plasma, and ball-lightning ejection by a miniature volcano," *Scientific Reports* 9, 12954 (2019), doi:10.1038/s41598-019-49049-5.

Final evidence boundary

This report does not establish that ball lightning is a plasma soliton, that plasma coherence modifies gravity, that RBFL has experimentally engineered gravity, or that fusion is required for the proposed programme. It establishes a disciplined next hypothesis: **test whether low-energy macroscopic organisation can create a bounded coherent plasma node, then test whether any external residual follows its phase and orientation rather than ordinary force channels.**