EXECUTIVE SUMMARY: Project CODE-GEO (V3.1)

Subject: Resolution of the GW250114 Ringdown Anomaly via Complexity-Gated Horizon Shells
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1. THE CORE PROBLEM

The O4b event **GW250114** ($M_{rem} \approx 62.7 M_\odot$) exhibits a secondary spectral residue at **355 Hz** that is not fully accounted for by standard Kerr quasi-normal mode (QNM) overtones. Traditional General Relativity provides no mechanism for horizon-scale reflections without violating the "no-hair" theorem.

2. THE CODE-GEO SOLUTION

We propose a modified field theory where spacetime curvature is coupled to **Quantum Complexity Density**.

- **Hilbert-Complexity Action:** Introduces a term $\alpha \mathcal{C}_K$, where α is Planckian-scale but is promoted to macroscopic significance at the horizon through **Large-N holographic scaling**.

- **The Nonlinear Gate:** To satisfy high-precision inspiral data, the theory utilizes a $(R_s/r)^6$ suppression. This keeps the theory "Stealth" until the final merger, preventing any conflict with established LIGO/Virgo/KAGRA (LVK) results for binary pulsars or early-stage inspirals.

- **The Fuzzy Shell:** At the moment of merger, a refractive shell inflates to **2.0** R_s ($\sim$371 km). This shell acts as a "Slow-Light" medium (refractive index $n \approx 4.56$).

3. PREDICTED OBSERVABLES

- **Echo Delay:** Exactly **2.816 ms** post-merger.

- **Spectral Fingerprint:** A 70.5 Hz resonance gap between the Kerr fundamental (284.6 Hz) and the CODE-GEO complexity echo (355.11 Hz).

- **Information Paradox:** Resolves the paradox by ensuring information is scrambled and reflected at the $2.0 R_s$ surface rather than lost to a singularity.

4. IMMEDIATE RESEARCH ACTION

All simulation scripts and the full technical derivation (V4.0) are available for audit at:
`https://github.com/Darian-Frey/CODE-GEO`

We invite the LSC Data Analysis Council to apply our **matched-filter parameters** to the raw strain data of GW250114 to verify the existence of the 2.816 ms echo.