Aharonov–Bohm Effect (ABE) vs Gravitational ABE (GABE): Seminar Handout

This seminar handout expands upon the comparison between the **electromagnetic Aharonov–Bohm effect (ABE)** and its proposed **gravitational analog (GABE)**. The discussion is situated at the intersection of physics, quantum theory, and speculative engineering. Emphasis is placed on conceptual frameworks, equations, and theoretical implications for communication, neuroscience, and cybersecurity.

1. Electromagnetic ABE Basics

The ABE demonstrates that the **vector potential (A)** has observable effects even when the magnetic field (B) is zero. Electrons traversing two different paths enclosing a magnetic flux experience a relative phase shift, given by: $\Delta\phi = (q / \blacksquare) \blacksquare A \cdot dl$ This shift leads to measurable interference effects, despite the absence of a classical Lorentz force along the path. The ABE thus shows that potentials—not just fields—carry physical reality. This insight underpins proposals for potential-based communication systems and non-local coupling devices.

2. Gravitational ABE (GABE)

Proposed by R.Y. Chiao and others, the gravitational analog replaces the vector potential with the **gravitomagnetic potential** arising in general relativity. Just as EM potentials shift phases, the curvature of spacetime (encoded in the metric and its connection) could produce a similar shift in quantum wavefunctions. Equation (heuristic form): $\Delta\phi\_g = (1 / \blacksquare) \blacksquare h\mu\nu\ p\mu\ dx\nu$ Here, $h\mu\nu$ represents perturbations in the spacetime metric (gravitational waves, gravitomagnetism), and $p\mu$ is the particle's four-momentum. If real, GABE would imply that gravitational potentials can establish phase correlations across spatially separated systems.

3. Comparative Features of ABE vs GABE

Feature	ABE (Electromagnetic)	GABE (Gravitational)
Carrier	Vector potential A, scalar ϕ	Gravitomagnetic potential, metric perturbations
Equation	$\Delta\phi = (q / \blacksquare) \blacksquare A\cdot dl$	$\Delta\phi\_g = (1 / \blacksquare) \blacksquare h\mu\nu\ p\mu\ dx\nu$
Medium Sensitivity	EM shielding (Faraday cages)	Gravitational shielding (not possible)
Engineering Use	Potential-based communication, nonlocal coupling	Speculative: gravitational sensors, links

4. Phase-Locking and Biological Systems

Biological systems such as neurons are exquisitely sensitive to phase relationships. Phase-locking refers to the synchronization of oscillatory activity between neurons or brain regions. Persinger, Rouleau, and Kernbach reported that under identical EM field configurations, separated biological systems (cells, brains) showed correlated responses. If ABE-like processes establish a common phase reference across systems, perturbing one system could induce measurable changes in the other. This is often interpreted as “macro-entanglement” but could alternatively reflect vector potential– induced phase coherence.

5. Accelerating Rhythms and 3 ms Timing Windows

Experimental protocols often emphasize accelerating or decelerating frequency sweeps and discrete pauses (~3 ms). Acceleration enhances coupling by forcing systems through multiple resonance windows, increasing the chance of alignment. Why 3 ms? This interval aligns with known neuronal refractory periods and oscillatory cycle subharmonics in the brain. Thus, structured timing may optimize resonance and coherence both in biological systems and engineered devices.

6. Broader Implications

Both ABE and GABE highlight the primacy of **phase information** over classical energy transfer. This principle underlies theoretical pathways toward: - Communication systems immune to conventional jamming (vector potential signaling) - Brain–computer interfaces exploiting phase coherence - Speculative gravitational-phase sensors for astrophysics or security - Possible neuroweapon or neurodefense applications While experimental evidence remains debated, the theoretical frameworks suggest rich opportunities for physics, engineering, and neuroscience.