Section 13. Canonical Examples (Mechanistic Illustrations with Equation Links)

This section provides canonical examples to illustrate QIA mechanisms in a familiar experimental language. The goal is not merely to reinterpret known experiments rhetorically, but to explicitly connect QIA's architecture (codewords, routing, constraints, and entropic stability) to the mathematical backbone introduced earlier. Each example is framed as a specific routing scenario in the lossless entropic network.

13.1 Double-slit: interference as multi-path routing superposition

In the double-slit experiment, standard quantum mechanics describes the particle as a wavefunction that evolves through two paths and interferes at the screen. In QIA, this is modeled as multi-path routing superposition. The wave-pattern encoding is routed through multiple compatible channels simultaneously, and the final intensity distribution reflects the phase-consistent combination of these routing paths. Interference is therefore not an abstract wave mystery but a direct consequence of phase-sensitive code routing.

$$\Psi = \Psi\_path1 + \Psi\_path2 \Rightarrow P(x) \propto |\Psi|\verb|^|2 \ (routing\ superposition)$$

13.2 Stern–Gerlach: discrete channels as spectrum-locked routing

The Stern–Gerlach experiment yields discrete outcomes when a spin-bearing particle passes through an inhomogeneous magnetic field. QIA interprets this discreteness as spectrum-locked routing. The measurement apparatus injects a constraint spectrum that defines stable eigen-channels. Routing dynamics then locks the incoming codeword into one of these stable channels, producing discrete outputs. This example directly corresponds to the eigen-channel locking mechanism introduced in Section 7.5.

$$\begin{aligned} &Constraint\ spectrum\ \ \rightarrow\ \ stable\ routing\ channels\ \{i\} \\ &\rightarrow\ \ discrete\ outcomes \end{aligned}$$

13.3 EPR pair: shared code and correlation via consistency constraint

For an EPR pair, QIA assigns a single shared codeword distributed across two spatially separated nodes. Measurement at one node injects a constraint that updates local routing, but the joint code must remain globally consistent. Therefore, correlations are enforced by a routing-consistency constraint rather than by superluminal signal exchange. The observed EPR correlations are simply the network-level manifestation of shared-code consistency.

$$\begin{aligned} &Shared\ codeword\_AB\ \ with\ \ global\ consistency \\ &\Rightarrow\ \ correlated\ outcomes \end{aligned}$$

13.4 Quantum teleportation: classical bits as routing instruction; entanglement as pre-shared code

Quantum teleportation is often described as the transmission of an unknown quantum state using entanglement and classical communication. In QIA, the mechanism becomes transparent. Entanglement provides a pre-shared joint code across nodes, establishing a prepared routing topology. The classical bits do not transmit quantum information directly; they function as routing instructions that specify which correction constraint must be injected at the receiver node to restore the intended codeword. Teleportation is therefore a routing-controlled reconstruction process.

$$\begin{aligned} &Classical\ bits\ =\ instruction\ for\ constraint\ update \\ &\Rightarrow\ \ receiver\ routing\ reconstructs\ codeword \end{aligned}$$

13.5 Delayed-choice: constraint update timing vs perceived time order

Delayed-choice experiments suggest that later measurement decisions influence earlier particle behavior. QIA interprets this as a mismatch between constraint update timing and perceived time order. The routing configuration must satisfy global consistency under all constraints. If constraints are injected late, the final consistent routing description may reclassify earlier intermediate routing interpretations. The paradox disappears because no information is sent backward in time; rather, the network's routing must be described relative to the full set of boundary constraints. The delayed-choice effect is therefore a consistency-driven reinterpretation, not literal retrocausality.

$$\begin{aligned} Delayed - choice&: late\ constraint\ injection \\ &\rightarrow\ \ global\ routing\ consistency \\ &\rightarrow\ \ apparent\ retrocausality \end{aligned}$$