Syntropy Time Crystal State: Gate Coherence Quantum Simulations

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This article presents a paradigm shift: the Time Crystal as a Syntrodynamic State. We propose the syntropic time crystal and syntrodynamic coherence teleportation theory (SCTT), a mathematical model in which information is encoded not in static spatial configurations, but in the temporal structure of matter itself. Central to this framework is a new 13-dimensional real algebra C_{11}, defined by a dual algebraic structure where conjugate imaginary units i and j satisfy the fundamental relation j = 1/i. This duality creates a split-complex sector allowing information to be represented simultaneously in entropic and syntropic forms. The algebra embeds naturally into twistor space via the Penrose transform, where quantum states become holomorphic sections and teleportation manifests as null-geodesic propagation along a Lorentzian information manifold with metric ds2=dS2-d Σ2.

We construct a mapping from this algebra into quantum circuits via a compiler pipeline–the Hopf Gold Simulation Framework–which translates higher-dimensional algebraic structures (including X(11) modular geometry) into executable unitary operators. These operators are embedded into Floquet-engineered quantum circuits and evaluated using GPU-accelerated statevector simulation. To overcome the exponential memory bottleneck inherent in classical quantum simulation, we implement a heterogeneous parallelization architecture combining CPU memory capacity with GPU computational throughput. The system leverages high-bandwidth tensor operations on NVIDIA H100 GPU while extending qubit capacity through distributed CPU memory allocation. This hybrid model enables simulation of larger Hilbert spaces while preserving performance-critical GPU execution paths. Simulations were executed using a GPU-accelerated quantum backend (Qiskit Aer with CUDA/cuQuantum integration), achieving numerical state fidelities exceeding 0.9999998 over 100 Floquet cycles, validating the stability of syntrodynamic states. The resulting dynamics exhibit a π-spectral gap characteristic of robust time-crystalline order, with decoherence suppressed exponentially via frequency-domain encoding.

Gate operations preserving this structure correspond to knot invariants–specifically Jones polynomials at q=e2 πi/11. We identify the prime number n = 11 as optimal for balancing minimal redundancy with maximal topological protection, leveraging the arithmetic geometry of the modular curve X(11). We detail the construction of the syntrodynamic state, its stabilization via Floquet engineering, and the emergence of a π-spectral gap that provides exponential suppression of decoherence. Furthermore, we explore the Quantum Theory of Frequencies Information, where information is encoded in stable frequency modes.