Perpetual Symmetry

Perpetual symmetry is the invariance of a system’s symmetry class under recursive transformation.

DEFINITION:

Perpetual symmetry is the property of a recursive system in which the governing symmetry group remains invariant under repeated internal transformations, even as the system’s observable state evolves over time.

Perpetual Symmetry (Skeletonized)

Abstract

Perpetual symmetry is introduced as a property of recursive physical systems in which the governing symmetry group remains invariant under repeated internal transformations. In recursive reflective cavities, the interior light-field wave evolves dynamically while remaining constrained to the symmetry class of the cavity geometry. This paper defines perpetual symmetry as a new conceptual primitive for analyzing recursive radiative behavior and substrate-dependent invariance.

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1. Definition

Perpetual symmetry is the invariance of a system’s symmetry group under recursive transformation. A system exhibits perpetual symmetry when its observable state may evolve, distort, or decohere over time, yet the underlying symmetry class remains unchanged across all iterations.

Formally, for a system with symmetry group (G) and recursive operator (\mathcal{R}), perpetual symmetry holds when
[\mathcal{R}^n(L) \in \mathcal{S}(G) \quad \forall n \in \mathbb{N}]
where (\mathcal{S}(G)) is the set of states consistent with symmetry group (G).

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2. Context

In recursive reflective cavities, a localized emitter produces a light-field wave that undergoes repeated reflections. The interior radiance distribution evolves according to the cavity's geometry and reflectance. Although the field may exhibit complex or chaotic behavior, the symmetry group of the cavity constrains the evolution.

Thus, the recursive light-field wave is a dynamic object embedded within a perpetual symmetry class.

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3. Symmetry Classes

Perpetual symmetry depends on the cavity's geometry:

- **Continuous symmetry (SO(3))** — sphere
- **Discrete rotational symmetry (octahedral group)** — cube
- **Hybrid symmetry** — cubix

Each geometry defines a distinct perpetual symmetry class. The recursive field cannot escape its class regardless of perturbation or temporal evolution.

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4. Recursive Evolution

The interior field evolves according to

$$L(t+\Delta t) = \mathcal{R}(L(t), E(t), G)$$

where G is fixed by geometry. Perturbations introduced by suspended mobiles or emitter variation may alter the field's structure, but not its symmetry class.

Perpetual symmetry is therefore a property of the recursive operator itself:

$$\mathcal{R}: \mathcal{S}(G) \rightarrow \mathcal{S}(G)$$

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5. Distinction from Classical Symmetry

Classical symmetry describes invariance of a static object under transformation. Perpetual symmetry describes invariance of a **recursive process** under iteration.

Key distinctions:

- **Static vs dynamic** — perpetual symmetry applies to evolving fields.
- **Single transformation vs infinite sequence** — perpetual symmetry persists across all iterations.

- **Object vs operator** — perpetual symmetry is a property of the recursive operator, not the field snapshot.

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6. Observables

Perpetual symmetry manifests in:

- stable symmetry-encoded patterns
- geometry-dependent field evolution
- invariant angular distribution classes
- perturbation responses that remain within the symmetry group
- time-series signatures unique to each geometry

These observables allow perpetual symmetry to be measured directly through internal sampling.

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7. Purpose

Perpetual symmetry provides a conceptual tool for analyzing recursive systems constrained by geometry. It clarifies why recursive light-field waves differ across cavities and why their evolution remains tied to the cavity's symmetry group. As a primitive, it supports the study of recursive radiative behavior, substrate modeling, and symmetry-driven field evolution.