

Recursive Reflective Cavity

Abstract

A recursive reflective cavity (RRC) is a bounded reflective geometry designed to induce repeated internal reflections that generate a self-interacting radiative field. This paper defines the RRC as a new class of optical environment for producing and studying light-field waves.

1. Definition

An RRC is a cavity (C) with interior surface (∂C) exhibiting symmetry group (G), containing a localized emitter and optionally an internal sensor. The cavity's purpose is to induce recursive radiative behavior.

2. Reflective Boundary

The boundary is characterized by reflectance ($R(\lambda)$) and geometric symmetry. The symmetry group determines the transformation properties of the recursive field and the stability or instability of emergent patterns.

3. Internal Emitter

A localized emitter ($E(t)$) produces radiance ($L_E(\lambda, t)$). The emitter may vary in spectrum or intensity, providing a controllable input to the recursive system.

4. Recursive Interaction

Light undergoes repeated reflections on (∂C), producing a sequence of radiance fields

$$[L_1, L_2, L_3, \dots]$$

Each field is a transformation of the previous under the cavity's geometry and reflectance.

5. Field Evolution

The cavity induces a recursive radiative operator

$$[L(t) = \mathcal{R}(L(t-\Delta t), E(t), G)]$$

This operator defines the evolution of the interior light-field wave.

6. Distinction from Classical Optical Cavities

Traditional cavities aim to stabilize or suppress recursion (e.g., laser resonators). An RRC is designed to amplify, reveal, and study recursive behavior. Its purpose is exploratory, not stabilizing.

7. Observability

An internal sensor may record the time-series

$$[I(t) = S[L(t)]]$$

providing a measurable projection of the recursive field.

8. Purpose

The RRC is introduced as a new environment for generating and studying light-field waves.

It provides a controlled setting for exploring recursion, symmetry, and field evolution.