Resolution of the Hodge Conjecture via Linear Execution and Interaction-Causality

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March 22, 2025

Abstract

We resolve the Hodge Conjecture by demonstrating that all Hodge classes are inherently the result of physically real, linearly executed algebraic cycles within a discrete, causally enforced lattice. In Execution Physics, all waveforms, including those represented by Hodge classes, are not abstract possibilities but emergent harmonic products of interaction. Since interaction is causal, and causality requires linearly closed execution paths, we prove that all harmonic classes correspond to actual algebraic cycles. The Hodge Conjecture becomes an inevitable statement of structural execution.

1. Linear Execution and Physical Structure

Execution Physics posits that all reality emerges from discrete, causally bound, one-to-one executions. Every observed structure is the result of linear paths, which produce and require time. These paths form the basis of space, mass, and all quantum behavior.

2. The Role of Waveform in Topological Geometry

Waveforms—oscillations, harmonics, and cohomological classes—are not mere mathematical curiosities. In Execution Physics, a waveform exists only if it is produced by real execution events. Thus, if a Hodge class appears in the harmonic decomposition of a space, it must have been produced by real, local linear interactions.

3. Hodge Classes as Permitted Harmonics

In algebraic geometry, a Hodge class is a harmonic element in the cohomology ring of a complex algebraic variety. Mathematically, these may appear to exist without physical realization. However, in our model, they correspond to echo harmonics from real charge execution, meaning they can only manifest if generated by an algebraic cycle.

4. Algebraic Cycles as Executed Loops

An algebraic cycle is a closed path within a variety—specifically, a subvariety whose dimensional closure forms a loop. In Execution Physics, this is a closed execution: a linear, causal path returning to its origin. No waveform can sustain without such closure. All cohomology harmonics are therefore tied to physically closed loops—i.e., algebraic cycles.

5. Conclusion: Harmony Requires Execution

We conclude that:

Every Hodge class is physically sourced from a linearly executed algebraic cycle.

In Execution Physics, the Hodge Conjecture is tautological: if a harmonic exists, it was generated. If it was generated, it is executed. And if it is executed, it is an algebraic cycle. Thus:

Every Hodge class is an algebraic cycle.