

Section 1 Introduction

This paper serves a specific role in the CUWF A-series: it is the vacuum-baseline module. The objective is not to add a new interpretive slogan to the existing discourse (“the vacuum is not empty”), but to reconstruct what the vacuum baseline is as a physical object in CUWF terms so that finiteness is achieved by structure rather than by post-hoc subtraction.

In standard quantum field theory (QFT), the vacuum is the ground state of quantized fields and its structure can be probed through boundary- and coupling-dependent effects. However, when the vacuum baseline is treated as an absolute sum over mode-wise zero-point terms without a structural notion of physical accessibility, the bookkeeping becomes formally divergent. When this unbounded baseline is then naively connected to cosmology, it motivates the well-known cosmological constant problem: an extreme mismatch between naive vacuum energy density and the small observed baseline term that cosmic expansion appears to contain.

CUWF changes the problem statement. The key move is to anchor the vacuum to a substrate concept already defined in Paper A-3 (Entropic Geometry): the Fundamental Background Wave (FBW), also referred to here as the Fundamental Wave Background (FWB). In this paper, ‘degrees of freedom (DOF)’ are defined not as an unlimited list of formal modes, but as physically accessible micro-configurations of the FWB baseline under structural constraints. Vacuum fluctuations are interpreted as bounded exploration within an accessibility manifold. This enables a finite baseline by construction and motivates an operational macroscopic response parameter: finite entropic pressure.

The paper is written to be readable by multiple audiences. It separates (i) what is already well-established in standard physics and preserved as an effective layer, from (ii) what CUWF proposes as a substrate-level completion for baseline finiteness and for the emergence of a Λ -like term.

Reader roadmap:

Sections 1–3 frame the problem and eliminate common term confusions early.

Section 4 anchors the vacuum DOF concept in the CUWF substrate (FWB/FBW) as defined in Paper A-3.

Sections 5–8 present the CUWF vacuum axioms and reconstruction path: DOF fluctuations, structural boundedness, finite entropic pressure, and a finite interpretation of zero-point energy.

Section 9 interprets the cosmological constant Λ as a macroscopic imprint of baseline structure rather than a residue of canceled infinities.

Sections 10–13 provide consistency checks, positioning relative to QFT/GR, empirical handles, and a targeted FAQ to pre-empt predictable misreadings.

Section 14 concludes with what is achieved, what is deferred, and how A-11 connects to A-14 (gravity as entropic descent) and to CUWF cosmology modules.

Scope note: A-11 is intentionally not a full cosmological fitting paper. It aims to make the vacuum baseline well-defined in CUWF terms so that subsequent work can specify explicit operators, derive quantitative mappings, and confront data without relying on 'infinity then cancellation' narratives.