# Universal Modular Dynamics (UMD): Major Evolutionary Stages of Emergent Structure

*Visual Atlas from the Density Operator $\rho$ and Modular RG-Proxy Flow*

Nesen Oleg

## Abstract

This visual atlas presents the UMD program as an RG-style *storyboard*: (i) canonical state representation by the density doperator $\rho_e$ (ii).: modular generators and CPTP modular RG-proxy flow; (ii) operational locality via the block total correlation $T\gamma^{78}(\rho)$. (ivi) emergent geometry from correlation graphs and its stability; (vi) matter-like spectral modes (including a conservative Higgs-as-reshaping interpretation); (vi) gauge patching and holonomy lopp tests; and (vii) dark-sector and *vacuum proxies* including $\Lambda_{Ep}$. Each figure is placed on its own page with a short operational caption.

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## How to read the atlas

UMD is presented as a measurement–flow program. We start from $\rho$, build canonical functionals and modular generators, evolve by CPTP modular RG-proxy dynamics, and interpret emergent notions only in stable domains (*geometry* is meaningful *only when certified by stability criteria*).

## Legend of symbols (minimal)

- $\rho$ — density operator, $\rho \geq 0$, $\mathrm{Tr}\rho - 1$.
- $K = -\log\rho$ — modular generator (on $supp(\rho)$).
- $A_F$ — access algebra; $Z_{IF} \subset A_F$ — pointer/center.
- $P^*$ — protocol-defined optimal partition (stable charting).
- $T_p^{\pi s}(\rho) = D(\rho)$ II $\gamma = P i)$.
  — operational locality (**distinguishability gap**).
- $\Lambda_{IIF}$ — normalized entropic vacuum proxy; $R_{\Gamma}$ — *backreeation resiual.*

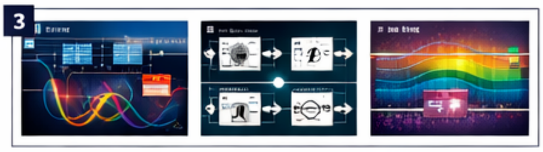

Fig 2. Program ladder and anchors: $\rho$ — K —CPTP flow; locality and geometry (multi-panel).

Fig 3. Diagnostics and stability overlays (multi-panel).

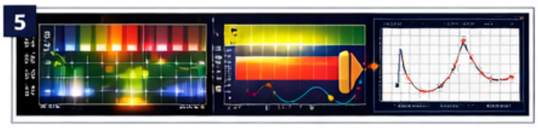

Fig 4. Matter as stable modular spectral bands: mass proxy $m_{\epsilon\eta} = \Delta k$.

Fig 6. Dark sector and ($\Lambda_{\Pi}$, $R_{\theta}$) separation (two-panel).

Fig 2. Locality as $T\mathcal{I}$ (i0), distinguishability gap between $\rho$ and best blook product desarphion.

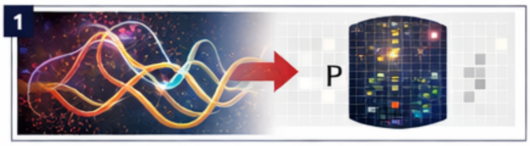


Fig 0. Minimal RG start: *interacting degrees of freedom* — canonical state $\rho$.

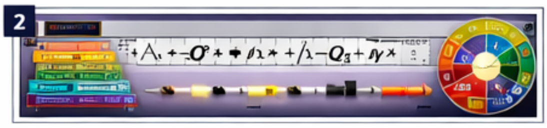

Fig 1. RG timeline strip and master poster (equation + module wheel).

Fig 3. Program ladder and anchors: $\rho$ — K — CPTP flow; locality and geometry (aun-prann

Fig 4. Matter as stable modular spectral bands; mass proxy $m_{\epsilon\eta} = \Delta k$,

Fig 5. Higgs (conservative): controlled spectral reshaping and mass reorganization of stable **bands**.

## References (baseline)

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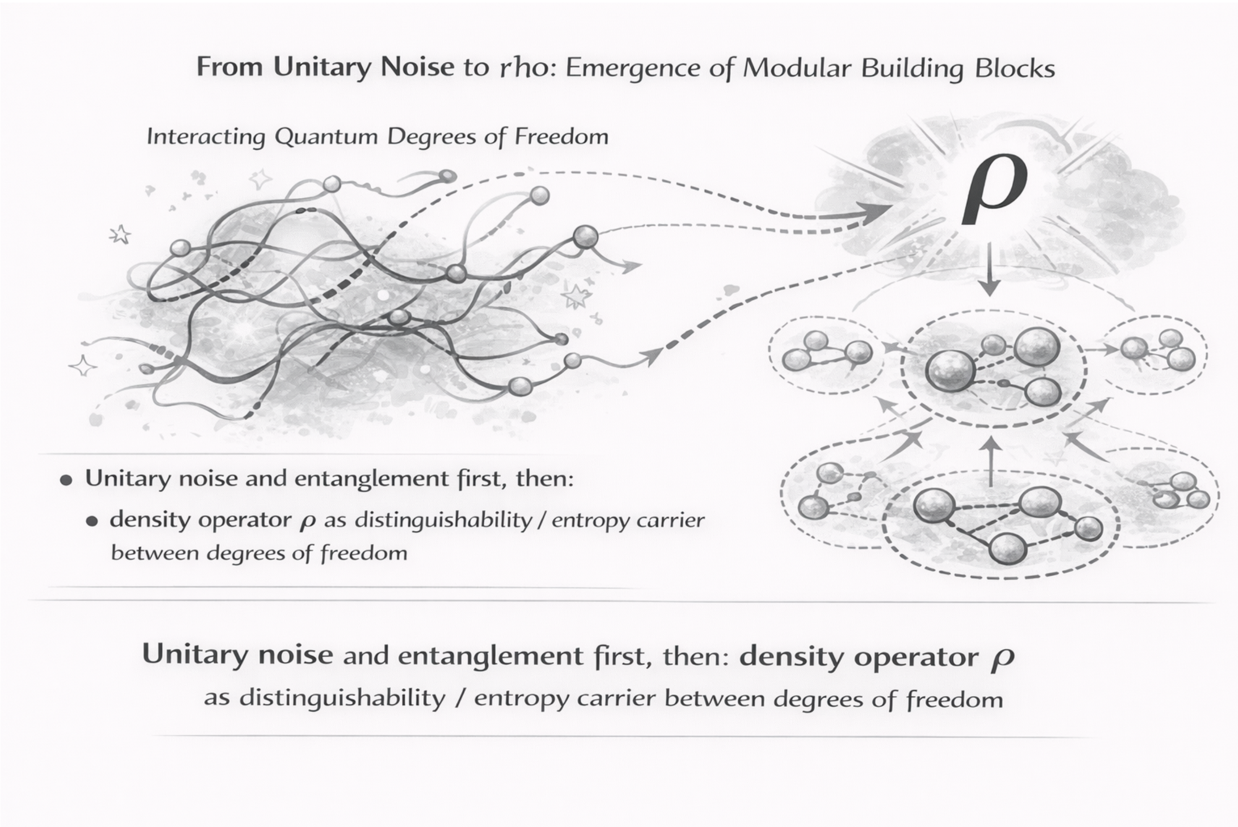


Fig 0. Minimal RG start: interacting degrees of freedom → canonical state ρ.

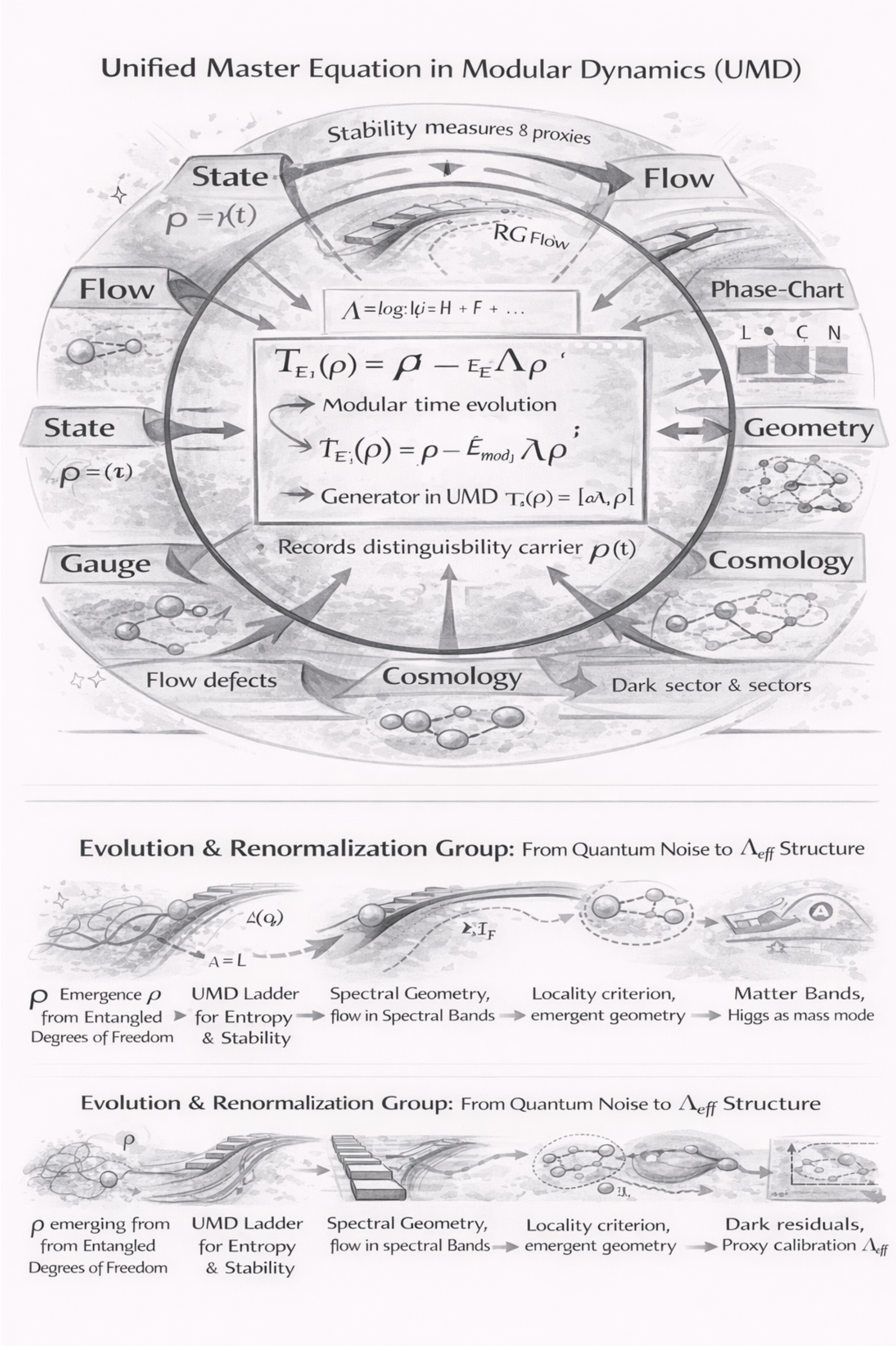


Fig 1. Timeline strip and master poster (equation + module wheel).

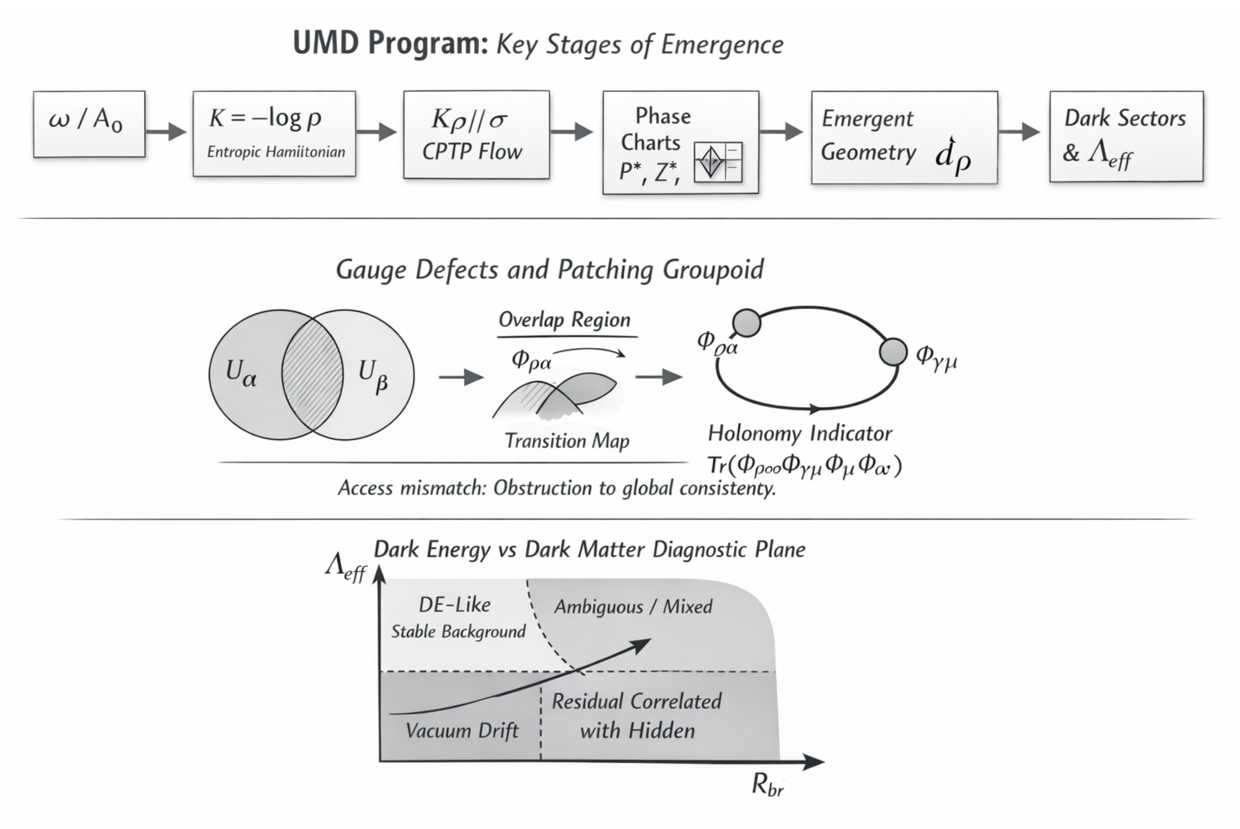


Fig 2. Program ladder and anchors (three-panel overview).

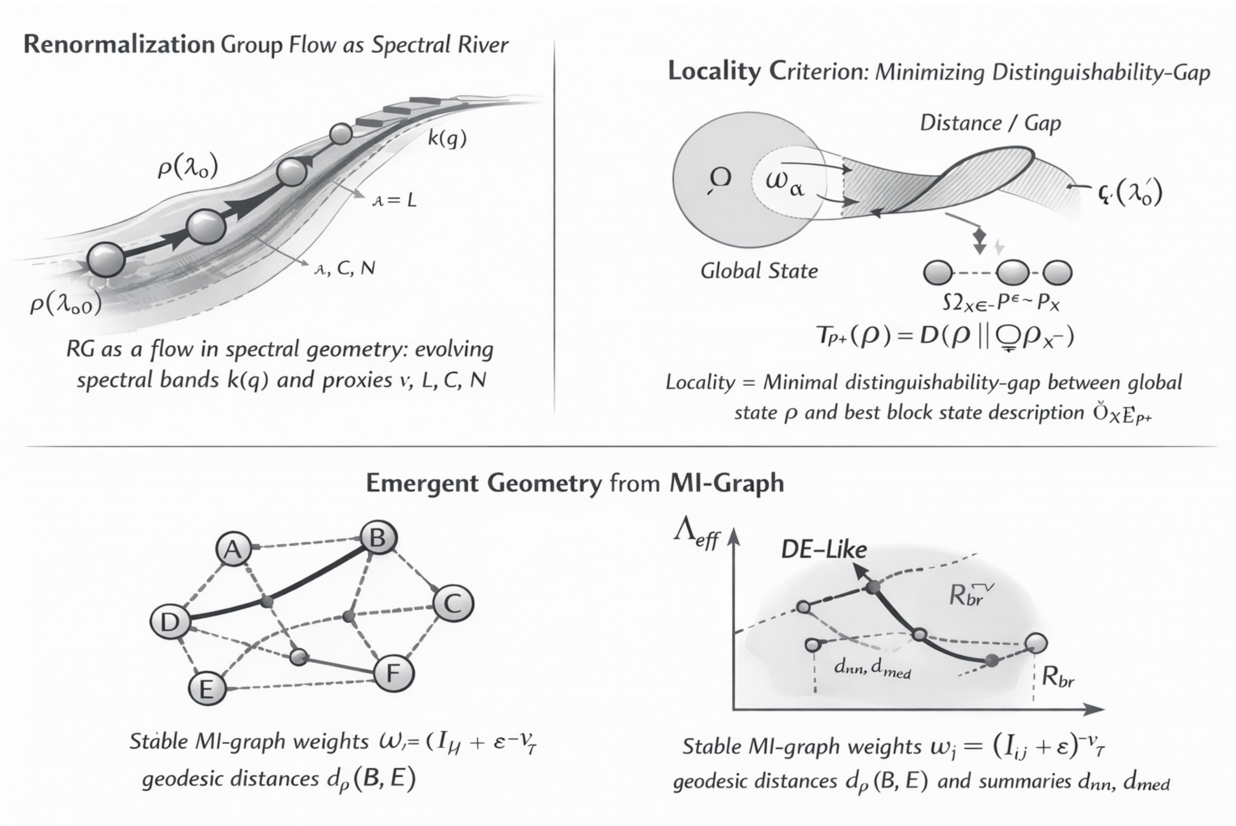


Fig 3. Diagnostics and stability overlays (three-panel overview).

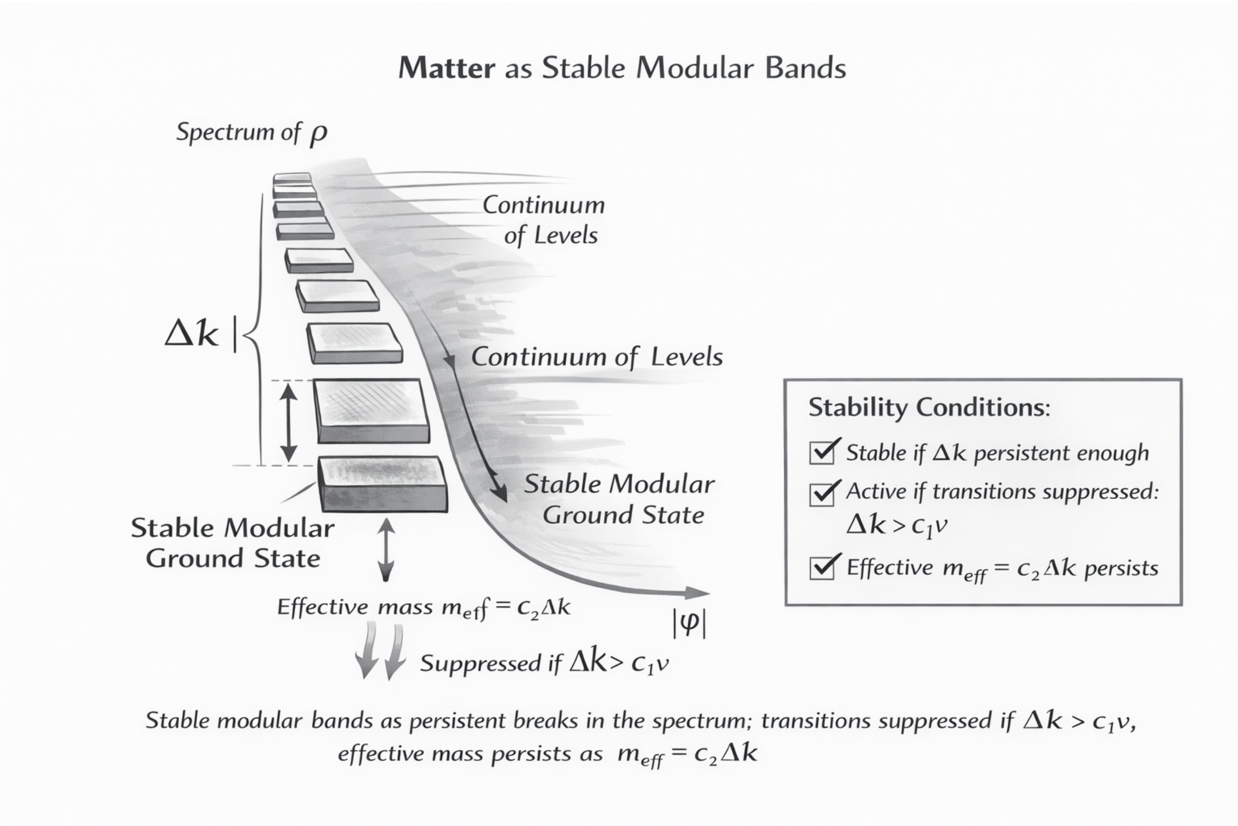


Fig 4. Matter as stable modular spectral bands; m_eff ∝ Δk.

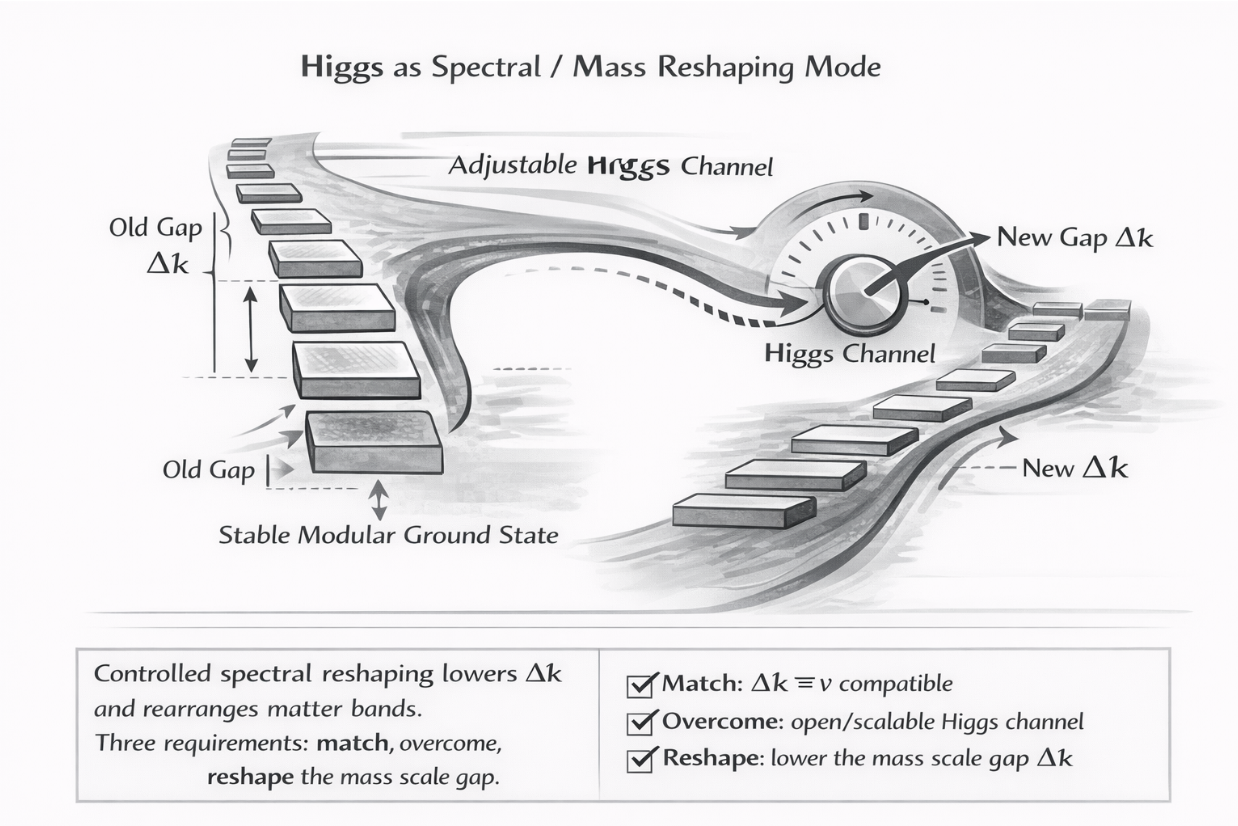


Fig 5. Higgs (conservative): controlled spectral reshaping / mass reorganization.

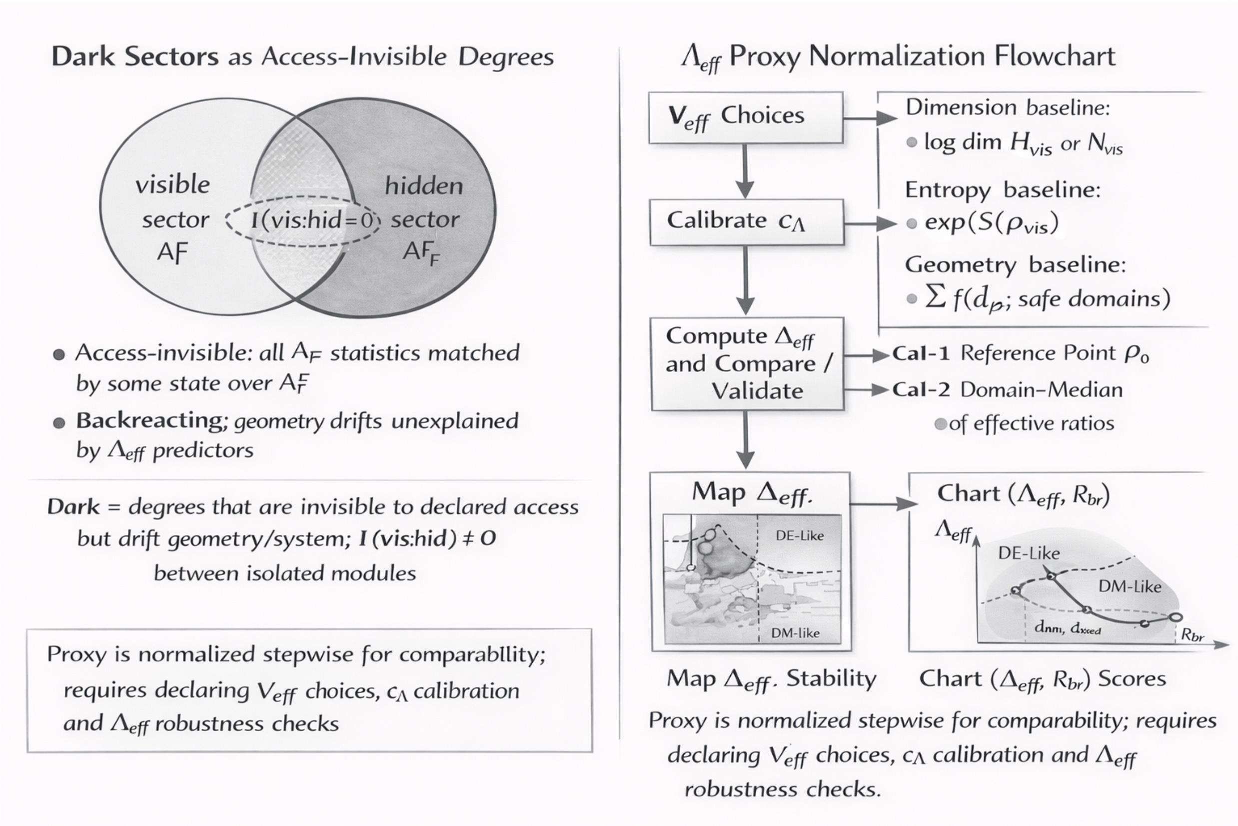


Fig 6. Dark sector + Λ_eff separation plane (conceptual two-panel).

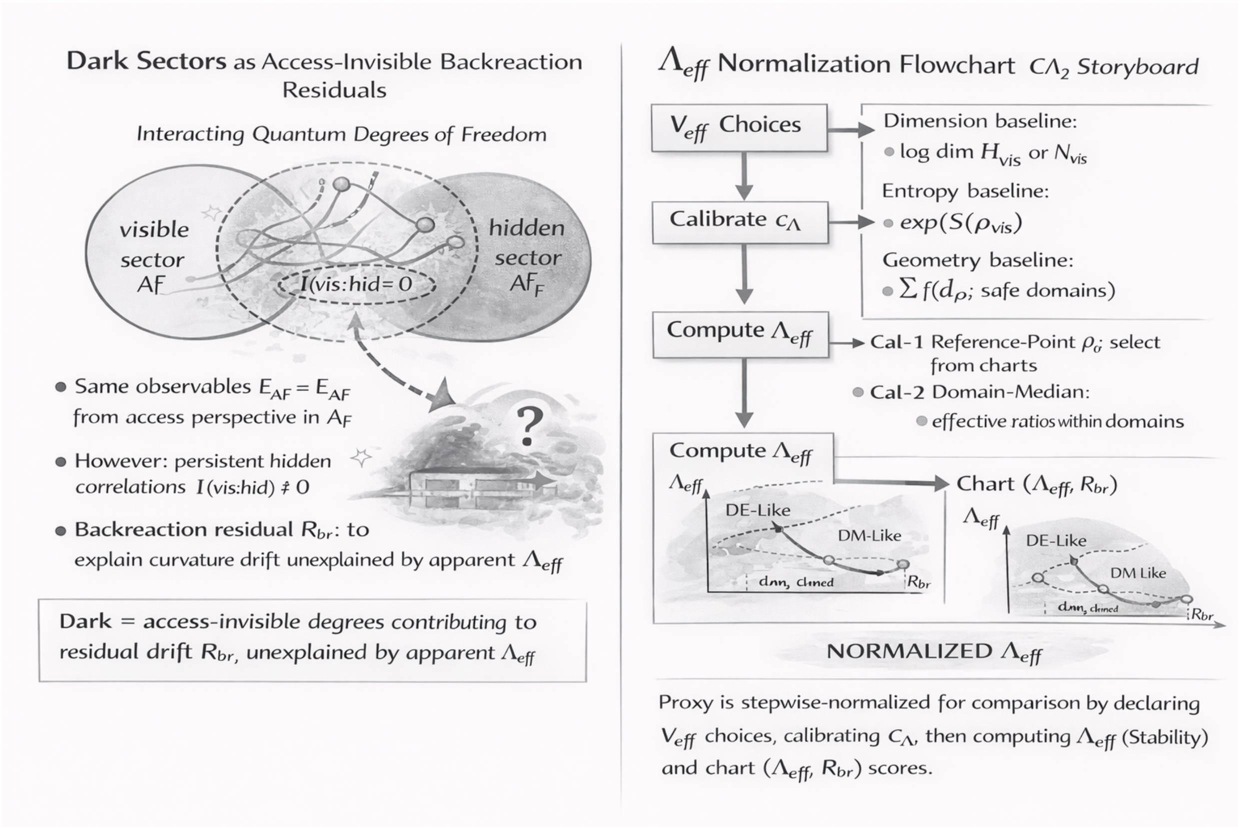


Fig 7. Normalization / pipeline storyboard (CΛ2).

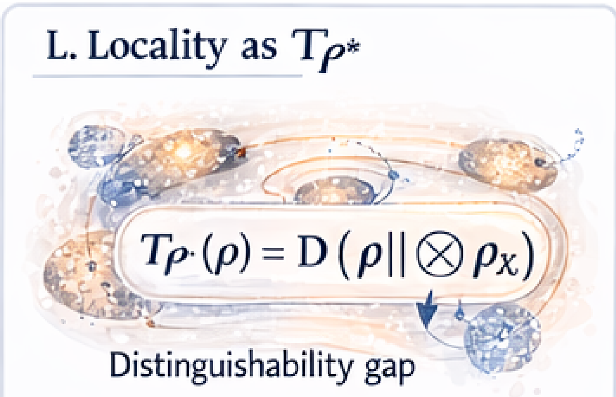


Fig 8. Locality as 𝒯_{P*}(ρ): distinguishability gap functional.

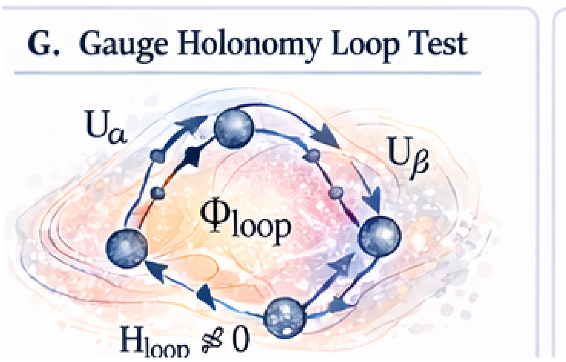


Fig 9. Gauge holonomy loop test: groupoid patching signature.

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