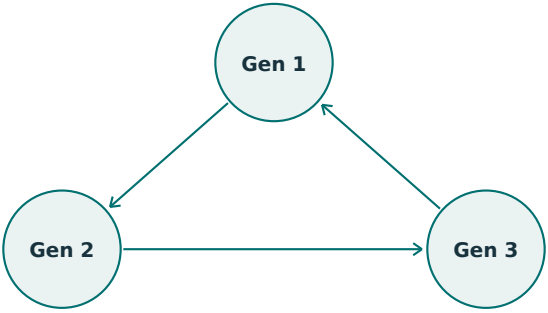
PRELIMINARY PAGES

K.E.Y.C.H.A.I.N. & V.A.S.K.

InteractionSpace, Activation & the Z-gate

Magnus Randa Esq.

Vector Activation Subspace Keying



InteractionSpace Primal, SpaceTime Emergent

TRIAL EDITION 01 / 14 OCTOBER 2026

256 PDF pages: eight preliminary pages followed by the 248-page public book/manual.

PRELIMINARY PAGES

Edition & authorship

Prepared for Magnus Randa Esq. and ALLALONG&AFTERALL. This trial edition consolidates the project into a public-facing, modular technical manual. It is supplied for editorial and technical inspection before any final publication.

The framework and its source lineage are attributed to Magnus Randa. This draft was compiled with AI-generated drafting, human-supplied source material and scripted finite checks. Mathematical background is attributed in the reference section. These credits do not imply that cited researchers endorse the project.

The edition distinguishes defined premises, verified finite calculations, implemented software and proposed physical connections. A trial layout or a published record does not independently establish the physical interpretation.

No ISBN is assigned by this draft. Original authorial material and third-party works retain their respective rights. The diagrams were constructed for this edition; the supplied screenshots were used as source evidence and are not reproduced as interior artwork.

Trim: 4 x 9 inches. Numbering: preliminary i-viii; manual 001-248. A physical print proof and publisher-specific prepress checks remain part of the final production process.

PRELIMINARY PAGES

Preface to the trial edition

The purpose of this book is to make K.E.Y.C.H.A.I.N. and V.A.S.K. inspectable. The key-and-lock language introduces a proposed interaction architecture; operators and fields then give the language a calculational meaning. The Z-gate provides the central finite construction.

The account follows the organising doctrine InteractionSpace Primal, SpaceTime Emergent. It begins with permissions and internal states, develops activation and generation operations, and records the proposed route towards matter, geometry and cosmology.

The reader is given the equations needed to repeat selected checks. A matrix action, scalar-potential derivative or geometric measure can be verified within its stated assumptions. The book also records the physical maps and coefficients still needed to turn those constructions into predictions.

A structured manual should make progress reversible. Definitions have locations; alternative versions are labelled; calculations have inputs; open tasks have a register. This trial edition applies that discipline to the project without asking the reader to reconstruct a long chat history.

Read the conceptual route first if the notation is unfamiliar. Use the calculation route and equation register when inspecting a specific result. Both routes belong to the same 248-page manual.

PRELIMINARY PAGES

Reading routes

The manual uses four-page learning units. Each unit introduces a purpose, states the construction, performs a check and explains the result. The four preliminary foundation units establish the reading conventions used by the fifty principal modules.

Concept route | F01-F04; M01-M06; M11; M25-M28; M35-M40; M43-M45

Calculation route | M08-M10; M12-M18; M20-M24; M26-M32; M37-M38; M46-M49

Research route | M02; M15-M16; M24; M29-M34; M41-M45; M49-M50; claim ledger

Every route can be followed within this volume. External references document the background; the relevant definitions and worked calculations remain on the manual pages. PDF bookmarks and module cross-references provide navigation.

An index entry identifies a module start. The unit is four pages long, so read all four pages before carrying its conclusion into another part of the framework. The phase labels identify explanation, construction, calculation and interpretation.

Continue with: F01 / M25 / M46

PRELIMINARY PAGES

Contents / foundations to Z

Manual 001-016 | Foundations | F01-F04

Manual 017-040 | Orientation | M01-M06

Manual 041-064 | Permissions & observables | M07-M12

Manual 065-088 | E8 substrate | M13-M18

Manual 089-112 | Activation & dynamics | M19-M24

Manual 113-152 | Z-gate | M25-M34

The Z-gate section contains ten units: generation subspaces; forward shift; reverse cycle; Fourier basis; full-space extension; full-action spectrum; symmetric Hamiltonian; mass matrices; physical time; automorphism identification.

The contents use manual page numbers. Add eight to obtain the physical PDF page number. Manual page 001 is PDF page 9. The viewer page labels already distinguish the preliminary pages from the numbered manual.

Continue with: F01 / M01 / M07 / M13 / M19 / M25

PRELIMINARY PAGES

Contents / geometry to references

Manual 153-176 | Geometry & projection | M35-M40

Manual 177-196 | Matter & gravity | M41-M45

Manual 197-216 | Checks & tests | M46-M50

Manual 217-224 | Glossary & symbols

Manual 225-228 | Equation register

Manual 229-236 | Claim ledger & open tasks

Manual 237-244 | Annotated references

Manual 245-248 | Encoding, provenance & production

The final thirty-two pages are part of the book material. They define terms, locate equations, record the research state and preserve reproducibility information. They are not blank forms or extra preliminary pages.

This trial edition contains 248 numbered manual pages exactly. Its eight preliminary pages give title, authorship, preface, navigation, contents and notation without using the manual budget.

Continue with: M35 / M41 / M46

PRELIMINARY PAGES

Status & scope

DEFINED | A premise or construction selected for the model.

VERIFIED | A finite result reproduced under explicitly stated assumptions.

IMPLEMENTED | Executable behaviour available and actually run.

PROPOSED | A physical connection or consequence awaiting completion or testing.

LEGACY | A preserved earlier formulation outside the current account.

TOSS | Removal only after author verification; source history is retained.

A status applies to the identified claim. The projector algebra can be verified while its physical assignment is proposed. A working program can implement an equation while the equation remains a defined model choice.

Where a module contains several scopes, the text states them locally. The status in the running header identifies the module’s main task and does not certify every interpretation mentioned on its pages.

The claim ledger supplies concrete completion conditions. This preserves continuity from the source history to the trial manuscript and later editions.

PRELIMINARY PAGES

Notation & page convention

H_int denotes the internal Hilbert block. Psi is its state; rho is a density matrix. Pi_a selects a sector. K_p is a weighted composite permission. P_a is an occupation probability. Alpha_a is an independent activation where the selected formulation defines it that way.

H is a Hamiltonian with energy units. Z is a dimensionless unitary structural operator. Tau is effective proper time where a metric is supplied. A cell edge, radius and reference length are distinguished in geometric formulas.

Natural-unit equations set hbar and c to one only when their dimensional meaning is retained. Physical length and energy comparisons require a scale. Hypercharges in the listed all-left-handed Standard Model family use Q = T3 + Y.

The fixed book count is an editorial constraint, not a physical deduction. The Z-gate section occupies manual pages 113-152. The final manual page 248 is physical PDF page 256. No blank padding pages are included.

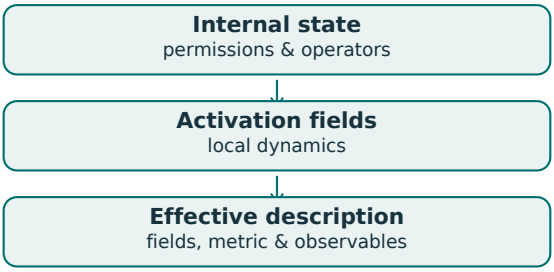
The trial uses embedded substitute fonts for the preferred final heading typeface. Final typography and publisher-specific production settings remain edition decisions.

A framework that readers can inspect

V.A.S.K. starts with a proposed ordering of explanation: interaction structure is primary, while spacetime is an effective description to be recovered. The reader's task is to understand the proposed ingredients before deciding what they explain. A useful manual gives every ingredient a name, a mathematical role and a boundary of application.

An ontology says what the model takes to exist. A dynamical law says how its states change. A measurement rule says how a state produces an observable result. These are separate parts of a scientific description. A statement in one part cannot silently replace a calculation in another.

Throughout this edition, equations are accompanied by their scope. An exact matrix identity is a mathematical result; a claim that the same matrix governs a particle interaction requires a physical mapping. Keeping the mapping visible lets a reader follow the argument without accepting an unexplained jump.



The three obligations

The proposed internal state belongs to a complex Hilbert space. Operators specify possible permissions and transformations. An effective spacetime description introduces coordinates, a metric and local fields. Observables connect these mathematical objects to measurements. The full framework needs a consistent relationship between these ingredients.

Boundary and initial conditions are part of a model. Even when an evolution equation is fixed, different initial states may produce different outcomes. A numerical prediction therefore needs the state, coefficients, units and conditions as well as the equation. Listing only a symmetry group is insufficient to reproduce an evolution.

A result becomes checkable when another reader can recover its inputs and repeat its calculation. That requirement is applied to the worked algebra in this book. It is also the standard to apply to the proposed physical consequences.

$$\mathcal{H}_{\text{int}} \simeq \mathbb{C}^{248}$$

Reading a complete calculation

Begin with the definition of the object being calculated. Identify whether each symbol denotes a number, vector, operator, field or coordinate. Check that the operation is defined on the appropriate space. Matrix multiplication, differentiation and taking an expectation value are different operations with different outputs.

Then check dimensions. A Hamiltonian carries energy units; a dimensionless activation is not an energy by itself. A probability is dimensionless and lies between zero and one. A spatial volume and a surface measure have different units even when the same radius appears in both.

Finally compare the calculated output with the stated conclusion. An eigenvalue calculation may establish a spectrum but leave the identification of those eigenvalues as masses unresolved. This procedure provides an inspection route through every technical module.

CHECK: Identify the inputs, calculate the output, and state exactly which conclusion follows.

The role of the trial edition

This edition presents a defined architecture, selected finite checks and a programme of physical calculations. It records open connections alongside the constructions they would connect. A reader can therefore use the book as an introduction, a technical reference or an inspection guide.

The manuscript does not use the length of the book as evidence. The 248-page manual is an editorial choice associated with the adjoint dimension. Its equations retain the same mathematical meaning on a shorter or longer page layout. Scientific assessment depends on the definitions, derivations and observations.

Review the status of each assertion before carrying it into another module. Preserve a distinction between a chosen premise and its demonstrated consequences. This is particularly important when moving from the key-and-lock language to operator algebra, and from internal transformations to spacetime interpretation.

CHECK: Inspection case: an eigenvalue is labelled a measured mass. First identify the operator and its units. Then locate the field normalisation and readout map. Keep the eigenvalue VERIFIED within the matrix calculation; retain the mass interpretation as PROPOSED until that mapping is supplied.

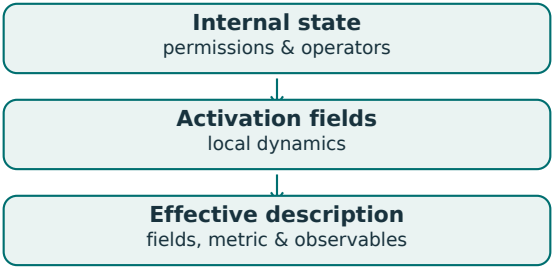
Continue with: F02 / F03 / M01

The organising doctrine

InteractionSpace Primal, SpaceTime Emergent is the organising doctrine of V.A.S.K. It places the structure of possible interactions ahead of the spacetime description in the explanatory sequence. The doctrine states the intended direction of construction; the remaining work is to specify how the effective description follows.

The internal space is not a collection of visible directions. It labels components of a state and the actions of operators on those components. A spacetime coordinate instead labels an event in an effective geometry. Giving both structures mathematical names prevents their dimensions from being confused.

An emergence proposal must identify what is recovered, under which conditions and with what approximation. For example, recovering a metric requires a rule that produces the metric's components and causal character. A drawing of a projection can explain a proposal, but it does not supply that rule by itself.



Internal and external descriptions

The internal block is written as a 248-dimensional complex vector space. In a chosen basis, a state has 248 complex coefficients. A four-dimensional spacetime description has four real coordinates and a metric. These dimensions count different things and do not add up as ordinary spatial axes.

If an internal state is assigned at each spacetime event, the construction already uses a spacetime base. Such a field-on-spacetime formulation can be an effective limit of the doctrine. To claim a more fundamental derivation, the map that supplies the base and its geometry must also be defined.

The trial edition uses effective spacetime coordinates where the supplied equations require them. It marks the deeper emergence map as part of the research programme. This preserves useful calculations without hiding the distinction between a postulated effective background and a derived one.

$$x^{\mu} = (ct, x, y, z)$$

What a projection must specify

A projection has a domain, a target and a rule. A linear projection may remove components of a vector. A quantum measurement effect supplies probabilities. A coarse-graining map may retain selected observables while discarding inaccessible information. The word projection is used for several operations, so its local meaning must be stated.

For a spatial drawing, name the selected coordinate axes and their scale. For an operator projection, give the matrix or the subspace. For a proposed emergence map, state which geometric quantity is produced. These specifications determine whether the construction can be repeated.

Two maps can generate similar pictures while having different dynamics. A root diagram that looks like a spatial cell does not yet determine a kinetic term, coupling strength or gravitational equation. Those quantities need their own definitions and derivations.

CHECK: Ask: projection of which object, by which map, into which target?

Using the doctrine consistently

The doctrine is retained throughout the book as the intended architectural direction. It should guide the choice of questions: how do interaction permissions become effective couplings, how do state variables become fields, and how does the metric participate in that effective description?

Consistency requires a relationship in both directions when back-reaction is claimed. A metric may affect activation through covariant derivatives, while activation may affect the metric through stress-energy or a non-minimal coupling. The combined equations must then satisfy the relevant conservation identities.

The public explanation can remain accessible: start with the proposed interaction rules, then follow the conditions under which a spacetime description would emerge. The technical route checks the same sequence using operators, actions and observables.

CHECK: Inspection case: a projection diagram is labelled emergent spacetime. Identify its domain, target and metric. Ask whether the map actually produces the metric and field equations or merely draws a point cloud. The doctrine fixes the direction of explanation; the map supplies its calculational content.

Continue with: M05 / M46 / M49

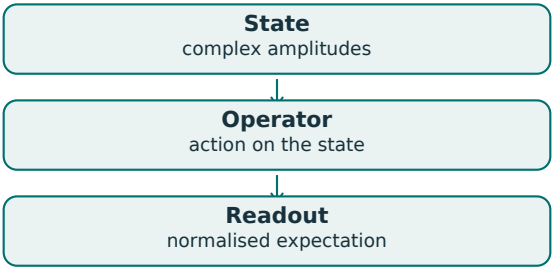
F03 / 1 OF 4

Naming the kind of quantity

A state vector is not a probability. A Hamiltonian is not a time coordinate. An activation is not automatically a coupling constant. Scientific notation is useful only when the kind of quantity remains clear. This module supplies the reading discipline used by the rest of the manual.

Complex amplitudes may interfere. Probabilities obtained from a suitable state and effect are real and bounded. Matrices act on vectors or other matrices; fields assign values over a base space. A derivative needs a variable and a domain. These distinctions prevent symbolic expressions from acquiring incompatible meanings.

The same letter may have several uses in the source history. The manual reserves the context explicitly: the Z-gate is an internal operator, while a drawn vertical axis is a spatial or activation coordinate. They may be related by a proposed construction, but their names alone do not establish that relationship.



F03 / 2 OF 4

A practical units convention

Use SI units when quoting a physical length, duration or energy. In field-theory equations, natural units with hbar and c set to one may simplify notation. Such a convention does not remove the dimensions of the underlying quantities; it changes how they are represented.

For a dimensionless activation alpha, its derivative has inverse-length units in a four-dimensional action. A kinetic coefficient with mass-squared units is then required if the potential has energy-density units. Writing only a dimensionless alpha beside a canonical kinetic term can hide this coefficient.

This edition distinguishes locking energies used in a Hamiltonian from coefficients in a spacetime potential density. Converting between them requires a volume or another specified normalisation. The conversion must be supplied before a mass formula can be evaluated.

$$[H] = E, \qquad [\alpha] = 1, \qquad [f^2] = E^2$$

Checking a proposed mass

A scalar mass is associated with a canonically normalised fluctuation and the curvature of its potential. If alpha is dimensionless and the kinetic coefficient is f squared, introduce a local fluctuation phi equal to f times the activation displacement around a stationary point.

The corresponding mass-squared is the potential's second derivative with respect to alpha divided by f squared, when the kinetic coefficient is locally constant and other fields do not mix. A coupled system requires a matrix version of this calculation. This result identifies the missing normalisation in many shorthand mass expressions.

The equation does not select numerical values for f or the potential coefficients. Those inputs need to be derived, specified or measured. The calculation becomes a physical prediction only after that input status is clear.

$$m_\phi^2 = \frac{V''(\alpha_*)}{f^2}$$

Evidence labels in use

DEFINED marks a construction chosen for the model. VERIFIED marks a finite result reproduced under stated assumptions. IMPLEMENTED marks available executable behaviour that has actually been run. PROPOSED marks a physical connection awaiting a derivation or test. LEGACY records a historical formulation outside the current account.

TOSS requires author verification before removal. Keeping source lineage makes revisions reversible. The public narrative can be edited for clarity while the original files retain their byte identities. A checksum supports that provenance, not the physical truth of a sentence.

Use the narrowest accurate label. A correct algebraic sub-result does not promote an entire cosmological mechanism to VERIFIED. A software run does not promote the model to established physics. Scope is part of the result.

CHECK: Inspection case: a dimensionless activation appears in a potential and is called a canonical scalar. Locate f squared in the kinetic term. Divide potential curvature by that coefficient when computing the single-field mass. Record units before inserting a numerical scale.

Continue with: M24 / M47 / M50

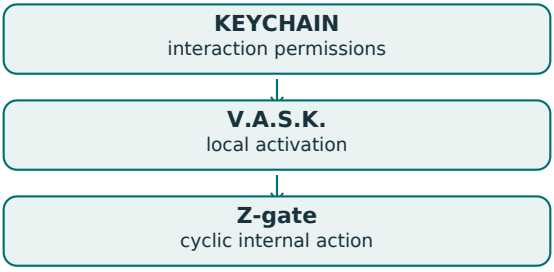
F04 / 1 OF 4

From a metaphor to operators

K.E.Y.C.H.A.I.N. introduces particles through their interaction permissions. A key denotes access to a sector; a keychain combines several permissions. V.A.S.K. adds local activation variables and a dynamical internal-state description. The Z-gate supplies a cyclic operation on a selected generation index.

The book follows that lineage without treating every older explanation as a present axiom. Source drafts used several names and several forms of the activation potential. An edited edition needs one explicit account of which version is being calculated. Alternative forms can remain as labelled variants.

The record also includes speculative physical interpretations and AI responses. These are useful for understanding how questions arose. Their confidence or repetition is not independent evidence. The manual extracts the definitions and calculations that can be stated clearly and inspected.



Keeping a stable vocabulary

The working expansion of V.A.S.K. is Vector Activation Subspace Keying. K.E.Y.C.H.A.I.N. is recorded as Kinetic Eigen-Yield Coupling of Hilbert-Axes Invariant Navigation in the supplied formulation. The acronyms identify the project; they do not determine a formula's validity.

The internal sector permission is denoted Pi_a. The species permission may be a weighted composite operator. Occupation is P_a when it is calculated from the state. Activation is alpha_a when it is independently defined as a local control field. The separation is retained even where older drafts used one symbol for two roles.

The generator H acts with energy units. Z is dimensionless and unitary on the specified space. Evolution uses an exponential or a differential equation involving H. These conventions keep a cyclic structural operation distinct from the physical duration of a transition.

$$g_{pa}(x) = g_a^{(0)} w_{p,a} \alpha_a(x)$$

Attribution and continuity

The E8 substrate, branching mathematics and sphere-packing background should be attributed to their established sources. The proposed combination and activation interpretation belong to the project described here. Claims that another scientist approves the proposal require an actual statement from that scientist.

A letter proposing a connection can be preserved as an authored proposal. It should not speculate about the recipient's private reasoning or substitute a narrative about their career for the current research literature. The references in this edition identify relevant primary papers.

Revision is constructive when it records the old definition, the reason for the change and the new calculation. This is especially important for the direction of the Z cycle and for the distinction between a diagonal matrix in an eigenbasis and a shift in the generation basis.

CHECK: Preserve the original source; identify the current definition; record the scope of the correction.

F04 / 4 OF 4

What the edition preserves

The edition preserves the organising doctrine, key-and-lock lineage, the 248-dimensional internal block, activation-dependent coupling rule, selected Z construction, geometry proposals and a programme of tests. It gives each a usable place in a single public manual.

Discarded numerical predictions are not restored to fill pages. An unsupported constant is not replaced by another number chosen to fit an observation. Where a derivation is incomplete, the book records the missing input or operation. That allows later editions to carry a genuine new result without rewriting the project's history.

The numbered modules and equation register provide continuity across versions. A reader can cite a specific module and calculation rather than a long conversation. This makes both public explanation and technical review more manageable.

CHECK: Inspection case: two source versions use the same name but different potentials. Preserve both originals. Identify which potential the current calculation uses, label the alternative and record why the choice was made. A stable name does not make two distinct equations equivalent.

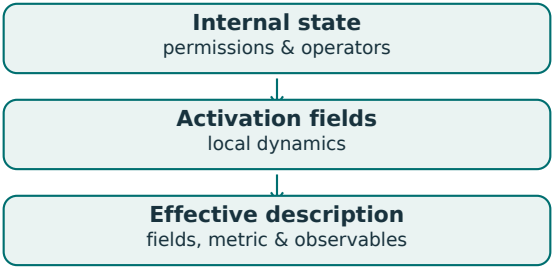
Continue with: M04 / M49 / M50

The proposed scope

V.A.S.K. aims to organise particles, interactions and effective spacetime within one framework. Its starting point is an internal state and a set of sector permissions. The interaction available to a species is expressed as a permission weight multiplied by a local activation and a sector coupling scale.

This scope includes several levels of description. The internal block carries algebraic structure. Local fields describe how activation may vary. Effective matter and gauge equations connect the structure to particle behaviour. A gravity proposal connects it to a metric and stress-energy. Each connection has an explicit obligation.

The manual can explain the architecture before those obligations are all completed. Doing so requires accurate status labels and calculable examples. The central examples concern projector algebra, the cyclic Z action, potential derivatives, geometric measures and the anomalies of a stipulated fermion family.



Ingredients with distinct jobs

The state vector contains amplitudes. A sector projector selects a subspace. A permission weight identifies which sector contributes to a species. An activation field supplies the proposed local modulation. A bare coupling scale supplies normalisation and must be specified if a numerical strength is to be predicted.

The equations must also explain what carries momentum, what makes a field local and how gauge transformations act. An internal vector by itself is not a complete field theory with all spatial modes. The internal block can be part of that theory, but the additional structure must be named.

The aim is therefore an internally organised route to an effective description. Every claim of unification should identify which structures have already been related and which have only been placed alongside one another.

$$|\Psi\rangle = \sum_{i=1}^{248} c_i |e_i\rangle$$

Inspecting the coupling rule

The rule g_pa equals g_a zero times w_pa times alpha_a is useful because it separates three inputs. A zero permission weight removes the specified coupling regardless of activation. A zero activation removes it in that effective rule even when the permission is present. A nonzero product makes the coupling scale relevant.

This is a definition, not a derivation of the observed coupling constants. If the bare scale is undetermined, the effective value is undetermined. If the activation varies with time or position, its equation and initial conditions are required to predict that variation.

No propagation speed follows from the multiplication alone. A speed is obtained from the kinetic and dispersion structure of a specified effective field equation. The later modules maintain this distinction.

$$w_{p,a} = 0 \implies g_{pa} = 0$$

$$\alpha_a = 0 \implies g_{pa} = 0$$

A useful reading goal

By the end of this manual, a reader should be able to identify the proposed ingredients, reproduce the finite Z calculation, distinguish the two roles of occupation and activation, inspect a scalar potential and understand what would make a proposed prediction testable.

The book does not rely on a reader accepting all interpretations at once. Its modular structure lets an exact algebraic result be used while a physical bridge remains under construction. This is a practical way to present an ambitious framework without obscuring its present mathematical state.

The key question for each later module is concrete: what inputs are given, what operation is performed, and what output follows? That question links the public explanation to the technical details.

CHECK: Inspection case: the effective coupling vanishes and the state is declared absent. The product rule establishes only that specified coupling. Check the kinetic term, other sector interactions and readout before drawing conclusions about localisation, energy or visibility.

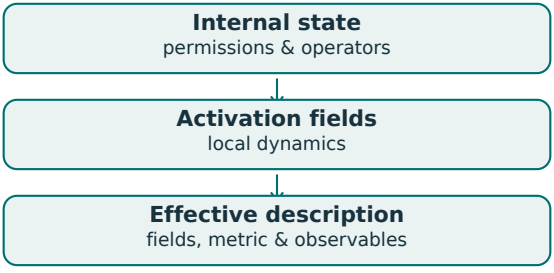
Continue with: F01 / M11 / M31

Starting with interactions

The emergence programme asks whether an interaction structure can determine the effective objects normally placed on spacetime. Its intended direction runs from internal permissions and dynamics towards local matter, gauge fields and geometry. The programme needs an explicit construction for each step.

A four-dimensional action written with an existing metric can organise effective activation dynamics. It is a useful starting point for calculations. It also assumes a base geometry, so the separate claim that the geometry emerges from the internal state needs an additional map or limiting argument.

The public explanation should therefore use two descriptions openly: the internal construction being proposed and the effective equations currently available for analysis. A successful future derivation would demonstrate their relationship rather than merely reuse their symbols.



Minimum requirements for an emergence map

Specify the input state or ensemble, the observables retained, the scale of coarse-graining and the output fields. If the output is a metric, state its signature and how coordinate changes act. If the output is a gauge connection, specify its transformation law and curvature.

Recovery of familiar equations should identify the approximations. A mean-field expansion may neglect correlations. A low-energy limit may discard heavy modes. A continuum limit may replace discrete structures with fields. Each can be justified in a regime, but each changes what the equations describe.

The manual records the proper-time and effective-action descriptions as supplied model structures. Their derivation from the finite internal block is an open bridge. This distinction helps a reader locate precisely where further mathematical work is needed.

$$g_{\mu\nu} = \mathcal{F}_{\mu\nu}[\Psi, \alpha, \ldots]$$

Testing a claimed limiting description

First identify the variables present in both descriptions. Then write the map between them. Apply that map to the proposed evolution and calculate the output equation. Compare the output's symmetries, degrees of freedom and conservation identities with the target theory.

A proposed Dirac limit, for instance, needs spacetime spinor fields and gamma matrices with the appropriate Clifford relation. An internal SO10 spinor label does not automatically supply a Lorentz spinor. A proposed gravitational limit needs a metric or frame and the corresponding field equation.

The schematic map on this page names the task, not a solved functional. Its dots represent structure that must be supplied in a technical completion, rather than hidden numerical adjustments.

$$\{\gamma^{\mu}, \gamma^{\nu}\} = 2g^{\mu\nu}I$$

Why this module matters

The doctrine becomes meaningful through the maps it motivates. It can guide model-building even before all maps are known. The manual preserves that motivation while keeping effective calculations attached to their stated assumptions.

For a public reader, emergence means explaining how a larger-scale description follows from a specified smaller-scale one. It is more demanding than drawing a shadow or saying that the visible world is a projection. A projection must produce the quantities used in the effective theory.

Use this module when a later diagram seems to make several steps look immediate. Return to the input, map and output. The sequence is the same whether the proposed output is a mass, a coupling, a metric or an epoch.

CHECK: Inspection case: a mean-field expansion is described as a full QFT derivation. Identify the fluctuation fields, statistics, retained modes and approximations. Verify the effective kinetic and interaction terms. Report the limit actually obtained rather than treating the expansion as every required bridge.

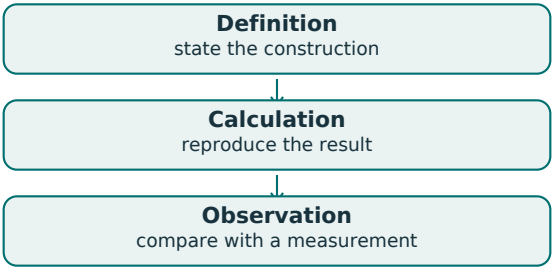
Continue with: F02 / M41 / M46

Three kinds of statement

A definition fixes the meaning of a symbol. A prediction is an outcome calculated from the model before the relevant observation is used to choose that outcome. An observation is a measured result with a stated method and uncertainty. These three kinds of statement need different support.

The coupling rule is a definition until its input parameters are fixed by the rest of the framework. A Z eigenvalue is a calculated mathematical result once the matrix is specified. A claim about a detector signal becomes a prediction only after the operator-to-signal calculation is supplied.

This distinction does not make speculative work unpublishable. It makes the proposal understandable. Readers can then assess the definitions, inspect calculations and compare derived outcomes with data without having to infer which stage an assertion has reached.



Building a prediction record

A usable prediction record contains the observable, its definition, the calculation, the input values or derivation rules, the uncertainty and the observational conditions. A detector energy range, baseline, distance or selection cut may be essential to interpreting the result.

An absence is meaningful only when a measurement was sensitive to the predicted effect. A statement that a resonance was not seen needs a specified production process, branching fraction and experimental sensitivity. A statement that a coupling difference is nonzero needs a magnitude or a bound that makes a finite test possible.

The trial manual avoids assigning numerical probabilities to unsupported outcomes. A probability requires a defined event and model or evidence from which that probability is calculated. Confidence expressed in a conversation is not that calculation.

CHECK: Define the observable and the experimental conditions before defining a falsification threshold.

Checking numerical independence

Trace every number used in a calculation to its origin. Some may be measured inputs. Some may be fixed algebraic invariants. Others may be fitted model parameters or arbitrary initial conditions. The resulting prediction depends on this classification.

Reproducing a measured mass after choosing an otherwise free coefficient from that same mass is a fit. It can still be useful for calibration, but it is not an independent prediction of the mass. A separate observable predicted from the calibrated model can provide a later test.

A numerical coincidence does not specify an interaction. The explanatory work is the derivation that connects the model's allowed terms, state and scales to the calculated result. This is the work recorded in the final test modules.

$$\text{inputs} + \text{dynamics} + \text{readout} \longrightarrow \text{observable}$$

Applying the status system

Mark a chosen permission weight DEFINED. Mark a verified matrix multiplication VERIFIED. Mark an executable, inspected code path IMPLEMENTED. Mark a proposed cosmological interpretation PROPOSED until its observational calculation is complete. Retain prior versions as LEGACY when they explain the source history.

An entry may contain more than one status when its parts have different scope. For example, the generation matrix is defined and its spectrum is verified, while the interpretation of that spectrum as observed masses remains proposed. This is more informative than giving the whole entry a single global verdict.

The ledger near the end of the book applies these distinctions to the present framework. It records concrete completion tasks so that a future edition can show what changed.

CHECK: Inspection case: a parameter is chosen using the observation later called a prediction. Mark it FITTED in the input record. The calibrated model may predict another observable, but the calibration value is not an independent test of itself.

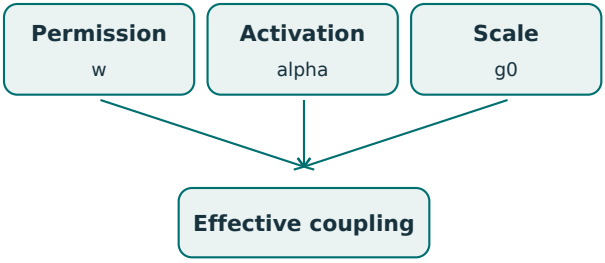
Continue with: F03 / M49 / M50

The permission picture

The key-and-lock language begins with a simple distinction: having access to an interaction is different from that interaction being locally active. A species may have a permission weight for a sector while the sector's activation is small or zero in a specified regime.

K.E.Y.C.H.A.I.N. supplies the permission metaphor. V.A.S.K. supplies a proposed state-space and activation formulation. The relationship is expressed through the effective coupling rule, whose three factors carry distinct roles. This is the conceptual continuity retained by the manual.

The metaphor should stop where its mathematical translation stops. Keys are not counted physical brakes, and inactive locks do not define motion outside causality. A dynamical conclusion needs an equation of motion and a readout rule.



From words to operators

A permission can be represented by a sector projector when it selects an internal subspace. A composite species permission can combine several sector operators. With fractional weights or overlapping projectors, the composite may no longer be an idempotent projector.

Activation can be defined as an independent field alpha_a between zero and one. Occupation can be calculated from the internal state and a projector. These constructions answer different questions. Using distinct symbols keeps the permission, occupation and activation descriptions from collapsing into one ambiguous quantity.

The interaction coefficient g_pa then uses a bare scale, a species weight and an activation. This rule is the present formal link between the KEYCHAIN language and the V.A.S.K. effective description.

$$K_p = \sum_a w_{p,a} \Pi_a$$

$$g_{pa} = g_a^{(0)} w_{p,a} \alpha_a$$

A direct limiting check

Take a sector and retain its bare coupling scale and species permission. When alpha_a is zero, the specified effective coupling is zero. When alpha_a is one, the specified effective coupling equals the bare scale times the permission weight. Intermediate activation gives the product stipulated by the rule.

This check establishes the behaviour of the definition at its endpoints. It does not establish why a real system chooses an endpoint or how long a transition takes. Those questions belong to the activation action, its stationary points and the initial conditions.

Similarly, setting generation-mixing coefficients to zero removes that term from the Hamiltonian. It does not necessarily remove every other source of evolution. The static-limit module examines what else must be fixed.

$$\alpha_a = 1 \implies g_{pa} = g_a^{(0)} w_{p,\,a}$$

Preserving the connection

The book can keep the memorable metaphor alongside precise notation. Introduce each new operator by explaining which permission it represents, then state what that operator actually does. Keep the field equations close to the explanation of locally active locks.

The Z-gate extends this picture by changing a generation label in a selected internal subspace. Its action is a matrix cycle. Whether that cycle participates in an effective interaction depends on its Hamiltonian coupling and the map to physical fields.

Use the KEYCHAIN narrative as an entry point. Use the operator and field definitions to calculate. The reader can then return to the metaphor with a more exact understanding of its permitted meaning.

CHECK: Inspection case: activation becomes constant and the entire state is called static. Inspect the full Hamiltonian. Constant coefficients can still generate phase evolution and mixing. Define which observables remain constant and which operator terms have actually been removed.

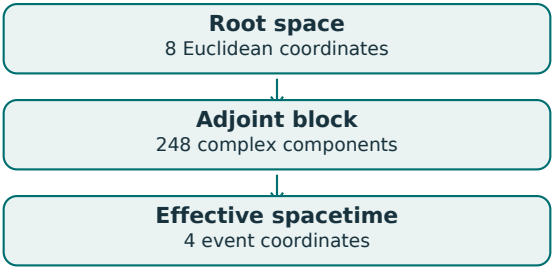
Continue with: M07 / M11 / M25

Counting different things

The number 248 is the dimension of the chosen complex adjoint block. The number eight is the rank of E8 and the dimension of its standard root-space description. Four is the dimension of an effective spacetime description used in the field equations. These statements concern different spaces.

A complex coefficient requires two real components, but replacing 248 complex components with 496 real components does not create 496 spatial directions. A state-space dimension measures the size of the linear representation. Physical dimension describes the coordinates and geometry of events.

The book uses labels such as internal, root-space, spatial and spacetime whenever dimensions are compared. This vocabulary makes the proposed projection programme comprehensible and prevents an attractive dimensional coincidence from becoming an unexplained physical identification.



The 248 decomposition

E8 has 240 roots and eight Cartan directions. The root count plus the Cartan dimension gives the adjoint dimension. The 240 roots can be represented in eight Euclidean coordinates, but each root corresponds to a generator direction in the Lie algebra construction.

The state vector in the adjoint block can use a basis adapted to these directions. A basis adapted to a subgroup branching reorganises the same space into representation blocks. Changing the basis does not change the total dimension or create additional physical components.

The selected generation block contains three copies of a 16-dimensional internal space, giving 48 dimensions. A full operator on 248 dimensions must also specify what it does on the remaining directions.

$$240 + 8 = 248$$

$$3 \times 16 = 48, \qquad 248 - 48 = 200$$

A block-extension check

An operator defined only on the 48-dimensional block is incomplete as a full-space operator. One possible extension is to act as the identity on a chosen 200-dimensional complement. That extension is unitary and has order three when the generation block does.

However, it need not be the action induced by a particular subgroup element on the full E8 branching. The latter also acts on the other representation blocks. Consequently the spectra of the simple identity extension and the complete subgroup action can differ.

Specify the extension before comparing dimensions or eigenvalue multiplicities. This step is essential when relating the Z-gate to a full algebra automorphism rather than merely to an internal linear operator.

$$Z_{248} = Z_{48} \oplus I_{200}$$

The physical reading

A four-dimensional spacetime includes time; it is not generally a four-dimensional Euclidean space. A hypersphere in Euclidean four-space has a positive-definite geometry, while a relativistic spacetime uses a Lorentzian metric. The difference is relevant to the black-hole projection proposal.

Likewise, the Leech lattice's twenty-four dimensions do not define twenty-four physical hours. A clock needs a dynamical variable and a scale. The dimension of a mathematical lattice does not provide either automatically.

When reading a claim that one structure projects into another, identify their metrics and maps as well as their dimensions. Dimension counting can reject an inconsistent construction, but matching dimensions alone cannot establish one.

CHECK: Inspection case: a 48-dimensional gate is compared with a full 248-dimensional operator. State the complementary action first. Identity padding and the full subgroup action have different multiplicities. Compare operators on the same complete domain.

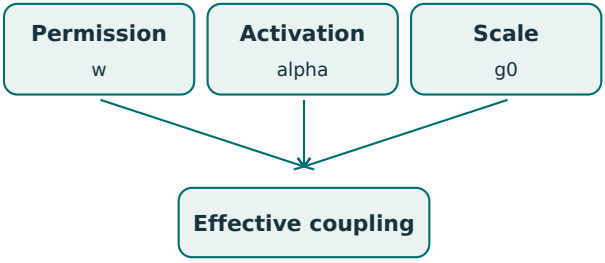
Continue with: M13 / M29 / M40

An accessible model language

The metaphor is useful when it preserves the distinction between permission and activation. A keychain names a species' access to several sectors. A lock names the locally available interaction. The activation field describes the proposed local state of that lock.

This gives readers a route into the effective coupling rule without beginning with a large matrix. Once the idea is understood, introduce the operator that selects the sector and the field that modulates its availability. The metaphor then has a precise mathematical referent.

The metaphor should not introduce hidden conservation laws, propagation rules or dimensions. Those are supplied by the action, kinetic terms, state constraints and measurement map. Giving them an evocative name does not calculate them.



The limits of counting keys

In the supplied permission rule, several nonzero weights indicate access to several sectors. The rule does not say that each permission adds a fixed amount of mass or divides the maximum speed by an integer. Such a statement would require an additional, specified effective dispersion law.

Ordinary relativistic dispersion relates energy, momentum and invariant mass. If an alternative refractive description is proposed, its coefficients, frame of application and compatibility with measured propagation need to be calculated. A permission weight alone does not specify those conditions.

The book therefore keeps the key metaphor tied to g_pa. Claims about propagation are assessed through the effective equations in the matter and testing sections.

$$E^2 = m^2c^4 + p^2c^2$$

Inactivity and observability

If alpha_a is zero, the specified coupling through sector a vanishes. That is the direct consequence of the product rule. It does not prove that the state has no kinetic term, no spacetime localisation or no gravitational stress-energy.

To describe an entirely unobservable sector, specify every interaction and readout that could expose it. If a bath stores energy, define the bath Hamiltonian and coupling. If the metric is unaffected, show the stress-energy consequence in the gravitational equation. These are different tests.

The phrase inactive mass can be retained as a model label when its observable meaning is stated. It should not be used to infer an infinite speed or a conserved hidden mass without the corresponding equations.

CHECK: Inactivity in one coupling rule does not specify every dynamical or observational property.

A consistent public explanation

Introduce a key as permission, a lock as local availability and activation as a field. Explain that the picture is a guide to a mathematical rule. Then show the rule and its limiting cases. This gives the reader an accessible explanation with a clear boundary.

When the next calculation requires an extra assumption, name it explicitly. Examples include a potential for activation, an extension of Z to the full space and a rule relating internal states to stress-energy. The reader can then see which conclusion depends on which assumption.

Use the metaphor to organise the account, not to fill a missing derivation. The subsequent modules provide the necessary operators, calculations and inspection routes.

CHECK: Inspection case: fewer active permissions are said to imply a faster particle. The coupling definition contains no dispersion law. Derive the kinetic and energy-momentum relation before calculating speed. A zero interaction coefficient does not mean an infinite velocity.

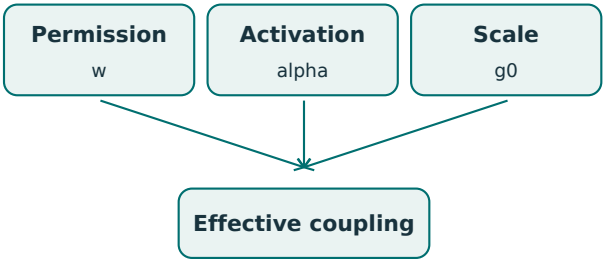
Continue with: M04 / M18 / M43

Access as an internal property

A particle permission names the sectors through which a species may interact in the model. It is separate from the local strength of that interaction. This distinction lets a species keep its permission pattern while an activation field changes over spacetime.

The permission weight w_pa is assigned to species p and sector a. The minimal formulation uses binary weights. A refined formulation permits fractional weights. Either choice needs a stated construction from the internal representation if the weights are to be derived rather than specified.

The public keychain picture collects these permissions into one description. The mathematical account uses operators and weights. A complete species definition also needs its effective field, spin, statistics and transformation properties. Permissions alone do not supply those ingredients.



The sector rule

Let Pi_a be the projector selecting the internal subspace associated with sector a. The weight w_pa specifies the species' access to that subspace. In the coupling rule, the weight is multiplied by the local activation and a bare sector scale.

The same sector may contribute to several species. A species may have several sector permissions. This is a relation between species labels and sector labels, not necessarily a decomposition into mutually exclusive particles. The operator geometry and the particle spectrum must be specified independently.

Where a fractional weight is used, state what it means. It might define a model coefficient or a measurement effect, but those meanings are not interchangeable. The weighted-permission module examines the operator constraints.

$$0 \leq w_{p,a} \leq 1$$

$$g_{pa} = g_a^{(0)} w_{p,a} \alpha_a$$

Source example | Permission labels

Photon | EM

Electron | EM, Weak, Higgs

Neutrino | Weak; Higgs depends on mass construction

Quark | EM, Weak, Higgs, Strong

Proposed dark species | Gravity, Dark

These are minimal source permission examples, not a complete measured coupling spectrum.

Endpoint behaviour

For a fixed sector activation and bare scale, a zero weight gives a zero coupling through that rule. A unit weight gives the full activated sector scale. These are exact consequences of the multiplication and do not need a simulation.

With fractional weights, the rule scales the coupling linearly in that weight. A transition probability, however, generally depends on the full evolution and may involve a squared amplitude or interference. The weight's appearance in a coupling does not make it a measured probability by definition.

This is why the manual uses different notation for permission weights and occupations. One sets an interaction coefficient; the other is calculated from a state and a projector. Their numerical ranges can agree while their jobs remain different.

CHECK: A coefficient in an interaction is not automatically a probability of an outcome.

Completing a species description

To turn a keychain into a physical species, identify the relevant representation, Lorentz spin, statistics, kinetic term and mass structure. State how the proposed internal permission produces the effective interaction. Then derive observables under specific conditions.

If the construction uses only a gauge-generator direction, show how that direction acts on the matter representation. A projector onto a generator is not by itself the same thing as a projector onto a matter particle. This distinction matters for the electromagnetic example.

The permission language provides an organising layer. It becomes a calculational species model when the remaining structures are fixed. Keep both the organising value and the completion obligations visible.

CHECK: Inspection case: a permission weight is treated as an outcome probability. Identify the state and measurement operator that would supply that probability. Keep the interaction coefficient and the measurement readout separate even when both lie in the unit interval.

Continue with: M08 / M09 / M41

Selecting a subspace

A projector selects a subspace of a vector space. For an orthonormal basis and an index set S_a, the sum of the basis dyads belonging to that set is an orthogonal projector. Acting on a state retains those components and removes the rest.

This is the natural mathematical translation of a sector permission when the sector is a specified internal subspace. A subgroup branching can supply such subspaces, provided the basis and representation action are explicit. The projector's rank is the selected dimension.

A collection of projectors may overlap. Overlap is a statement about their selected subspaces; completeness is a separate statement about their sum. The book does not assume either property merely because the projectors have different sector names.

$$\Pi_a = \sum_{i \in S_a} |e_i\rangle\langle e_i|$$



Selected components

An exact selection, not a particle picture

The defining identities

An orthogonal projector is Hermitian and idempotent. Hermiticity means that its adjoint equals itself. Idempotence means that applying the selection twice has the same effect as applying it once. Its eigenvalues are zero or one.

For a finite-dimensional orthogonal projector, the trace equals the rank. This identity supports occupation and dimension calculations throughout the manual. It does not determine which subspace corresponds to a physical interaction; that identification remains part of the model construction.

If two projectors are built by selecting subsets of the same orthonormal basis, they commute, even when those subsets overlap. Noncommutativity needs a different relationship between the subspaces and cannot be inferred from overlap alone.

$$\Pi_a^2 = \Pi_a, \qquad \Pi_a^\dagger = \Pi_a$$

$$\mathrm{Tr}\,\Pi_a = d_a$$

Direct matrix verification

In a basis adapted to the selected sector, the projector has ones on the selected diagonal entries and zeros elsewhere. Squaring the matrix leaves every entry unchanged. Transposing and conjugating it also leaves it unchanged. Counting its diagonal ones gives its trace and rank.

For two common-basis selections, matrix multiplication keeps the intersection of their selected indices. Reversing the multiplication gives the same intersection. Therefore their commutator vanishes. This is a direct finite calculation independent of a physical interpretation.

If their intersection is nonempty, their product is nonzero. The projectors then commute but are not mutually orthogonal. The distinction is relevant when their sum is used as a permission operator.

$$\Pi_a \Pi_b = \Pi_b \Pi_a$$

$$\Pi_a \Pi_b = 0 \quad \text{only for disjoint selections}$$

Using sector names carefully

The names electromagnetic, weak, strong, Higgs, gravity and dark identify proposed roles. Each role needs the selected subspace and the operator action on the relevant states. A name cannot replace the construction of the projector.

Gauge-generator subspaces and matter-representation subspaces should be distinguished. The Higgs is represented by matter fields with transformation properties; it is not simply another gauge subalgebra. The same care applies to gravity and sterile sectors.

When reviewing a sector definition, ask for its basis, rank, generators, overlap with other sectors and physical readout. Once those are available, the projector can be checked using the identities on these pages.

CHECK: Inspection case: overlapping common-basis sectors are called noncommuting. Multiply their projectors. The product selects the intersection in either order, so the commutator vanishes. Overlap, mutual orthogonality and commutation are separate properties.

Continue with: M09 / M13 / M17

Combining selected sectors

The source formulation combines sector permissions with weights. This is a useful operator construction, but its result is not always an orthogonal projector. The manual writes K_p for the composite so that its algebraic type can be inspected before it is used as a filter or effect.

If the projectors are mutually orthogonal and the weights are only zero or one, their selected sum is again a projector. Fractional weights generally remove idempotence. Overlapping sectors can produce eigenvalues larger than one when they are added without further normalisation.

These are mathematical properties of the construction, not disagreements about the keychain metaphor. They determine which observable formulas are well defined and which extra assumptions are needed.

$$K_p = \sum_a w_{p,a} \Pi_a$$

Squaring the composite

Expand the square rather than assuming the projector identity. The expansion contains weighted diagonal terms and cross terms. With orthogonal projectors, the cross terms vanish, but the squared weights remain. Idempotence then requires each nonzero weight to equal one.

With overlapping projectors, cross terms contribute. If all selected projectors are positive and weights are nonnegative, the sum is positive. Positivity alone does not make it bounded above by the identity. A measurement effect requires that additional bound.

An internal permission operator may be useful without being a measurement effect. The book therefore names the intended use before choosing an expectation or normalisation formula.

$$K_p^2 = \sum_{a,\,b} w_{p,\,a} w_{p,\,b} \Pi_a \Pi_b$$

$$0 \le E_p \le I \quad \text{for a measurement effect}$$

An exact fractional-weight check

Take a nonzero projector Pi and multiply it by one half as an operator test. The square is one quarter times Pi, so it is not equal to the original operator. Its eigenvalues are zero and one half. It is a positive effect, but it is not an idempotent projector.

This finite example tests the source allowance of fractional weights. It assigns no measured physical coupling and introduces no fitted model constant. Its purpose is to show why a weighted species permission needs its own algebraic label.

If two identical permissions are added with unit weights, the result is twice Pi. It remains positive, but its selected eigenvalue is two and it cannot be a probability effect without another definition.

$$K = \tfrac{1}{2}\Pi \quad \Longrightarrow \quad K^2 = \tfrac{1}{4}\Pi$$

Consequences for observables

For a filter K acting on a state, the norm of the filtered state uses K dagger K. For a measurement effect E, a compatible elementary filtering operator is its positive square root, subject to the chosen measurement instrument. These constructions use different denominators.

The next modules retain this distinction. A composite keychain can remain a permission label while the readout uses a separately defined effect. This prevents the same weighted operator from being treated as three different objects without explanation.

When adapting an older equation, change the operator type and normalisation together. A notation change alone cannot fix the meaning of an expectation value.

CHECK: Inspection case: a weighted sum is used as a projector. Square it and compare with the original. Then check whether its eigenvalues lie between zero and one if a measurement effect is intended. Choose the readout formula for the operator actually obtained.

Continue with: M10 / M12 / M17

A probability obtained from a state

Occupation of a sector is calculated from a normalised state and an orthogonal projector. The result is real, nonnegative and no greater than one. It answers how much of the specified state lies in the selected subspace.

Occupation is not the same as having permission to interact. A species permission is a model assignment; occupation depends on the state. Nor is occupation automatically an independent local activation field. The book writes P_a for occupation to keep these roles separate.

For a mixed state, replace the vector expectation by the trace of the density matrix with the projector. This permits an ensemble description while retaining the same probability interpretation.

$$P_a = \langle \Psi | \Pi_a | \Psi \rangle$$

$$P_a = \mathrm{Tr}(\rho \Pi_a)$$

Completeness changes the constraints

If the projectors are mutually orthogonal and sum to the identity, their occupations sum to one. This follows directly from state normalisation. The individual occupations are therefore constrained and cannot all vanish in the same normalised state.

If projectors overlap, the occupations need not form a mutually exclusive probability distribution. If the collection is incomplete, their sum need not be one. The probability of each orthogonal projection remains meaningful, but the interpretation of the whole list changes.

These conditions must be written before using sector occupations as cosmological switches. Independent activation fields can all be assigned zero in a model, whereas a complete set of mutually exclusive occupations cannot.

$$\sum_a \Pi_a = I \quad \Longrightarrow \quad \sum_a P_a = 1$$

The uniform-state calculation

The source defines a uniform superposition over an orthonormal basis. For a sector projector selecting d_a of those basis directions, the expectation is d_a divided by 248. Each selected component contributes the same squared amplitude.

This result depends on the projector being diagonal in the basis in which that particular uniform state was defined. A uniform list of coefficients in one basis need not have equal amplitudes in another basis. The state and the basis convention must travel together.

The completely mixed state I divided by 248 gives the same rank-based occupation for any rank-d_a projector. That basis-independent ensemble is different from a chosen pure uniform superposition.

$$|\Psi_0\rangle = \frac{1}{\sqrt{248}} \sum_i |e_i\rangle$$

$$\rho_* = \frac{I}{248}, \qquad P_a = \frac{d_a}{248}$$

Keeping occupation and activation separate

If a model sets alpha_a equal to P_a, it inherits the occupation constraints and state dependence. If alpha_a is an independent scalar field, it needs an independent action or evolution law. A hybrid formulation must specify the relationship rather than alternating between the definitions.

The distinction affects claims about all sectors becoming inactive, the response of a Hamiltonian and the proposed mass sum. It also affects linearity: placing a state-dependent expectation inside H can make the effective Schrödinger equation nonlinear.

Use this module to identify which activation version a later calculation assumes. The activation section records both constructions and their consequences.

CHECK: Inspection case: every complete-sector occupation is set to zero. Sum the projectors and use state normalisation. If their sum is the identity, the occupations sum to one. An all-zero activation configuration belongs to the independent-field version, not that complete occupation definition.

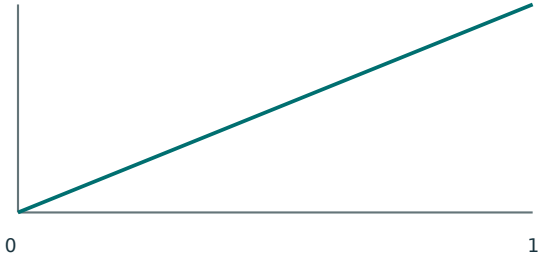
Continue with: M11 / M19 / M20

Permission and local availability

Activation supplies the proposed local modulation of a permitted interaction. In the independent-field formulation, alpha_a assigns a real number between zero and one to each effective spacetime event. Its value can change while the species permission remains fixed.

This formulation expresses the KEYCHAIN distinction between carrying a key and finding an active lock. The model's dynamics must then determine alpha rather than leaving it as an arbitrary slider. The action, potential, couplings and conditions specify that task.

An occupation-defined activation is an alternative construction. It derives its value from the state and inherits the constraints described in the preceding module. The manual does not merge the two versions into one unstated definition.



Exact model shape; axes are dimensionless

The independent-field definition

Let the effective spacetime base be M and define alpha_a as a map from M to the closed unit interval. The coupling product then uses this field at the same event as the effective matter and gauge variables. A spacetime-dependent coupling requires attention to gauge invariance in the full action.

A local field has a kinetic structure and interacts with other fields through specified terms. These terms determine whether constant activation is stable, whether gradients cost energy and whether transitions can occur. Assigning a range does not establish those properties.

The unit interval can be enforced through a constrained theory or a parametrisation. The choice affects field equations, endpoint behaviour and numerical evolution, so it belongs in the model specification.

$$\alpha_a : \mathcal{M} \longrightarrow [0, 1]$$

$$g_{pa}(x) = g_a^{(0)} w_{p,a} \alpha_a(x)$$

Endpoint and ratio checks

The product rule gives a zero effective coupling at zero activation and the permitted bare coupling at unit activation. This is a direct limiting check. It does not show which endpoint is reached or whether a potential makes it stable.

A ratio of activations at two epochs can exceed one even though both activations lie in the unit interval. The numerator only needs to exceed the denominator. Therefore a ratio claim must not be rewritten as an absolute activation outside the allowed range.

If a mass is assumed proportional to activation, the same caution applies to mass ratios. The full mass formula may include a changing vacuum scale or other factors, so the proportionality and its regime must be stated.

$$\frac{g_{pa}(x_1)}{g_{pa}(x_2)} = \frac{\alpha_a(x_1)}{\alpha_a(x_2)}$$

M11 / 4 OF 4

The next dynamical question

Once the activation definition is chosen, ask what its equation predicts. A potential identifies stationary configurations. A kinetic term sets the response to gradients. Initial conditions determine which solution is followed. Couplings to other fields provide back-reaction.

The proposed cosmological epochs correspond to activation remaining near selected configurations for long periods. To calculate their duration or sequence, the dynamics and transition rates need to be evaluated. A drawing of successive plateaus is a useful guide to this calculation, not its output.

The activation modules now develop these obligations using the supplied potential variants and exact derivatives. Their status remains tied to the stated inputs.

CHECK: Inspection case: an epoch ratio exceeds one and is called an invalid activation. Check whether the statement concerns alpha itself or a ratio of two allowed values. For a coupling ratio, ensure the denominator is nonzero and all other factors are fixed.

Continue with: M19 / M22 / M45

Conditioning a state

A sector-conditioned observable asks for an expectation after a specified selection or filtering operation. For an orthogonal projector, the filtered state is Pi times Psi. Its squared norm gives the probability of the selected sector. Dividing by that norm produces the conditional expectation when the probability is nonzero.

For a general filtering operator K, the squared norm contains K dagger K. The denominator must match the operation used in the numerator. Replacing it with K alone can give an incorrect result even for the identity observable.

A measurement effect E specifies an outcome probability, but a full measurement instrument also specifies the state update. Choosing the positive square root is one elementary construction, not the only possible instrument.

$$\langle O \rangle_K = \frac{\langle \Psi | K^\dagger O K | \Psi \rangle}{\langle \Psi | K^\dagger K | \Psi \rangle}$$

Projector and effect versions

When K is an orthogonal projector, K dagger K equals K. The familiar projector denominator is then correct. This special case explains why the formula works in the simplest sector construction but cannot be transferred unchanged to every weighted keychain.

For a positive effect E bounded by the identity, the outcome probability is the expectation of E. If the filtering operator is its positive square root, the numerator contains square roots of E on both sides of the observable. The denominator is the expectation of E.

The formula must state which selection is used. A reader should never have to guess whether a species operator is an idempotent projector, a general filter or a measurement effect.

$$K = \sqrt{E} \quad \Longrightarrow \quad K^{\dagger} K = E$$

The identity-observable check

Set O equal to the identity. A correctly normalised conditional expectation must be one whenever the denominator is nonzero. In the general filter formula, the numerator and denominator are identical, so the result is one exactly.

This provides a fast consistency test for any proposed conditioning rule. With a fractional permission substituted into the projector-only denominator, the result can differ from one. That failure identifies a normalisation mismatch, not a novel physical identity observable.

If the selection probability is zero, the conditional state is undefined. A zero denominator cannot be treated as evidence for an infinite expectation or instantaneous behaviour. The selected event has no normalised conditional state under that rule.

$$O = I \quad \Longrightarrow \quad \langle I \rangle_K = 1$$

Using a readout in the model

The readout rule connects internal operators to predictions. It must therefore be treated as carefully as the Hamiltonian. State the operator, the state, the selection and the normalisation. If the observable is position-dependent, also state the effective field description supplying that dependence.

Different filters can produce different conditioned states while sharing an outcome probability. This is why a probability effect alone does not determine all subsequent dynamics. A complete measurement construction needs the instrument or another specified state-update rule.

The source's particle permissions can remain useful organising objects. The public manual improves their calculational use by separating permission, filtering and observation wherever their mathematical properties differ.

CHECK: Inspection case: a conditional formula gives an identity expectation different from one. Match its denominator to the filtering norm K dagger K. If the outcome probability is zero, no normalised conditional state exists under that selection.

Continue with: M09 / M10 / M18

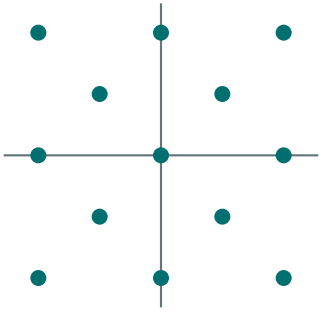
The internal substrate

The selected internal substrate is the complexified adjoint representation of E8. Its dimension is 248. Eight commuting Cartan directions organise the root-space description, and the remaining generator directions correspond to 240 roots. This is a statement about Lie-algebra structure.

The model uses this structure to organise sector permissions. A root is a vector in an eight-dimensional Euclidean description; a generator is an element of the algebra; a state is a vector in the chosen representation space. These objects are related, but they are not identical.

Naming each object prevents a diagram of roots from being mistaken for a physical arrangement of particles. The physical interpretation requires representation assignments, effective fields and a map to observed interactions.

$$\dim \mathfrak{e}_8 = 240 + 8 = 248$$



First two root coordinates; coincident images merged

An explicit root construction

Use eight orthonormal Euclidean coordinate directions. One root family has two entries equal to plus or minus one and the other six entries zero. Choosing the two positions gives 28 choices, and their four sign choices give 112 roots.

The second family has all eight entries equal to plus or minus one half, with an even number of minus signs. There are 128 allowed sign patterns. Every vector in either family has squared length two. Together they supply the 240 roots.

This construction is suitable for a finite code check. Keep exact integer coordinates by doubling the vectors, then divide dot products by four when returning to the conventional normalisation.

$$4\binom{8}{2} = 112, \qquad 2^7 = 128$$

$$112 + 128 = 240$$

Root lengths and angles

For the first family, the two nonzero unit entries give squared length two. For the second family, eight squared halves sum to two. The common length makes the angle between roots depend directly on their dot product.

For distinct non-opposite roots in this normalisation, the possible dot products are minus one, zero and one. These give angles of 120, 90 and 60 degrees. Opposite roots have angle 180 degrees. This finite set concerns roots, not all possible vectors of the lattice or their spatial projections.

A very small continuous misalignment used elsewhere in the model therefore needs another construction. It cannot be described as the smallest angle between distinct E8 roots without changing the object under discussion.

$$\cos\theta = \frac{r \cdot s}{2}$$

From a root list to an algebra

The root list supplies geometry and representation weights. A Lie algebra also needs its bracket and the normalisations of its generators. Assigning a linear transformation to roots is not enough to establish that it preserves all brackets.

An algebra automorphism must preserve the bracket for every pair of elements. A candidate Z action can therefore be checked at two levels: its finite linear action on the representation, and its compatibility with the algebraic multiplication. These are distinct calculations.

The Z section uses the root and branching structure as an organised substrate. It keeps the automorphism-identification obligation explicit where a physical or algebraic interpretation requires it.

CHECK: Inspection case: the 248 basis directions are all called roots. Separate the 240 roots from the eight Cartan directions. Use the eight-coordinate root construction for lengths and angles, and retain the full generator set when checking brackets.

Continue with: M14 / M15 / M34

Subgroups reorganise the same space

A branching rule describes how a representation decomposes when restricted to a subgroup. The total dimension is preserved. The resulting blocks may transform differently under that subgroup, even though they originated within one irreducible representation of the larger group.

This is the basis for defining candidate sectors in V.A.S.K. The projectors select representation blocks after a branching has been specified. Different branching routes organise the space differently; they require a correspondence before their labels can be combined.

Quadratic Casimirs depend on the algebra, representation and normalisation. A value for the full E8 adjoint must not silently be replaced by a value for an SO10 vector or a restricted subgroup operator.

$$C_2(R) I_R = \sum_A T_R^A T_R^A$$

Algebra | Adjoint dimension | C2 adjoint

U1 | 1 | 0: ratio undefined

SU2 | 3 | 2

SU3 | 8 | 3

G2 | 14 | 4

F4 | 52 | 9

E6 | 78 | 12

E7 | 133 | 18

E8 | 248 | 30

Representation and adjoint values

The source uses the conventional adjoint values two for SU2, three for SU3 and thirty for E8. A matter representation has its own value: the SU2 fundamental has three quarters and the SU3 fundamental has four thirds in the corresponding conventions.

For SO10 with vector-index normalisation one, the vector 10 has Casimir nine halves, and the chiral spinor 16 has Casimir forty-five eighths. Their dimension-to-Casimir ratios are therefore different from ratios built using an adjoint Casimir.

The U1 adjoint is neutral and its quadratic adjoint Casimir is zero. Dividing its dimension by that zero does not define a finite stability ratio. Any special U1 baseline is an additional model convention.

$$C_2(10) = \frac{9}{2}, \qquad C_2(16) = \frac{45}{8}$$

An exact ratio comparison

For the stated SO10 representation convention, the vector ratio is ten divided by nine halves. The spinor ratio is sixteen divided by forty-five eighths. Performing the arithmetic gives twenty ninths and one hundred twenty-eight forty-fifths.

The spinor ratio exceeds the vector ratio by twenty-eight forty-fifths. Consequently a rule favouring the smallest dimension-to-Casimir ratio does not select the spinor ahead of the vector under this particular definition. The result checks the definition; it does not choose a physical activation model.

If another restricted operator is intended, state that operator and repeat the calculation. A change of definition must not be presented as an unchanged numerical consequence of the old formula.

$$\mathcal{R}_{10} = \frac{20}{9}, \qquad \mathcal{R}_{16} = \frac{128}{45}$$

$$\mathcal{R}_{16} - \mathcal{R}_{10} = \frac{28}{45}$$

Inspecting a Casimir filter

Before using a Casimir in an activation inequality, identify which generator sum appears and on which representation it acts. State the dimension counted by d_a. A subalgebra dimension and the dimension of a matter block answer different questions.

Then fix the threshold's temperature and coupling normalisation. Ratios can order candidate thresholds, but they do not fix which sectors are active at a particular epoch without the actual cutoff and dynamics. Conjugate representations also share the same quadratic Casimir.

The later threshold and dormancy modules apply these checks to the source formulas. This preserves the filter as a proposed organising mechanism while making its current calculation reproducible.

CHECK: Inspection case: a block ratio uses a Casimir from another representation. State the algebra, generator normalisation and representation. Recalculate the dimension-to-Casimir ratio with those same conventions before applying any threshold comparison.

Continue with: M16 / M24 / M46

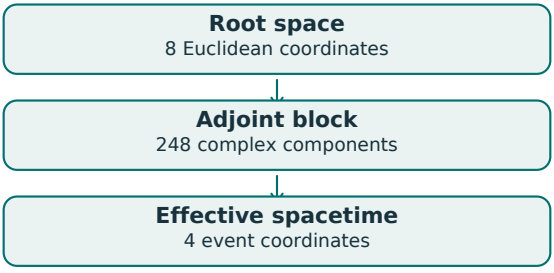
A selected branching route

The proposed generation construction uses the E6 x SU3 branching of the E8 adjoint. The decomposition contains an E6 adjoint, an SU3 adjoint, a tensor block transforming as 27 times 3, and its conjugate. The dimensions add to 248.

The SU3 factor in this route is labelled generation SU3 to distinguish it from colour SU3. The model chooses a cyclic element acting on the three-component generation index. Its group membership does not decide whether the symmetry is gauged, global or explicitly broken in the effective dynamics.

The branching provides a candidate location for three selected SO10 spinor copies. It also contains other representations and conjugate blocks whose physical roles require a full spectrum assignment.

$$248 = 78 + 8 + 81 + 81$$



The selected 16-dimensional copies

Under Spin10 x U1, the E6 fundamental 27 decomposes into a chiral spinor 16, a vector 10 and a singlet. The conventional charges in the supplied route are one, minus two and four, respectively.

Tensoring the spinor component with the generation triplet supplies three copies of the internal 16. Selecting those copies defines the 48-dimensional generation block used in the explicit Z construction. It does not remove the other components of the 27 or the conjugate 81-dimensional block.

Spin10 is used here for the group that carries spinor representations. Its Lie algebra is the same as that conventionally labelled so10. The distinction avoids suggesting that the internal spinor is an ordinary vector representation.

$$27 = 16_{1} \oplus 10_{-2} \oplus 1_{4}$$

$$\mathcal{H}_{\text{gen}} = \mathbb{C}^{3} \otimes \mathbb{C}^{16}$$

Dimension and action checks

The selected block has dimension three times sixteen. The full 27 times 3 block has dimension eighty-one. Its thirty-three remaining directions belong to the triplets of the vector 10 and singlet 1. They are part of the full generation-SU3 action.

The E6 adjoint block is fixed by a subgroup element acting only on generation SU3. The SU3 adjoint transforms by conjugation, and the conjugate triplet transforms with the conjugate action. These details determine the full 248-dimensional spectrum later in the book.

The dimension sum is a necessary consistency check. Identifying the selected copies as the observed chiral families additionally requires Lorentz assignments, gauge charges and a demonstrated treatment of the other states.

$$81 - 48 = 33$$

Physical questions left by the branching

The branching does not itself choose an active vacuum, derive Yukawa matrices or eliminate mirror degrees of freedom. A permission or activation mechanism may be proposed for these tasks, but it must specify the operators and the resulting effective spectrum.

The model states that generation SU3 is global in its intended construction. An explicitly chosen Hamiltonian can then break that symmetry. If a gauged version is later introduced, gauge invariance, gauge fields and anomaly conditions would need to be reconsidered.

This route gives the Z section a precise internal space and a candidate full action. Keeping those facts separate from the physical completion makes the construction both readable and reviewable.

CHECK: Inspection case: three selected spinor copies are said to exhaust the branching. Count the remaining components and conjugate block. The 48-dimensional selection is explicit; its identification with the complete active chiral spectrum needs the additional field and dormancy construction.

Continue with: M25 / M29 / M30

A second organisation of the substrate

The source also uses a route through so16 to so10 plus so6. At the group level, spin covers are required when spinor representations are used. The E8 adjoint decomposes into the so16 adjoint and one chiral spinor of Spin16.

The so16 adjoint has dimension 120, and the selected spinor has dimension 128. Under Spin10 x Spin6, the adjoint contains blocks of dimensions 45, 15 and 60. The spinor supplies two tensor blocks of dimension 64 each.

This route is useful for inspecting the source's unwanted-sector discussion. It must be related explicitly to the E6 x SU3 route before labels from both decompositions are treated as one common sector list.

$$248 = 120 + 128$$

$$120 = 45 + 15 + 60$$

The representation blocks

The adjoint branches as (45,1), (1,15) and (10,6). The spinor branches as a 16 paired with a Spin6 spinor 4 and the conjugate pair. The sum of all five block dimensions remains 248.

These are representation blocks. Calling a block a mirror-fermion sector additionally requires a Lorentz-spin and chirality assignment. The vector 10 and singlet labels in another branching are also not, by their names alone, opposite-chirality copies of the observed families.

The internal charges can be calculated from the chosen subgroup action. Their interpretation as particles needs an effective field construction. The manual keeps that extra step visible when considering dormancy.

$$248 = 45 + 15 + 60 + 64 + 64$$

The full-adjoint trace check

The supplied dormancy appendix defines an effective Casimir by tracing the full E8 Casimir over a projected block and dividing by its dimension. In the stated adjoint normalisation, the full operator equals thirty times the identity.

Consequently the trace over a rank-d projector is thirty times d. Dividing gives thirty for every selected block. The (10,6) block therefore yields ratio sixty over thirty, and the (1,15) block yields fifteen over thirty.

This calculation supplies the exact result of the written formula without a computer algebra system. It does not establish dormancy. A restricted-subgroup Casimir is a different operator and needs a separately stated definition.

$$\frac{\mathrm{Tr}(\Pi_a 30 I)}{d_a} = 30$$

$$\mathcal{R}_{(10,6)} = 2, \qquad \mathcal{R}_{(1,15)} = \tfrac{1}{2}$$

Diagonal colour needs an actual restriction

If physical colour is proposed as a diagonal subgroup of two SU3 factors, restrict each representation to that subgroup explicitly. A representation charged under only one factor does not become a singlet merely because the subgroup is diagonal.

For example, an element g acts on a tensor representation R times 1 as R(g) times 1. The same R action survives under the diagonal embedding. A separate projection could remove states, but that projection would need to be defined and justified.

The unwanted-spectrum problem therefore needs both the representation restriction and the activation or removal mechanism. A dimension list or a placeholder ratio cannot replace these calculations.

$$(R, 1)|_{\text{diag}} \simeq R$$

CHECK: Inspection case: a scalar full-adjoint Casimir is expected to distinguish blocks. Trace thirty times the identity over a rank-d projector and divide by d. The answer remains thirty. Use an explicitly different restricted operator if selective values are intended.

Continue with: M14 / M24 / M46

From a stated sector to a matrix

Let B contain basis vectors for a selected subspace as its columns. If those columns are linearly independent, their Gram matrix B dagger B is invertible. The corresponding orthogonal projector can then be constructed without assuming that the columns were already orthonormal.

This formula is useful for turning a branching or weight-space selection into a finite matrix. It makes the sector definition inspectable: the subspace is carried by B, while the inverse Gram matrix supplies the required normalisation.

If the columns are dependent, the ordinary inverse does not exist. A rank-revealing method or a correctly defined pseudoinverse is required. A numerical routine must report that distinction rather than silently ignoring it.

$$\Pi = B(B^\dagger B)^{-1}B^\dagger$$

The defining properties

The inverse Gram matrix is Hermitian when B dagger B is positive definite. Taking the adjoint of the projector expression therefore leaves it unchanged. Multiplying the expression by itself cancels the central Gram matrix against its inverse and returns the original expression.

The projector acts as the identity on the column space of B. It removes vectors orthogonal to that space. Its rank equals the number of independent columns. These facts connect the matrix to the intended selected sector.

The result depends only on the subspace, not on a particular independent basis for it. An invertible change of basis among the columns produces the same orthogonal projector.

$$\Pi^{\dagger} = \Pi, \qquad \Pi^{2} = \Pi$$

A symbolic verification

Write G for B dagger B. In the square of the projector, the middle factors B dagger B form G. The product G inverse times G times G inverse simplifies to G inverse. The remaining outer factors give the original projector.

For an orthonormal column set, G is the identity. The formula reduces to B B dagger, or the sum of the selected basis dyads. This matches the common-basis sector expression used earlier in the book.

A numerical check should compute the Hermiticity residual, idempotence residual and trace. Residuals are assessed against an explicitly chosen precision and matrix norm. A small residual verifies the implementation of the selected projector, not its physical assignment.

$$\Pi^2 = BG^{-1}GG^{-1}B^\dagger = \Pi$$

A reproducible construction record

Record the basis columns, their ordering, the generator normalisation and the method used to determine rank. Store the matrix or enough data to regenerate it. List any tolerance used by a numerical decomposition.

If two sector projectors are compared, calculate their product and commutator. This reports overlap and compatibility directly. Do not infer either from the sector names. If a complete decomposition is intended, also verify that the projectors sum to the identity.

This record is the practical basis of an IETM-style inspection module. It states the input, operation, expected identities and interpretation of the output so another reader can repeat the construction.

CHECK: Inspection case: the basis-column Gram matrix is singular. Do not use an ordinary inverse. Determine the rank, remove redundant columns or specify a pseudoinverse construction. Then verify Hermiticity, idempotence and rank of the resulting projector.

Continue with: M08 / M09 / M46

A state requires a dynamical context

A vector in the internal block is a proposed internal state. Its components depend on the chosen basis. A density matrix describes a pure state or an ensemble. Both descriptions require an evolution law and observables before they make predictions.

The finite internal block is not a full Fock space of a quantum field theory. Field excitations over spacetime involve additional degrees of freedom and a statistics assignment. A derivation of the effective field theory must construct those structures rather than infer them from the number 248.

This module sets the internal-state conventions used by the Hamiltonian and Z-gate calculations. It leaves the physical field-theory completion to the later matter and testing modules.

$$\langle \Psi | \Psi \rangle = 1$$

$$\rho \geq 0, \qquad \operatorname{Tr} \rho = 1$$

Evolution with a Hermitian generator

For a state-independent Hermitian Hamiltonian, the Schrödinger equation generates norm-preserving evolution. A time-independent generator gives a unitary exponential. A time-dependent generator requires time ordering when its values at different times do not commute.

The source uses proper time in an effective geometry. A covariant derivative may include a connection. Its compatibility with the state inner product must be stated so that the evolution preserves the intended norm. A connection coefficient does not automatically have the energy units of a Hamiltonian term.

The generation Hamiltonian is one part of the supplied total generator. Setting that part to zero does not imply that the locking, mixing, geometric or bath terms vanish.

$$i\hbar \frac{d|\Psi\rangle}{d\tau} = H|\Psi\rangle$$

$$U(\tau) = e^{-iH\tau/\hbar}$$

The density-matrix check

For the same closed, linear unitary dynamics, the density matrix evolves by a commutator with H. Taking its trace gives zero because the trace of a commutator vanishes. Thus the state remains normalised.

Unitary evolution also preserves the eigenvalues of the density matrix in a closed system. A reduced state obtained by tracing over a bath can behave differently because its dynamics includes correlations and exchange with that bath. The enlarged description must specify the bath and its coupling.

An expectation inserted into H can make the effective equation state-dependent. Even if the norm is preserved, further requirements such as linearity and causal consistency need separate analysis.

$$i\hbar\dot{\rho} = [H, \rho]$$

$$\mathrm{Tr}[H, \rho] = 0$$

Choosing a readout

Specify the observable operator and the state before evaluating an expectation. If the calculation is conditional, also specify the filter or effect and its normalisation. If it concerns a physical detector, provide the map from the internal observable to the detector quantity.

The source's sector expectations are finite and calculable once the inputs are given. Predicting an actual cross-section, transition rate or mass requires the effective interaction and kinematic structure. The internal expectation is one ingredient in that larger calculation.

This layered description is useful precisely because each layer can be checked. It becomes a physical prediction when the maps between them are explicit and their approximations are controlled.

CHECK: Inspection case: normalisation is preserved and causality is declared proven. Record the norm result, then inspect locality, the effective metric and the observable algebra separately. A finite unitary operator does not by itself supply every field-theory consistency property.

Continue with: M12 / M20 / M41

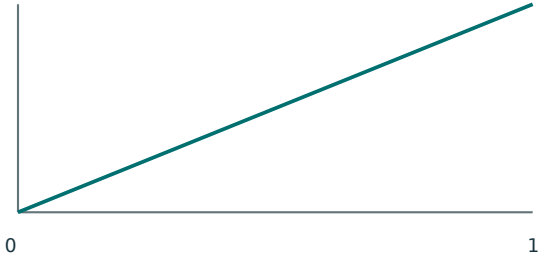
Choosing the activation construction

The activation field represents the model's local availability of an interaction. Its range is the unit interval. The independent-field construction gives it a separate spacetime dynamics, while the occupation construction derives it from the internal state. A calculation must choose which construction it uses.

Independent fields can all be inactive without violating the normalisation of an unrelated internal state. Complete orthogonal occupations cannot all vanish. This difference matters for the proposed dormant-sector and black-hole interpretations.

This edition uses independent alpha fields when analysing the supplied scalar actions. It uses P_a when evaluating sector occupation from a normalised state. A relationship between the two is an additional model assumption that must be written before it is used.

$$0 \le \alpha_a(x) \le 1$$



Exact model shape; axes are dimensionless

Enforcing the allowed interval

An evolution law must keep activation in its allowed domain. One approach uses constrained variables with boundary conditions. Another writes activation as a bounded function of an unconstrained field. The second approach changes the effective kinetic term through the derivative of that function.

A potential with a logarithmic entropy term has endpoint behaviour different from a simple polynomial. Numerical evolution must handle the domain explicitly rather than stepping across a logarithm's singular boundary. A finite time step is not a physical transition rule.

The chosen domain treatment affects stationary points, fluctuations and the meaning of a fully active endpoint. Record it alongside the action so that analytical and numerical calculations use the same model.

CHECK: State how the field equation preserves the activation domain.

Occupation-defined activation

If alpha_a is set equal to the expectation of Pi_a, it lies in the unit interval for an orthogonal projector and a normalised state. Its evolution follows from that state's dynamics. For a complete orthogonal decomposition, the alpha values then sum to one.

Placing those expectations inside H makes the effective generator state-dependent. The resulting evolution must be analysed as such. Norm preservation can still hold for a Hermitian state-dependent operator, but that fact alone does not establish a fundamental linear theory.

The source proposes an auxiliary bath to realise effective feedback in an enlarged linear system. That proposal needs the enlarged Hamiltonian and reduction rule, which are treated in the energy-balance module.

$$\alpha_a = P_a \quad \Longrightarrow \quad \sum_a \alpha_a = 1$$

Reading an epoch statement

An epoch is proposed as a regime in which relevant activations remain near a configuration for an extended duration. Constant activation is a description of that regime; it is not a calculation of its stability. The potential and kinetic terms must supply the latter.

The labels Higgs ON and Higgs OFF can identify intended regimes. They do not determine the background scale factor, transition history or survival of earlier photons. A cosmological solution is needed before those observational claims are evaluated.

This module gives the fields a clear domain and interpretation. The remaining activation modules now examine dynamics, stationary points and the threshold claims rather than prescribing an epoch sequence by label.

CHECK: Inspection case: an independent activation is replaced by a state expectation during differentiation. Record the change of definition and its constraints. Re-derive the field or state equation; do not carry the old independent-field dynamics into the occupation version unchanged.

Continue with: M10 / M22 / M45

Closed-state norm preservation

For the internal Schrödinger equation, a Hermitian generator preserves the norm when the state space and derivative are compatible with the chosen inner product. This is a finite dynamical consistency requirement independent of the proposed interpretation of the state.

Different sector amplitudes can change while the total norm remains one. Probability can move between sectors through off-diagonal terms. A change in an individual occupation does not imply loss of the total state norm.

Independent activation fields have a different conservation question. Their action may carry energy and couple to other fields, but the sum of their values is not automatically a conserved probability. A constraint linking them must be specified separately.

$$i\hbar\dot{\Psi} = H\Psi, \qquad H^{\dagger} = H$$

Differentiating the norm

Differentiate the inner product using the evolution of the ket and its adjoint. The two terms contain H with opposite signs. For a Hermitian generator they cancel exactly, leaving a zero derivative of the norm.

For a density matrix, the same cancellation appears as the trace of a commutator. This is the appropriate closed-system check. A bath reduction changes the system dynamics but must still preserve the total state's norm when the enlarged evolution is unitary.

If the covariant derivative includes a connection, verify compatibility with the inner product used. The generator and the connection must not be counted twice in two inconsistent versions of the same equation.

$$\frac{d}{d\tau}\langle\Psi|\Psi\rangle = 0$$

$$\mathrm{Tr}\,\dot{\rho} = 0$$

Sector-transfer equations

For a fixed projector, its occupation derivative is determined by the commutator with H. If the projector also depends on time, its explicit derivative adds another term. This distinction matters when the basis or selected sector changes during a transition.

A projector commuting with H has constant occupation in a closed evolution when it has no explicit time dependence. A diagonal locking Hamiltonian therefore changes phases but does not, by itself, transfer probability between its own fixed sectors.

Mixing terms or a moving sector definition can change the occupations. Relaxation towards a preferred occupation requires additional dynamics, such as a specified open-system mechanism, rather than only a deep diagonal energy label.

$$\dot{P}_a = \tfrac{i}{\hbar}\langle [H, \Pi_a] \rangle$$

$$[H, \Pi_a] = 0 \quad \Longrightarrow \quad \dot{P}_a = 0$$

What conservation does not prove

Norm preservation does not establish locality, Lorentz covariance or energy conservation for an explicitly time-dependent generator. It also does not supply a physical detector readout. These are separate properties that require their own equations.

For a Hamiltonian depending on evolving activation fields, the fields may exchange energy with the internal system. A consistent combined action or enlarged Hamiltonian must account for that exchange. Simply retaining a normalised state is not the full energy-balance calculation.

Use the norm calculation as a necessary internal check. Continue with the Hamiltonian, connection and bath modules to examine the remaining dynamical requirements.

CHECK: Inspection case: a deep diagonal locking term is said to transfer occupation into its sector. Calculate the commutator with the fixed sector projector. If it vanishes, the closed occupation is constant. Add and specify the dynamics responsible for any claimed relaxation.

Continue with: M18 / M21 / M44

The supplied generator structure

The source splits the internal generator into locking, sector mixing, geometry or connection, bath completion and generation mixing. Each term requires a defined operator and units. The sum is meaningful only when all terms act on the specified space and share energy units.

A locking term assigns energies to selected sectors. A mixing term transfers amplitude through off-diagonal operators. A connection describes parallel transport in a chosen effective geometry. A bath term acts on an enlarged space. The Z term acts on the selected generation index.

These terms provide a model architecture. Their coefficients and physical mapping remain essential inputs. Listing the terms does not determine their numerical strengths or prove that they recover a complete effective field theory.

$$H = H_0 + H_{\mathrm{mix}} + H_{\mathrm{gen}} + H_{\mathrm{bath}}$$

Covariant derivative bookkeeping

The source uses a derivative containing a connection Gamma_tau. Written as d/dtau plus Gamma_tau, it has inverse-time units. Moving that connection to the right-hand side of the Schrödinger equation produces a term with an explicit factor of minus i hbar.

Thus a connection matrix is not automatically a Hamiltonian in energy units. If it is represented as a geometric Hamiltonian contribution, show the conversion. The inner-product compatibility condition determines the appropriate adjoint relation in the representation being used.

For a Lorentz spinor description, the spacetime spinor inner product and frame structure require their own treatment. Internal Euclidean unitarity should not silently be substituted for that covariant construction.

$$D_\tau = \partial_\tau + \Gamma_\tau$$

$$i\hbar \partial_\tau \Psi = (H - i\hbar \Gamma_\tau)\Psi$$

Mixing operators and units

A Hermitian sector-mixing term can be formed from an operator M_ab plus its adjoint, multiplied by a real coefficient with suitable energy units. If the coefficient is dimensionless, the operator or an additional scale must supply the energy dimension.

The source's temperature and gravitational-potential factors are dimensionless ratios. They modulate a coefficient but do not supply its missing scale. The same point applies when a small angle is used as an off-diagonal entry: an angle is dimensionless, while a Hamiltonian entry carries energy.

Check units before integrating the evolution. Otherwise a numerical routine can evaluate a formally typed array while the resulting duration and frequency have no consistent physical meaning.

$$H_{ab} = \varepsilon_{ab}(M_{ab} + M_{ab}^{\dagger})$$

A consistent static limit

To define a static limit, specify the activation configuration, state, generator and observables. Constant coefficients do not require a time-independent state. A state may still evolve in phase or undergo mixing under a constant Hamiltonian.

Setting the Z coefficients to zero removes generation mixing through that term only. Recovering a particular older E8 field theory requires matching its action, field content, real form and dynamics. It is not established by setting an internal matrix to the identity.

The trial edition uses 0Z as the model's defined inactive-generation-mixing regime. A full equivalence with another theory is an additional bridge to be demonstrated.

CHECK: Inspection case: a connection with inverse-time units is added directly to an energy Hamiltonian. Show the factor and sign obtained by moving it from the covariant derivative. Verify the inner-product convention and avoid counting the connection twice.

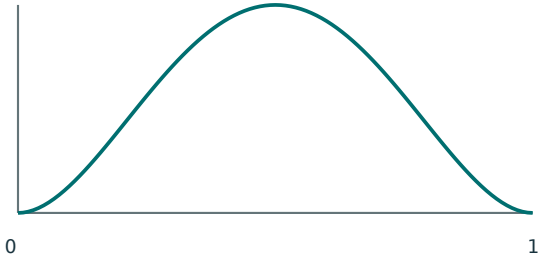
Continue with: M18 / M31 / M34

Why the variant must be named

The source history contains a polynomial-plus-entropy potential and a tilted double-well potential. Both can be studied mathematically, but they are different functions. Their stationary points, endpoint behaviour and transition structure cannot be combined as though one derivation applies unchanged to both.

The entropy variant uses a linear locking coefficient, a quadratic ordering term, a quartic coefficient and a temperature-dependent entropy contribution. The double well uses a quartic polynomial vanishing at two endpoints before a tilt is introduced.

The manual presents each with its own coefficients and scope. A final canonical action may select one or define a relationship between them. Until then, calculations must name the chosen variant.



Exact model shape; axes are dimensionless

The entropy variant

Write K_a for T_eff times d_a. This abbreviation makes the derivatives easier to inspect. The potential includes the mixing entropy alpha log alpha plus one minus alpha times log one minus alpha. Its interior derivatives are singular as either endpoint is approached at positive K_a.

All coefficients in this spacetime potential must carry compatible energy-density units when alpha is dimensionless. A locking energy from the internal Hamiltonian is not the same coefficient without a specified conversion. The kinetic normalisation is treated separately.

The logarithmic function is retained when analysing stability. Replacing it with a local polynomial approximation must state the expansion point and validity range.

$$V = -\mu\alpha + \tfrac{1}{2}(K - r)\alpha^2 + \tfrac{1}{4}u\alpha^4$$

$$V_{\mathrm{ent}} = K[\alpha \ln \alpha + (1-\alpha)\ln(1-\alpha)]$$

The tilted double well

The polynomial variant is lambda times alpha squared times one minus alpha squared in the factorised sense alpha squared times (alpha minus one) squared, plus a linear tilt. At zero tilt, the endpoints are equal minima and the midpoint is a barrier for positive lambda.

Differentiation gives a cubic stationary equation. A nonzero tilt changes the energies and locations of stationary points. It cannot be assumed to preserve both endpoint minima exactly. The field's constrained interval also affects how endpoint configurations are interpreted.

The diagram shows the symmetric dimensionless shape normalised to its maximum. It is a graph of the stated polynomial, not a computed cosmological history.

$$V_{\mathrm{dw}} = \lambda\alpha^2(\alpha-1)^2 + \varepsilon\alpha$$

$$V'_{\mathrm{dw}} = 2\lambda\alpha(\alpha-1)(2\alpha-1) + \varepsilon$$

Selecting a calculational model

Specify the potential, kinetic term, sector couplings and allowed field domain together. Then calculate stationary points and fluctuation masses. To claim a first-order transition, compare distinct minima and evaluate the transition conditions; a coefficient sign alone does not complete that analysis.

Bubble nucleation additionally needs a gradient term, dimensional context and an appropriate action. Thermal and vacuum tunnelling calculations use different bounce constructions. The same expression cannot be carried between them without its regime being stated.

The following modules carry out exact local derivatives of the entropy variant and inspect the proposed Casimir inequality. These checks are finite parts of the activation programme.

CHECK: Inspection case: the entropy potential and tilted double well are used in one unstated derivation. Identify the selected function. Recompute stationary points and curvature for that function, including its domain and any limiting temperature.

Continue with: M23 / M24 / M45

Stability starts with derivatives

A stationary point of an unconstrained interior activation potential satisfies V prime equal to zero. A positive second derivative gives local stability for a single canonically normalised scalar in the absence of coupled directions. Multiple fields require a Hessian and a kinetic matrix.

For the entropy variant, keep the logarithmic term when differentiating. Its derivative is the log of alpha divided by one minus alpha. Its second derivative is one over alpha times one minus alpha. These contributions remain relevant at positive temperature.

The calculation on these pages establishes the local shape of the written potential. It does not determine its coefficients or select a cosmological solution without initial conditions and the coupled field equations.

$$V'(\alpha_*) = 0$$

Exact interior derivatives

With K equal to T_eff d_a, the first derivative contains the linear locking contribution, the quadratic ordering contribution, the cubic quartic contribution and the entropy logarithm. The second derivative contains K minus r, three u alpha squared and the positive entropy curvature.

For positive K, the endpoint derivatives are not finite. A statement that the minimum occurs exactly at alpha equal to one therefore requires a limiting or constrained-boundary treatment. It cannot be substituted into the interior formula without that explanation.

These exact derivatives provide a direct inspection test for shorthand threshold claims. Any proposed instability criterion must be consistent with the actual curvature of the selected potential.

$$V' = -\mu + (K - r)\alpha + u\alpha^3$$

$$V'_{\text{ent}} = K \ln \frac{\alpha}{1-\alpha}$$

$$V'' = K - r + 3u\alpha^2 + \frac{K}{\alpha(1-\alpha)}$$

A zero-temperature check

At K equal to zero, the entropy term drops out of this potential. If the unconstrained polynomial is stipulated to have a stationary point at alpha equal to one, its first derivative gives u equal to mu plus r. Substituting this relation into the second derivative gives three mu plus two r.

This result is a potential curvature. It is not automatically a mass squared until the kinetic normalisation is supplied. For a constant coefficient f squared, the corresponding fluctuation mass squared divides that curvature by f squared.

This exact calculation replaces the unsupported shorthand that the same potential always gives mass squared equal to two times its linear locking coefficient.

$$u = \mu + r \quad \Longrightarrow \quad V''(1) = 3\mu + 2r$$

$$m_\phi^2 = \frac{3\mu + 2r}{f^2}$$

Coupled fluctuations

For several activation fields, evaluate the Hessian at a stationary configuration. The kinetic matrix determines the canonical normalisation. The physical small-fluctuation mass-squared eigenvalues come from the normalised Hessian, not from its raw entries alone.

Mixing with the Higgs, metric or other fields can alter this calculation. A non-minimal gravitational coupling may require a frame transformation and additional field normalisation before a particle mass is identified. The variables and approximations should be explicit.

The mass programme therefore needs both the potential coefficients and the kinetic structure. The manual's testing section records those inputs as prerequisites for a numerical prediction.

CHECK: Inspection case: potential curvature is called a physical scalar mass squared. Locate the kinetic coefficient and any coupled directions. Use the normalised Hessian if several fields mix. A raw second derivative does not remove the need for canonical normalisation.

Continue with: F03 / M24 / M47

The proposed filter

The source proposes an ordering drive proportional to a quadratic Casimir and compares it with an entropic cost proportional to sector dimension and effective temperature. This is intended to organise activation thresholds. Its physical force depends on the precise potential and coefficient definitions.

The original inequality is written as r_a greater than four T_eff d_a. If r_a equals B times C2(a), where B collects the remaining factors, the equivalent inequality retains the temperature. Removing it requires a stated rescaling.

A list of dimension-to-Casimir ratios can organise candidate inequalities. It cannot determine the current active gauge group without a fixed cutoff, a valid sector definition and a dynamical solution.

$$r_a = BC_2(a), \qquad r_a > 4T_{\text{eff}} d_a$$

$$B > 4T_{\text{eff}} \mathcal{R}_a$$

The curvature check

For alpha in the open unit interval, alpha times one minus alpha is at most one quarter. Its reciprocal is therefore at least four. With K positive and u nonnegative, the entropy-variant curvature is bounded below by five K minus r.

Consequently r greater than four K does not, by itself, establish a nonconvex potential or a first-order transition. A range remains in which the stated inequality is met but the lower curvature bound is still positive.

A first-order transition needs competing minima and a comparison of their energies, together with the appropriate transition dynamics. The numerical coefficient in a proposed inequality must follow from that analysis.

$$\frac{1}{\alpha(1-\alpha)} \geq 4$$

$$u \geq 0 \quad \Longrightarrow \quad V'' \geq 5K - r$$

Dormancy requires an interval

To activate a selected set while keeping another set dormant, the model needs a cutoff lying between the relevant thresholds. Merely saying that unwanted ratios are larger does not establish that they lie above the actual cutoff. The selected parameter interval must be calculated.

Conjugate representations have the same quadratic Casimir in a fixed convention. A Casimir-only drive therefore cannot distinguish them by chirality. Any proposed epoch, initial condition or additional operator that provides the distinction must appear in the calculation.

The source's full-adjoint trace definition also yields the same effective Casimir on every projected block. A more selective operator would be a revised definition, not a missing numerical evaluation of that scalar trace.

CHECK: Calculate the cutoff and all relevant sector thresholds in the same normalisation.

PROPOSED

M24 / 4 OF 4

A calculational route forward

Choose the sector operator and potential. Find all stationary configurations and test their local stability. Compare competing minima as the control parameters change. Then calculate whether the selected initial conditions reach the desired configuration and how transitions occur.

For a tunnelling claim, specify whether the calculation is thermal or quantum, the action being extremised and the gradient coefficient. For an ordinary roll, solve the field equations with the relevant background and damping. These are distinct mechanisms.

The filter remains a proposed organiser in this trial edition. Its completion task is explicit and finite enough to be inspected: a consistent set of operators, inequalities, minima and solutions.

CHECK: Inspection case: an inequality is labelled a first-order transition proof. Calculate all minima, their stability and their relative energies. The source curvature bound shows why its stated threshold alone is insufficient to establish the required potential structure.

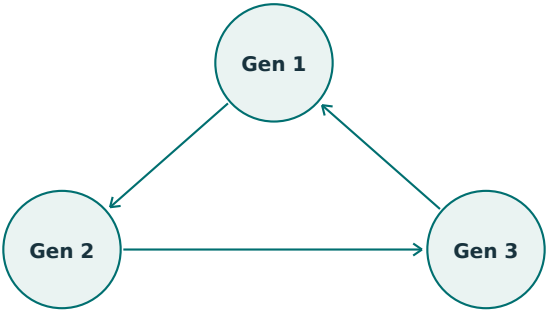
Continue with: M14 / M16 / M22

Defining the selected block

The explicit Z-gate acts on three selected internal subspaces of dimension sixteen. Their direct sum has dimension forty-eight. This definition fixes the domain of the block matrix before any claim is made about its action on the full 248-dimensional substrate.

In the chosen E6 x SU3 route, the copies come from the spinor component of the 27 tensored with the generation triplet. The label generation identifies their proposed physical role. Establishing that role requires the effective chiral spectrum and field-theory mapping.

The construction can nevertheless be examined exactly as internal linear algebra. Each subspace has an orthogonal projector, and the intended Z operation sends one selected subspace to the next. The following modules supply and inspect that operation.



A tensor-product basis

Choose an orthonormal basis for the generation label and an orthonormal basis for the sixteen internal directions. Their tensor products give the forty-eight basis directions. The generation projectors select one label while acting as the identity on the internal factor.

They are mutually orthogonal on this block and their sum is the block identity. If embedded in the full substrate, their sum is the projector onto the forty-eight-dimensional block, not necessarily the full identity. This difference must remain visible in a full-space occupation calculation.

The block basis is the basis in which generation labels have their simplest projector matrices. The Z eigenbasis will mix those labels while leaving the internal factor unchanged.

$$\Pi_g = |g\rangle\langle g| \otimes I_{16}$$

$$\sum_{g=1}^{3} \Pi_g = I_{48}$$

The projector cycle condition

The defining requirement is conjugation of each generation projector to the next. Acting on a state, Z therefore transfers the selected subspace. Applying the operation three times returns every generation label to its original position.

The projector condition does not by itself specify the internal sixteen-dimensional action. The simplest construction uses the identity there. A more general cycle could carry additional internal transformations, provided their three-step product obeyed the intended condition.

This edition uses the simple identity action on the internal factor. That is the explicitly calculable block construction carried into the Hamiltonian analysis.

$$Z\Pi_1 Z^{-1} = \Pi_2$$

$$Z\Pi_2 Z^{-1} = \Pi_3$$

Scope of the block definition

The block construction defines an internal cyclic operator. It does not select a vacuum or remove the other representation blocks. It also does not derive a physical evolution time merely by requiring three steps.

The coefficients that couple Z to a Hamiltonian must carry an energy scale. Activation fields may modulate those coefficients, but their dependence must be specified before a transition can be calculated. The later Z modules show what follows from the symmetric Hamiltonian already supplied.

Read the first five Z modules as a construction record: domain, basis, forward action, inverse action, eigenspaces and full-space extension. The physical interpretation is assessed after those parts are fixed.

CHECK: Inspection case: the three generation projectors are summed and called the full substrate identity. Their sum is the identity on the selected 48-dimensional block. State how that block sits inside the 248-dimensional space before using completeness.

Continue with: M15 / M26 / M29

A matrix with an unambiguous direction

For column vectors ordered by generations one, two and three, choose the shift whose columns send the first basis vector to the second, the second to the third and the third to the first. This convention fixes the meaning of forward in the manual.

The displayed matrix is off-diagonal in the generation basis. Its entries are ordinary zero and one values on the three-label factor. Replacing each unit entry by the sixteen-dimensional identity gives the full forty-eight-dimensional block action.

The matrix maps a column of block components to the ordered column consisting of the old third, first and second components. The movement of basis labels and the reordered list of components are two descriptions of the same operation.

Forward shift P

$$\begin{vmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{vmatrix}$$

Column vectors: 1 to 2 to 3 to 1

The three-step identity

Applying P twice gives the reverse shift. Applying it three times gives the identity. Because a permutation matrix has orthonormal columns, its inverse equals its transpose; for this real matrix the transpose also equals its Hermitian adjoint.

The tensor product with the internal identity preserves these properties. Thus Z is unitary on the selected block and satisfies the required order-three identity. It is not the identity operator because it changes each selected generation label.

These statements are finite matrix calculations. They are not consequences of an analogy with a spatial rotation or a change of epoch.

$$P^3 = I_3, \qquad P^{-1} = P^2 = P^\dagger$$

$$Z = P \otimes I_{16}$$

Checking a basis vector

Apply the matrix to the first generation basis vector. The output is the second basis vector. Apply it again and obtain the third. The third application returns the first. Repeating the same check from either of the other starting labels gives the same cyclic order.

To check the projector relation, map a vector in the first selected block through Z, apply the second projector and compare with projecting before the shift. The actions agree on every vector in the direct sum. Conjugating the first projector therefore produces the second.

The supplied verification script performs these products using exact integer entries, so no floating-point tolerance is needed for this part of the construction.

$$P(1,0,0)^T = (0,1,0)^T$$

$$P(v_1,v_2,v_3)^T = (v_3,v_1,v_2)^T$$

Retaining the convention

The transpose matrix is equally valid as a reverse convention. Trouble arises only when the displayed matrix and stated projector cycle disagree. The trial edition fixes that disagreement by using this forward matrix consistently.

If another basis ordering is adopted, record the permutation that changes it. Matrix entries and projector labels must transform together. A written arrow such as one to two is not sufficient unless the basis convention is known.

The forward shift supplies the structural Z operation. Its Hamiltonian use requires the further calculations in the second half of the Z section.

CHECK: Inspection case: the displayed matrix and forward arrow disagree. Apply the matrix to each basis column. Label the cycle obtained, then update projectors and arrows consistently. This exact test fixes orientation without any physical interpretation.

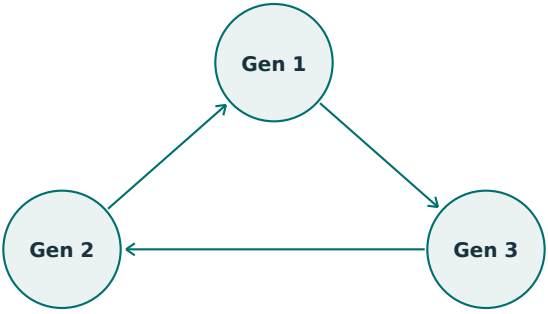
Continue with: M25 / M27 / M31

The inverse is the second power

The order-three identity makes the inverse operation the square of Z. In the chosen column-vector convention, the inverse sends generation one to three, three to two and two to one. Applying forward and reverse in either order returns the original state.

The direction labels describe the internal index operation. They do not themselves describe increasing or decreasing activation. A model may couple one regime to one direction, but the coupling is an additional dynamical statement.

The minus sign used in the source's minus-Z regime is therefore a label to be interpreted carefully. The negative matrix minus Z is not the same as Z inverse.



Signs and inverses

For the order-three operator, Z inverse equals Z squared. Multiplying Z by minus one instead gives a matrix whose cube is minus the identity. These are different algebraic operations with different orders and eigenvalues.

A negative coefficient in a Hamiltonian changes the sign of that Hamiltonian contribution. It may reverse continuous evolution under that contribution when the other conditions are fixed. It does not automatically apply the inverse discrete shift once.

The source's activation and deactivation language can remain useful, provided its sign, operator and field-evolution meanings are specified separately. This prevents a regime label from being mistaken for a matrix identity.

$$Z^{-1} = Z^2$$

$$(-Z)^3 = -I$$

Changing the generation basis

Let U be a unitary basis transformation. The matrix representing Z changes by conjugation, and every generation projector changes by the same conjugation. The projector cycle then remains true in the new basis because the transformation acts on the entire relation.

Keeping the old projector matrices while diagonalising only Z gives a different collection of operators. In that inconsistent combination, diagonal phases commute with the old block projectors and cannot cycle them.

A basis change is therefore a simultaneous change of representation for all relevant states and operators. It changes their coordinates, not the underlying linear map or the probabilities calculated consistently from them.

$$Z' = U^\dagger Z U, \qquad \Pi'_g = U^\dagger \Pi_g U$$

Regime definitions

The model's 0Z regime can be defined by zero generation-mixing coefficients. The plus-Z and minus-Z labels can identify activation and deactivation regimes. Those definitions need not change the underlying order-three operator.

A switch in a coefficient requires a control law, threshold and transition duration. A discontinuous rule is possible as a constructed model, but its energy and field-theory implications need to be checked. A tangent-coordinate singularity does not supply those conditions automatically.

Use the regime label as a navigation aid. Use the actual matrix, coefficient and field equation when calculating what happens in that regime.

CHECK: Inspection case: minus Z is used for the inverse shift. Cube it: the result is minus the identity. The inverse of the order-three gate is Z squared. Keep deactivation, a negative coefficient and inverse cycling as distinct specified operations.

Continue with: M21 / M31 / M33

Three cube roots of unity

The cyclic shift has eigenvalues one, omega and omega squared, where omega is the complex cube root exp of two pi i over three. Their cube is one, and their sum is zero. These are exact algebraic properties of the chosen matrix.

An eigenvector can be written using the ordered components one, lambda squared and lambda, divided by the square root of three. Applying P returns lambda times that vector when lambda is one of the three cube roots.

The resulting three eigenvectors form an orthonormal Fourier basis. The operation is diagonal in that basis even though it is a shift in the generation basis.

$$\omega = e^{2\pi i/3}, \qquad 1 + \omega + \omega^2 = 0$$

Verifying the eigenvectors

Applying P to the components one, lambda squared and lambda gives lambda, one and lambda squared. Multiplying the original vector by lambda gives the same list because lambda cubed equals one. This proves the eigenvalue equation directly.

For lambda equal to one, the eigenvector is the symmetric sum of the three generation labels. The other two eigenvectors have phases separated by the cube roots. Their mutual orthogonality follows from the zero sum of the cube roots.

The internal identity factor repeats each eigenvector construction in every one of the sixteen internal directions. Each eigenvalue therefore has multiplicity sixteen on the generation block.

$$f_\lambda = \frac{1}{\sqrt{3}}(1, \lambda^2, \lambda)^T$$

$$P f_\lambda = \lambda f_\lambda$$

Diagonalisation and projectors

Collect the normalised eigenvectors as columns of F. The transformed matrix F dagger P F is diagonal with the three eigenvalues. A generation projector transforms with the same F and becomes a matrix that generally has off-diagonal entries in the eigenbasis.

This explains the earlier diagonal-versus-shift issue without changing the operator. The diagonal phase matrix is a representation of the shift after the basis change, not a phase operation on the unchanged generation blocks.

An expectation value remains invariant when states and operators transform consistently. The observable calculation therefore provides a second check on a proposed basis change.

$$F^{\dagger} P F = \mathrm{diag}(1, \omega, \omega^2)$$

Reading the spectrum physically

Eigenvalues of a dimensionless unitary are phases. They are not energies or masses by themselves. A Hermitian generator built from Z can have energy eigenvalues after its coefficients are assigned energy units. Its physical interpretation still depends on the effective matter construction.

The eigenbasis is useful for solving the supplied Hamiltonian. It also makes degeneracy and symmetry transparent. It does not identify a preferred time direction, a detector signal or a particle mass without additional equations.

The next modules use this basis to extend the action and calculate the full candidate spectrum and continuous evolution.

CHECK: Inspection case: Z is diagonalised while the generation projectors are left unchanged. Transform them by the same Fourier basis change. Recheck conjugation and expectations using the transformed state and operators together.

Continue with: M29 / M30 / M31

Completing the operator domain

The explicit generation matrix occupies only forty-eight dimensions of the chosen substrate. A full operator must specify an action on every other direction. There is more than one mathematical way to do this, and the choice affects the full spectrum.

A simple direct-sum extension uses the identity on a chosen two-hundred-dimensional complement. It is a valid unitary order-three operator on the full vector space. That construction does not automatically preserve the E8 Lie bracket or implement the full subgroup action.

An alternative uses the generation-SU3 element on every block of the E6 x SU3 branching. That action includes the other components of the 27, its conjugate and the SU3 adjoint.

$$Z_{\text{simple}} = Z_{48} \oplus I_{200}$$

Two different spectra

On the generation block, each cube-root eigenvalue has multiplicity sixteen. Adding the identity complement therefore gives multiplicities two hundred sixteen, sixteen and sixteen. The total remains 248.

The full subgroup-induced action has multiplicities one hundred thirty-four, fifty-seven and fifty-seven, as calculated in the next module. The difference is produced by the nontrivial actions on blocks outside the selected three spinor copies.

These are different full operators even though they agree on the selected block. A claim involving a full E8 automorphism must choose the complete action before a spectrum comparison is meaningful.

$$\mathrm{mult}(Z_{\mathrm{simple}}) = (216, 16, 16)$$

$$\mathrm{mult}(Z_{\mathrm{subgroup}}) = (134, 57, 57)$$

Constructing the subgroup action

The candidate SU3 element is the cyclic permutation matrix P. Its determinant is one, so it belongs to SU3. It acts on the triplet factor, by conjugation on the adjoint factor, and with its conjugate action on the conjugate triplet.

The E6 adjoint paired with an SU3 singlet is fixed. The 27 tensor triplet repeats each triplet eigenvalue twenty-seven times. The conjugate block supplies the same multiplicities because conjugation exchanges omega and omega squared.

The corresponding full action is a linear operator induced by the specified subgroup representation. To write its numerical 248 by 248 matrix, a common basis for all blocks is required.

$$\det P = 1$$

Scope and identification

The full subgroup action is a candidate structural realisation of Z. Its existence does not identify it with every order-three triality construction. Equal order is a weak comparison, and equal spectra are still only a linear-space comparison unless the named algebra and physical subspaces are also matched.

When a basis intertwiner is proposed, state the matrices it intertwines and the constraints it preserves. If gauge or Lorentz assignments are fixed, the intertwiner must respect those assignments where required by the physical claim.

The book records the block operator, simple extension and subgroup extension separately. This makes future comparisons precise instead of relying on an ambiguous phrase such as the full Z-gate.

CHECK: Inspection case: an identity-padded extension is assigned the subgroup spectrum. Count the 200 fixed complementary directions and the sixteen fixed generation directions. The simple extension has multiplicities 216,16,16; the full subgroup action needs its other blocks.

Continue with: M15 / M30 / M34

Counting every block

The full generation-SU3 action is calculated on the E6 x SU3 branching. The E6 adjoint is fixed, the SU3 adjoint transforms by conjugation, and the two eighty-one-dimensional blocks transform through their triplet and conjugate-triplet factors.

The calculation is finite and independent of a particle interpretation. It asks how many internal directions have each cube-root eigenvalue under this specified subgroup element. The answer is useful for comparison with another explicitly given full operator.

Each block's contribution must be counted before the totals are combined. Omitting the other components of the 27 or the SU3 adjoint would incorrectly give the spectrum of a simpler block extension.

1
multiplicity 134

omega
multiplicity 57

omega squared
multiplicity 57

The SU3 adjoint contribution

Diagonalise the triplet action so its eigenvalues are one, omega and omega squared. Conjugation sends a matrix unit with row i and column j to the same unit multiplied by the ratio of those eigenvalues.

The diagonal traceless matrices form two fixed adjoint directions. Among the six off-diagonal matrix units, three have eigenvalue omega and three have eigenvalue omega squared. Thus the eight-dimensional SU3 adjoint contributes multiplicities two, three and three.

Each 27 tensor triplet contributes twenty-seven directions at each eigenvalue. The conjugate tensor block contributes the same multiplicities, with the two nonreal eigenvalues exchanged.

$$\mathrm{mult}(\mathrm{Ad}_{SU3}P) = (2, 3, 3)$$

Combining the contributions

The fixed multiplicity is seventy-eight from the E6 adjoint, two from the SU3 adjoint and twenty-seven from each tensor block. The other two multiplicities each receive three from the SU3 adjoint and twenty-seven from each tensor block.

The totals are therefore one hundred thirty-four, fifty-seven and fifty-seven. They add to 248. The trace of Z is one hundred thirty-four plus fifty-seven times the sum of omega and omega squared, giving seventy-seven.

The trace of Z squared is also seventy-seven. These trace values provide another exact check on the full candidate action and its spectral projectors.

$$m_1 = 78 + 2 + 27 + 27 = 134$$

$$m_\omega = m_{\omega^2} = 3 + 27 + 27 = 57$$

$$\operatorname{Tr} Z = 77$$

Spectral projectors and scope

The fixed eigenspace projector is one third of the sum of the identity, Z and Z squared. Its trace is the fixed multiplicity. The other spectral projectors use the corresponding conjugate phase weights and have rank fifty-seven.

These eigenspace projectors are not the three generation-block projectors. One labels phases of the full operator; the other labels three selected copies of the internal spinor. Keeping the two decompositions distinct is essential to the interpretation.

The spectrum verifies the candidate subgroup action. Identification with a specific named triality operator requires its full action and compatibility conditions, which remain explicit in the final Z module.

$$E_1 = \frac{I + Z + Z^2}{3}$$

$$\operatorname{Tr} E_1 = 134$$

CHECK: Inspection case: the phase-eigenspace projectors are called family projectors. Compare their ranks and definitions. The fixed full eigenspace has rank 134; a selected family projector has rank sixteen. They organise different decompositions.

Continue with: M28 / M29 / M34

Two written terms, one matrix structure

The source Hamiltonian uses the Hermitian combinations Z plus Z dagger and Z squared plus its adjoint. For an order-three unitary, the two combinations are equal. Their coefficients therefore combine into one effective coefficient kappa.

This is a useful simplification, but it also limits what the term can do by itself. It treats the forward and reverse neighbours symmetrically. Separate signs on the original two coefficients do not create two independent matrix directions.

The generator has energy units when kappa does. It produces continuous unitary evolution; it is not the same operation as applying the discrete shift once. The next pages calculate this distinction explicitly on the three-label block.

$$H_{\mathrm{gen}} = \kappa(Z + Z^{\dagger})$$

$$\kappa = \kappa_1 + \kappa_2$$

Eigenvalues and a closed solution

On the three-label factor, the Hermitian matrix is kappa times J minus I, where J is the matrix with every entry equal to one. J acts as three on the symmetric vector and as zero on the two-dimensional zero-sum subspace.

The Hamiltonian therefore has eigenvalues two kappa and minus kappa twice. Its exponential can be calculated using the symmetric projector J over three and its orthogonal complement. Define s as kappa tau over hbar to display the dimensionless evolution variable.

This solution assumes a constant real kappa and no other Hamiltonian terms. It is an exact solution of that specified subsystem, not a cosmological evolution result.

$$A = J - I, \qquad H_{\text{gen}} = \kappa A$$

$$s = \frac{\kappa \tau}{\hbar}$$

$$U = e^{is}\left[I + \frac{e^{-3is} - 1}{3} J\right]$$

Calculated transition probabilities

Start in generation one. The amplitudes to generations two and three are identical in this symmetric evolution. Their common probability is four ninths times the square of sin of three s over two. The remaining probability stays in generation one.

Adding the three probabilities gives one. Neither individual transfer probability reaches one, so this Hamiltonian cannot realise an exclusive perfect one-to-two shift at any duration under the stated assumptions. The same conclusion applies to the other starting labels.

This is an exact dynamical limitation of the supplied symmetric term. Another term or a different generator would be needed to implement a particular directional gate as a timed physical operation.

$$P_{1\to 2} = P_{1\to 3} = \frac{4}{9}\sin^2\frac{3s}{2}$$

$$P_{1\to 1} = 1 - \frac{8}{9}\sin^2\frac{3s}{2}$$

VERIFIED

M31 / 4 OF 4

A possible operator extension

The Hermitian matrix i times Z minus Z dagger is distinct from the symmetric combination. It changes sign when Z is exchanged with its inverse. It provides a mathematical direction-sensitive component in the algebra of cyclic operators.

Introducing it into the physical Hamiltonian would be a revised model choice with a new coefficient and interpretation. The trial edition records the operator possibility; it does not assign a physical value or claim that the source already derived that term.

The verified result here is the symmetry and exact evolution of the Hamiltonian actually supplied. Its physical completion must retain that result rather than assuming an uncalculated directional cycle.

$$A_{\text{odd}} = i(Z - Z^\dagger), \qquad A_{\text{odd}}^\dagger = A_{\text{odd}}$$

CHECK: Inspection case: the symmetric Hamiltonian is reported to transfer exclusively from generation one to two. Its exact solution gives equal probabilities for transfer to two and three. A directional timed gate requires a different specified generator or additional terms.

Continue with: M27 / M32 / M33

A spectrum is not yet a mass hierarchy

The symmetric generation matrix has one eigenvalue different from a doubly degenerate pair. On the selected forty-eight-dimensional block, the multiplicities are sixteen and thirty-two. This spectrum is exact for the stated matrix.

Interpreting it as physical fermion masses requires the effective mass terms and canonical field normalisation. For Dirac fermions, physical masses are singular values of the mass matrix. Signed eigenvalues of a Hermitian internal operator are not automatically those singular values.

The source proposes that Higgs and Yukawa contributions complete the mass structure. Those matrices and their activation dependence must be specified before the observed hierarchy or mixing angles can be derived.

2 kappa
16 directions

- kappa
32 directions

The fermion calculation

Let M_f be an effective Dirac mass matrix. Left and right unitary transformations bring it to a diagonal matrix of nonnegative masses. In the Standard Model convention, an effective Yukawa matrix produces the mass matrix through the Higgs vacuum scale divided by the square root of two.

The up-type and down-type left diagonalising matrices determine the quark mixing matrix. Neutrino mixing additionally depends on the chosen neutrino mass mechanism. A common internal generation operator does not by itself determine all these matrices.

The model must explain which terms break the cyclic symmetry, lift degeneracies and generate the relevant complex phases. Those are physical completion tasks, not properties of the order-three identity alone.

$$U_L^\dagger M_f U_R = \mathrm{diag}(m_1, m_2, m_3)$$

$$M_f = \frac{v}{\sqrt{2}} Y_f$$

The common-basis limitation

If two Hermitian mass constructions are functions of the same symmetric generation matrix and the identity, they commute. They can be diagonalised in a common basis. This does not force a measured nontrivial CKM matrix.

Degenerate subspaces permit arbitrary basis rotations whose apparent angles need not represent physical mixing between distinct masses. A realistic hierarchy and mixing analysis must first resolve the degeneracy and identify the charged-current couplings.

The CKM matrix is calculated from the mismatch of the left-handed diagonalising bases, not by simply reading an angle from a spatial cell drawing. The correspondence would require a defined Yukawa construction.

$$V_{\mathrm{CKM}} = U_{uL}^{\dagger} U_{dL}$$

$$[f(A), g(A)] = 0$$

What a completed derivation would contain

Supply the effective up, down, charged-lepton and neutrino matrices, their kinetic normalisations and the source of their coefficients. State which quantities are inputs, which are fitted and which are calculated from internal geometry or activation.

Then calculate singular values, mixing matrices and phase invariants at a specified scale. Compare with observations using consistent running and uncertainties. A geometric proposal becomes a mass prediction through this complete sequence.

The Z-gate supplies a calculable candidate mixing structure. The trial manual gives that structure a precise scope while recording the extra equations required for its mass interpretation.

CHECK: Inspection case: negative internal eigenvalues are listed as negative physical fermion masses. Construct the effective mass term and calculate its singular values after field normalisation. Determine mixing from the left diagonalising bases and charged-current structure.

Continue with: M31 / M47 / M49

A cycle needs a time scale

An order-three operator specifies a three-step internal cycle. It does not state how long a step takes. A continuous dynamics introduces a generator with energy units and a time parameter. Their ratio through hbar determines the dimensionless evolution phase.

The source's proper-time equation already uses an effective metric to define duration along a timelike worldline. Deriving time from a more primary internal structure requires a separate clock construction. Reusing the same proper-time symbol is not that derivation.

An arrow of time additionally concerns ordering or irreversible behaviour. A reversible finite unitary cycle can be traversed in either direction. A bath, coarse-graining or boundary condition may contribute to an arrow, but each requires an explicit model.

$$U(\tau) = \exp(-iH\tau/\hbar)$$

Proper time and coordinates

In an effective Lorentzian metric with the stated sign convention, proper time along a timelike trajectory is calculated from the line element. The value depends on the metric and trajectory. It is not the number of internal labels.

A photon follows a null path in the standard effective description, so its own proper-time interval is zero. This does not supply a photon rest-frame clock or imply an infinite signal speed. The spacetime causal structure defines local propagation.

An internal clock proposal needs an observable that changes predictably, a calibration scale and a range over which the readout is unambiguous. A cyclic phase alone repeats and must be unwrapped or accompanied by another count.

$$c^2 d\tau^2 = -g_{\mu\nu} dx^\mu dx^\nu$$

The antisymmetric-expectation check

For a unitary Z, the operator Z minus Z dagger is anti-Hermitian. Its expectation in a normalised state is purely imaginary. Consequently its complex argument can take only the sign-dependent imaginary-axis directions when the expectation is nonzero.

This expectation does not provide a smoothly advancing clock angle. When it vanishes, its argument is undefined. Multiplying that argument by a time scale cannot repair the absence of a continuously calibrated readout.

The result identifies a limitation of a proposed clock shorthand. A different relational observable or a fully specified clock subsystem could be investigated, but it would be a new construction with its own verification.

$$\langle Z - Z^\dagger \rangle \in i\mathbb{R}$$

Threshold language and time

A tangent function diverges at selected coordinate values. A model can choose that divergence as a diagnostic, but the divergence itself does not define the physical transition law. The law must state the control variable, threshold and behaviour on each side.

For a bounded activation, a smooth bounded control function may be convenient. A true singular driver needs a treatment of its domain and continuation. The identity of the Z operator does not decide between these dynamical choices.

The manual retains Z as an internal structure operator and treats a time-emergence interpretation as proposed. This keeps the exact cycle calculation separate from the still-needed clock and causal constructions.

CHECK: Inspection case: the argument of the Z minus Z-dagger expectation is used as a clock. The expectation is purely imaginary and its argument is undefined at zero. Choose a calibrated dynamical readout with an explicit duration scale.

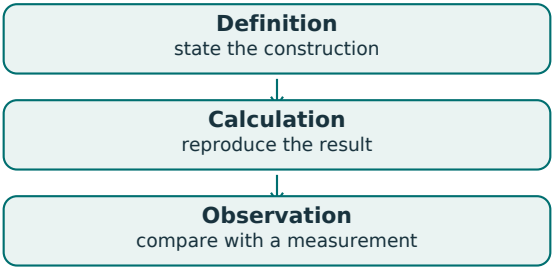
Continue with: F02 / M21 / M40

Matching more than the name triality

The cyclic SU3 element supplies an order-three action on the selected branching. Triality also appears in other algebraic constructions, especially the permutation of the three eight-dimensional Spin8 representation types. A shared order or name does not identify two specific operators.

For the complex E8 algebra, the Dynkin diagram has no nontrivial automorphism. An order-three subgroup element can nevertheless induce an inner algebra automorphism. Spin8 triality is an outer automorphism of Spin8; its embedding in a larger algebra requires a separate construction.

The trial manual records these distinctions so the proposed link to Lisi's triality work can be tested against actual operators instead of a diagrammatic resemblance.



The intertwining problem

Name both full operators, their bases and their inner products. Seek an invertible or unitary map U satisfying the stated intertwining relation. If the physical claim requires named gauge or Lorentz subspaces to remain fixed or to transform in a particular way, include those constraints.

If an algebra automorphism is claimed, verify bracket preservation on a basis of generators. If only a linear representation equivalence is claimed, say so. Matching spectra of normal operators can establish a linear unitary equivalence, but it does not establish the stronger named-subalgebra correspondence.

The spectrum comparison from the preceding modules is therefore a necessary piece of a constrained identification, not a substitute for its remaining conditions.

$$UZU^{-1} = t$$

$$Z[X, Y] = [ZX, ZY]$$

A finite inspection procedure

Construct the candidate matrices in a common basis. Verify order, inverse and adjoint relations. Compute eigenvalue multiplicities or exact traces. Check the proposed intertwiner. Then test every algebraic and physical-subspace condition actually used in the claim.

Record failure as a result. A mismatched spectrum rejects a proposed linear equivalence. A bracket failure rejects an algebra automorphism claim. A gauge-subspace mismatch can reject a physical identification while leaving the internal linear cycle valid.

This procedure makes the proposed connection falsifiable at the mathematical level. It is more informative than calling every order-three internal action the same Z-gate.

CHECK: State the exact equivalence being tested and its required invariants.

Present status of the Z programme

The selected forward block is defined and its matrix identities are verified. The symmetric Hamiltonian's spectrum and constant-coefficient evolution are verified. The candidate full generation-SU3 spectrum is calculated. Physical masses, time emergence and a particular external-operator identification remain proposed connections.

Lisi's relevant papers provide primary comparison material. The proposed model must still supply its own operator map and low-energy field content. Similarly, a dynamical projection does not automatically bypass the representation-theoretic obstruction discussed by Distler and Garibaldi.

The Z section closes with a concrete research record rather than a global proof claim. It supplies enough mathematics for a reader to repeat the central calculation and identify the next exact task.

CHECK: Inspection case: two operators have equal spectra and are declared the same physical triality. State whether the claim is linear equivalence, bracket-preserving equivalence or a gauge-compatible identification. Verify the extra conditions actually needed by that claim.

Continue with: M15 / M30 / M46

M35 / 1 OF 4

A projection requires a map

The source draws spatial cells as projections of a higher-dimensional internal structure. To calculate such a picture, specify a map from the root-coordinate space to the chosen drawing or spatial-coordinate space. The domain, target, basis and scale all affect the result.

A linear map from eight Euclidean coordinates to three drawing coordinates is straightforward to construct. It can merge distinct roots or change their projected angles. Its existence does not establish that the resulting coordinates are physical spacetime coordinates.

The book uses drawings to explain proposed relationships and analytical formulas to inspect them. A diagram labelled projection remains a diagram until the physical map and dynamics are supplied.



Concept diagram; not a derived E8 or spatial packing

An explicit linear description

Let Q be a three-by-eight matrix and let r be an E8 root-coordinate vector. The projected point is Qr. Its squared length is r transpose Q transpose Q r. The angle between two projected points depends on this same matrix and their projected lengths.

If Q has orthonormal rows, Q transpose Q is an orthogonal projector in the eight-dimensional coordinate space. Components orthogonal to the selected three-dimensional subspace are removed. The resulting point cloud retains only part of the root geometry.

A physical interpretation requires additional information: what selects Q, what sets its scale, and how effective observables depend on the projected coordinates. These are model inputs or derivation tasks.

$$x = Qr, \qquad Q : \mathbb{R}^8 \to \mathbb{R}^3$$

$$\|x\|^2 = r^T Q^T Q r$$

Projected angles

The dot product of projected vectors is r transpose Q transpose Q s. Divide by their projected lengths to obtain the cosine of the drawing angle when both projections are nonzero. A zero projection has no direction and therefore no defined angle.

The allowed root angles in eight dimensions do not automatically remain the same after projection. Conversely, a tetrahedral drawing angle need not be an angle between E8 roots. This is why the manual distinguishes internal geometry from spatial-cell geometry.

If an angle is proposed to produce a detector correlation, an additional readout calculation must connect this geometry to the observable. Similar-looking angles alone do not supply that connection.

$$\cos\theta_Q = \frac{r^T Q^T Q s}{\|Qr\|\,\|Qs\|}$$

A reproducible projection record

Record Q, the root-coordinate convention, any translation or scaling, and the method used to render the drawing. Distinguish a projection from a slice: projecting keeps images of all points, while slicing selects points satisfying an extra condition.

The tetrahedral and octahedral diagrams in this edition are schematic illustrations of the corresponding shapes. Their analytical measures are stated separately. They are not presented as a uniquely derived physical projection of E8.

This record makes the geometry programme inspectable. A future derivation can then show which projection the dynamics selects and what measurable consequence follows.

CHECK: Inspection case: a projected root angle is assumed unchanged. Calculate it using Q transpose Q and the projected lengths. A zero projection has no direction. The physical interpretation also needs a rule selecting the projection map.

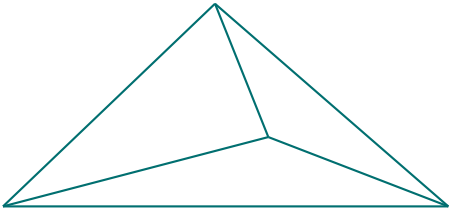
Continue with: M13 / M36 / M38

Defining the shape before measuring it

A regular tetrahedron has four equilateral triangular faces and six equal edges. A regular octahedron has eight equilateral triangular faces and twelve equal edges. The source's diamond language is retained as a visual name for the octahedral proposal where that regular shape is intended.

Some source constructions use a nonregular tetrahedron. A nonregular shape has different face areas, heights and angles. Its formulas must therefore be derived from its coordinates or edge lengths rather than borrowed from the regular case.

This module supplies regular-shape formulas as exact geometric reference material. Their physical use in the model requires a stated cell identification and length scale.



Schematic edges; use stated analytic measures

Regular tetrahedral directions

Four vectors with components chosen as the four sign patterns shown by the analytic construction have equal squared length three and pairwise dot product minus one. After normalisation, every distinct pair has cosine minus one third.

The corresponding angle is arccos of minus one third. Reversing one directed axis changes the sign and gives arccos of one third. Thus the two complementary directed angles arise from the orientation convention, not from two different root lengths.

These are cell-direction angles. They are distinct from the finite angles between E8 roots. A model relating them must supply the projection and readout map.

$$n_1 = (1, 1, 1), \qquad n_2 = (1, -1, -1)$$

$$\hat{n}_i \cdot \hat{n}_j = -\tfrac{1}{3} \quad (i \neq j)$$

Areas and volumes

For a regular tetrahedron of edge length a, its total surface area is the square root of three times a squared. Its volume is a cubed divided by six times the square root of two. These formulas use the edge as the length convention.

For a regular octahedron of edge a, the area is twice the square root of three times a squared, and the volume is the square root of two times a cubed divided by three. Using the centre-to-vertex radius instead changes the appearance of the formula.

Keep the length convention beside every geometric ratio. Otherwise a change from edge length to radius can introduce an unexplained numerical factor into a proposed mass expression.

$$A_{\mathrm{tet}} = \sqrt{3}\,a^2, \qquad V_{\mathrm{tet}} = \frac{a^3}{6\sqrt{2}}$$

$$A_{\mathrm{oct}} = 2\sqrt{3}\,a^2, \qquad V_{\mathrm{oct}} = \frac{\sqrt{2}}{3}a^3$$

Using the cell proposal

A space-filling construction requires compatible cells, their adjacency and a metric. A picture of one tetrahedron and one octahedron does not specify a unique honeycomb, a dynamical vacuum or an effective isotropic continuum.

If a cell measure is proposed to influence activation, define which measure and why it enters the action. If a mass is proposed to depend on a geometric ratio, specify the field normalisation and scale. The geometry is then an input to a calculation rather than a number selected after observing the output.

The next module develops the unit checks needed for those couplings.

CHECK: Inspection case: an edge length is replaced by a centre-to-vertex radius without changing a volume formula. Derive the relationship between the lengths and substitute it explicitly. The regular and nonregular cell formulas must also remain distinct.

Continue with: M35 / M37 / M38

Physical and normalised measures

An area has length-squared units, while a volume has length-cubed units. Their ratio has inverse-length units. A locking energy can therefore be formed from hbar c times an area-to-volume ratio, provided the physical reason for that coupling is specified.

If the geometry is normalised by a reference length ell_0, write dimensionless area a_g and volume v_g. The same energy formula then becomes hbar c divided by ell_0 times the dimensionless ratio a_g over v_g.

The two forms are equivalent when the normalisation is consistent. Multiplying hbar c divided by ell_0 by a physical area-to-volume ratio would instead introduce an extra inverse length.

$$A = \ell_0^2 a_g, \qquad V = \ell_0^3 v_g$$

A dimensionally consistent proposal

The source's geometric locking idea can be written using either physical measures or normalised measures. The dimensionally consistent forms agree exactly. Their physical justification remains a proposed coupling principle; dimensional consistency alone does not derive them.

The reference length must be fixed by a stated rule or measured input if a numerical energy is required. Calling it a unit choice does not determine its ratio to an independently measured physical scale. Dimensionless ratios remain physical information.

If a projected area depends on activation, that dependence must be included when differentiating an action. Treating it as constant in one step and field-dependent in another gives inconsistent equations.

$$\mu = \hbar c \frac{A}{\nabla}$$

$$\mu = \frac{\hbar c}{\ell_0} \frac{a_g}{v_g}$$

The stiffness dimension

The proposed cell functional sums alpha_a divided by a block dimension times the square of an area-to-volume ratio. With physical measures it has inverse-length-squared units. In natural units this can match a mass-squared coefficient multiplying curvature.

Its derivatives depend on how the areas and volume change with the fields. If they are fixed and the only field dependence is linear alpha, its second derivative with respect to that alpha is zero. It cannot then supply a nonzero scalar mass through that derivative alone.

This is a direct check of the written functional. A nonlinear geometry dependence is possible as a revised construction, but it must be stated before its curvature is calculated.

$$\mathcal{G}_{\text{cell}} = \sum_{a} \frac{\alpha_a}{d_a} \left(\frac{A_a}{V} \right)^2$$

From a coupling to a result

Choose the geometric measures, length convention, field dependence and coefficients. Insert them into a complete action. Differentiate to obtain field equations and a canonically normalised fluctuation problem. Only then identify a mass or another observable.

This procedure prevents an area-to-volume ratio from being treated as an automatic Higgs-mass formula. The internal locking energy, potential density and physical scalar mass have distinct units and roles.

The manual preserves the geometric coupling as a proposed bridge while providing the exact unit and derivative checks needed to develop it. Those checks can be repeated independently of the physical interpretation.

CHECK: Inspection case: an energy expression includes hbar c over ell_0 and a physical area-to-volume ratio. Check units: that adds an extra inverse length. Use physical measures with hbar c, or dimensionless measures with hbar c over ell_0.

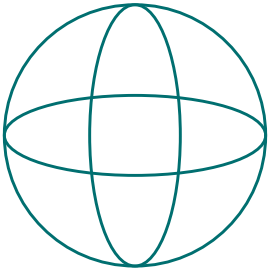
Continue with: F03 / M23 / M42

A sphere in four Euclidean dimensions

The three-sphere S3 is the set of points at a fixed radius in four-dimensional Euclidean space. It has three intrinsic dimensions. Its intrinsic measure therefore has length-cubed units, despite sometimes being described as the surface of a four-dimensional ball.

This geometric object is different from a two-sphere S2, whose area has length-squared units, and from a Lorentzian spacetime horizon. The source's hypersphere proposal must specify which of these structures is intended and how it maps to the physical description.

The exact Euclidean formulas can be calculated without endorsing a gravitational interpretation. This module supplies them as a reference for the later black-hole proposal.



Schematic projection; not a spacetime metric

Intrinsic measures

The S3 intrinsic measure is two pi squared times R cubed. Differentiating it with respect to R gives six pi squared times R squared. The S2 area is four pi times R squared. The derivative and the S2 area therefore have the same units.

Their ratio is three pi over two. That is a radial-response ratio, not an identification of the intrinsic S3 measure with an ordinary horizon area. Dividing the original S3 measure by S2 area would leave a factor with length units.

A proposed entropy correction must derive the relevant measure from its gravitational action. A dimensionless geometric ratio by itself does not establish which measure an entropy law uses.

$$\mathcal{V}(S^3) = 2\pi^2 R^3$$

$$\frac{d\mathcal{V}(S^3)}{dR} = 6\pi^2 R^2$$

$$\frac{d\mathcal{V}(S^3)/dR}{A(S^2)} = \frac{3\pi}{2}$$

Projection and slicing

Write a point of S3 as three spatial drawing coordinates plus a fourth Euclidean coordinate w. The sphere equation gives the squared three-coordinate radius as R squared minus w squared. Fixing w produces an S2 slice when the radius is positive.

Projecting all of S3 onto the three coordinates produces a filled three-ball, because every interior point has two possible fourth-coordinate values. This projection is not the same as taking the w-equal-zero slice, which gives the outer S2.

The distinction explains why the word shadow needs an explicit operation. A slice, projection and observed optical shadow are different constructions.

$$x^2 + y^2 + z^2 + w^2 = R^2$$

$$r^2 = R^2 - w^2$$

The model interpretation

The source uses pseudo-sphere and shadow as language for a higher-dimensional configuration's effective appearance. The geometry can help communicate the proposal. A physical black-hole identification also needs a metric, causal structure and stress-energy relation.

A fourth Euclidean coordinate is not automatically physical time. Substituting a timelike coordinate changes the metric and the meaning of the surface. Likewise, the projected three-ball is not automatically a material ball or a horizon.

Keep the exact measure calculation and proposed gravitational map together but separately labelled. The black-hole module then states what additional equations are required.

CHECK: Inspection case: S3 intrinsic measure is divided by S2 area and called dimensionless. The first has length-cubed units and the second length-squared units. The radial derivative of the S3 measure gives the stated dimensionless response ratio instead.

Continue with: M35 / M42 / M43

An established geometric background

Viazovska's result establishes the optimal density of the E8 lattice sphere packing in eight-dimensional Euclidean space. The result concerns congruent balls, Euclidean distances and packing density. It is a mathematical background for the project's use of E8 geometry.

It does not determine a spacetime activation potential or show that a physical vacuum minimises that potential at the E8 lattice. Those are distinct claims requiring a field action and an energy comparison. The manual attributes the packing theorem while keeping the proposed physical use explicit.

The lattice geometry also differs from the 248-dimensional adjoint state block. The same E8 name relates these mathematical constructions but does not make their dimensions interchangeable.



Concept diagram; not a derived E8 or spatial packing

A lattice-density calculation

In the standard E8 lattice normalisation, the shortest nonzero vector has length the square root of two and the fundamental-cell volume is one. Equal balls can therefore have radius one over the square root of two without overlap at nearest neighbours.

The volume of an eight-dimensional ball of radius r is pi to the fourth times r to the eighth divided by twenty-four. Substituting the packing radius gives pi to the fourth divided by 384. This computes the density of this lattice packing in the stated normalisation.

The density calculation establishes the candidate packing's density. The theorem that no packing exceeds it is the separate optimality result attributed in the references.

$$V_8(r) = \frac{\pi^4 r^8}{24}$$

$$\Delta_{E8} = \frac{\pi^4}{384}$$

Normalisation and scale

Uniformly rescaling a lattice and its ball radius leaves packing density unchanged. The numerator ball volume and the denominator cell volume scale by the same power. This is a dimensionless geometric ratio.

A physical energy scale is not fixed by that density. If a model identifies a lattice length with an interaction or gravitational scale, it must state a rule for that identification. The scale then enters physical observables separately from the packing fraction.

This distinction is useful for the geometric mass proposal: a dimensionless shape invariant can constrain a ratio only when the field dynamics specifies how it enters. The theorem does not supply the missing physical coefficient.

$$\Delta = \frac{V_{\text{ball}}}{V_{\text{cell}}}$$

Using the theorem responsibly

The theorem can support a chapter on the mathematical geometry selected by the project. A proposed connection to activation minima should be presented as a separate calculation to be performed: define the configuration space, potential, constraints and the map from states to lattice arrangements.

The public reader can then understand why E8 is an attractive background without being asked to accept that optimal packing already proves the physical framework. The distinction retains both the established result and the project's research question.

The next module makes the same distinction for the Leech lattice in twenty-four dimensions.

CHECK: Inspection case: optimal packing is claimed to fix an energy scale. Packing density survives a common rescaling. A physical scale therefore needs its own coupling or identification rule in the dynamics.

Continue with: M13 / M37 / M40

PROPOSED

M40 / 1 OF 4

Twenty-four dimensions need a named lattice

The Leech lattice is an even unimodular lattice in twenty-four Euclidean dimensions with no norm-two roots in its standard normalisation. The direct sum of three E8 lattices also has rank twenty-four, but it has norm-two roots. The two lattices are not identical.

The collaborative twenty-four-dimensional sphere-packing result establishes the optimality of the Leech lattice packing, including uniqueness among periodic optimal packings. That theorem does not identify every rank-twenty-four construction with the Leech lattice.

A proposed V.A.S.K. extension must therefore specify the lattice, embedding and physical map. Dimension arithmetic alone does not select the geometry.



Rank and root count are distinct invariants

An exact distinction

Each E8 summand has 240 norm-two roots. The direct sum has three times that number, since a norm-two vector can lie in one summand while the others are zero. This gives 720 roots in the standard direct-sum normalisation.

The Leech lattice has no norm-two roots in its standard even-unimodular normalisation. Its shortest nonzero vectors have squared norm four. These properties distinguish the structures even though their ranks agree.

Uniformly rescaling a lattice can change a shortest length, but it does not turn one lattice's complete structure into the other. A claimed identification needs a map preserving the intended lattice and metric properties.

$$\operatorname{rank}(E8^3) = 24$$

$$N_{\text{roots}}(E8^3) = 3 \times 240 = 720$$

Density and physical meaning

The standard Leech lattice has fundamental-cell volume one and shortest-vector length two. Its packing balls therefore have radius one. The twenty-four-dimensional ball volume is pi to the twelfth divided by twelve factorial in that radius convention.

This is a geometric packing density, not a probability that an epoch occurs or a duration of an internal cycle. A physical interpretation requires an action and the proposed state-to-lattice map. Any activation dependence must be included in the calculation.

The project's 8D-to-24D programme can be recorded as a research direction with these exact distinctions kept intact. No twenty-four-hour clock is derived by the rank count.

$$\Delta_{\mathrm{Leech}} = \frac{\pi^{12}}{12!}$$

A clock programme in this geometry

To derive a clock, choose a dynamical subsystem and observable, specify its generator and calibrate the relation between changes in that observable and effective duration. A lattice symmetry can organise the subsystem, but it does not supply the time scale alone.

If an epoch symmetry is proposed, define what transforms and what remains invariant. If three internal sectors are cycled, state whether the operation is a discrete symmetry or a continuous evolution. These questions connect the 24D programme to the exact Z analysis.

This module closes the geometric section with a clear distinction: established lattice facts, a defined project extension and an open physical-time construction.

CHECK: Inspection case: rank twenty-four is used to identify E8 cubed with the Leech lattice. Compare their roots in the stated normalisation: the direct sum has 720 norm-two roots, while the Leech lattice has none.

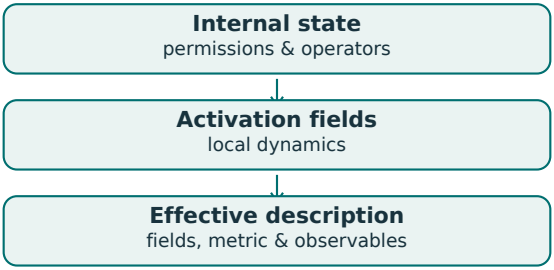
Continue with: M28 / M33 / M45

Internal structure and local fields

The source proposes that low-energy matter and gauge fields arise from the internal construction. A useful effective template contains spacetime spinor fields, gauge connections, couplings and mass terms. The template can organise calculations once those objects and their symmetries are specified.

A finite internal vector supplies representation components but does not automatically supply all field modes, a Fock space or fermionic statistics. The derivation must construct the local field description and identify the regime in which it applies.

The model's activation-dependent coupling can be inserted into a proposed effective action. Gauge invariance then needs to be checked in that complete action, including the transformation of every field and any space-dependent coefficient.



A Dirac template

The source uses a Dirac-type equation with gauge connections weighted by the effective sector couplings. The gamma matrices encode the spacetime Clifford relation. The matter field's gauge representation determines how the connection acts on its internal components.

An internal Spin10 spinor label does not itself provide a Lorentz spinor. The spacetime spin structure, frame and kinetic operator must be supplied. A gauge-generator projector likewise does not automatically specify the matter representation on which the gauge field acts.

This template is therefore a target effective description. A completed emergence calculation would derive its fields, coefficients and approximations from the more primary construction.

$$(i\gamma^{\mu}D_{\mu} - m_{p})\psi_{p} = 0$$

$$g_{pa}(x) = g_{a}^{(0)}w_{p,a}\alpha_{a}(x)$$

A propagation check

For the usual positive-energy relativistic dispersion, differentiating energy with respect to momentum gives the group velocity c squared p over E. The squared velocity divided by c squared equals one minus the rest-mass contribution divided by energy squared.

With nonnegative invariant mass squared, the local propagation is no faster than c in that effective description. The massless limit reaches c. These statements follow from the dispersion relation and do not count the number of active sector permissions.

An alternative dispersion or refractive model must be stated and tested separately. Inactive coupling factors do not remove a kinetic term or imply an infinite group velocity by themselves.

$$v = \frac{dE}{dp} = \frac{c^2 p}{E}$$

$$\frac{v^2}{c^2} = 1 - \frac{m^2 c^4}{E^2}$$

Coarse-graining as a derivation task

Specify the background state, fluctuation variables, retained correlations and field statistics. Expand the chosen action or Hamiltonian, then identify the effective kinetic and interaction terms. State which modes are integrated out and how their effects are represented.

The resulting theory must satisfy the symmetry and conservation requirements appropriate to its fields. A quadratic expansion alone does not prove the full interacting theory or its quantum consistency. It provides a calculable approximation whose scope must be reported.

The public manual can explain this route clearly. The test programme records the action, chiral spectrum and numerical predictions required to complete it.

CHECK: Inspection case: an internal spinor label is treated as a complete local fermion field. Construct the Lorentz spinor, kinetic term, gauge representation and statistics. The internal block organises components but does not supply all field modes.

Continue with: M18 / M42 / M46

Writing an actual coupled action

A scalar activation can back-react on a metric through its stress-energy. A non-minimal coupling can also make the coefficient of curvature depend on activation. These are familiar mathematical structures in a scalar-tensor effective action.

For one dimensionless activation, write a positive kinetic scale f squared, a potential density V and a curvature coefficient F(alpha). The source's cell-functional proposal can be included by defining F as the reduced Planck coefficient minus xi times that functional, with compatible units.

This gives an explicit effective coupling framework. It does not by itself supply a complete quantum-gravity theory or derive the cell functional from E8.

$$S = \int d^4x \sqrt{-g} \left[\frac{1}{2} F R - \frac{1}{2} f^2 (\nabla \alpha)^2 - V \right]$$

The metric and scalar equations

For a constant f and the displayed action, variation of the metric gives the Einstein tensor multiplied by F, the scalar stress-energy and derivative terms in F. Variation of alpha gives its wave operator, the potential derivative and a curvature source involving F prime.

The equations show back-reaction in both directions. The metric affects scalar evolution through covariant derivatives and curvature. The scalar affects the metric through stress-energy and the changing curvature coefficient. A proposed feedback mechanism needs these equations solved together.

If f or the geometric measures also depend on alpha, their derivatives add further terms. The trial equations on this page assume the locally constant kinetic scale stated above.

$$FG_{\mu\nu} = T_{\mu\nu} + \nabla_\mu\nabla_\nu F - g_{\mu\nu}\Box F$$

$$f^2\Box\alpha - V' + \tfrac{1}{2}F'R = 0$$

Effective strength and stability

In a constant-F background with the conventional minimal matter coupling, the gravitational coefficient is related to G by one over eight pi F in natural units. A changing F requires attention to scalar-mediated effects and the full effective description.

The source's F equal to a Planck coefficient minus xi times the cell functional can make the strength change when activation changes. The direction depends on the sign and field dependence. F must remain in the appropriate positive range for the intended effective gravitational kinetic term.

A stronger gravitational coefficient does not automatically imply accelerated expansion. Acceleration depends on the stress-energy and the complete field equations, including time derivatives of F where present.

$$F = M_{\mathrm{Pl}}^2 - \xi \mathcal{C}_{\mathrm{cell}}$$

$$G_{\mathrm{eff}} = \frac{1}{8\pi F} \quad (F \text{ constant})$$

What would validate the bridge

Define the geometric functional, its field dependence and coefficient scale. Check units, kinetic signs and the stationary background. Calculate the coupled solutions and their observable consequences. Then compare those consequences with gravitational and cosmological constraints.

The metric equation's derivative terms are essential for conservation. Omitting them while claiming a varying curvature coefficient would give an incomplete effective equation. The same care applies to stress-energy from all other fields and the bath.

The bridge is a proposed effective construction with a concrete calculation route. Its physical parameters and emergence from the internal substrate remain obligations of the framework.

CHECK: Inspection case: F varies but its derivative terms are omitted from the metric equation. Vary the full action and retain those terms. Check the scalar equation and stress-energy together before interpreting back-reaction.

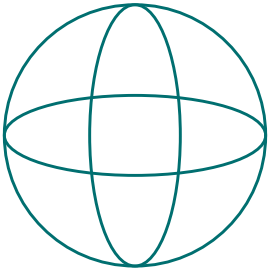
Continue with: M23 / M37 / M45

The source's geometric interpretation

The source proposes a black hole as a higher-dimensional configuration with an effective projected appearance. It uses hypersphere, pseudo-sphere and shadow as explanatory terms. To calculate the proposal, specify the higher-dimensional geometry and the map to the effective spacetime description.

A Euclidean S3 is not automatically a Lorentzian event horizon. In the usual four-dimensional nonrotating description, spatial cross-sections of the event horizon are S2 surfaces, while the full horizon is a null hypersurface in spacetime.

The model may propose a different underlying construction. It must still explain the effective metric, causal boundary and mass inferred from its observable gravitational effects.



Schematic projection; not a spacetime metric

A standard comparison geometry

For the Schwarzschild comparison case, the horizon radius is two G M over c squared. Its spatial area is four pi times that radius squared. These equations define the ordinary effective reference against which a proposed projection can be compared.

An optical black-hole shadow is not simply that horizon surface photographed. In the nonrotating comparison geometry, the limiting photon-orbit structure determines a critical impact parameter. The apparent angular size also depends on distance and observer conditions.

Calling an image a shadow is therefore acceptable as an analogy, but the model's projection map and the observed optical-shadow calculation must remain separate operations.

$$R_s = \frac{2GM}{c^2}, \qquad A_H = 4\pi R_s^2$$

$$ds^2 = -fc^2dt^2 + f^{-1}dr^2 + r^2d\Omega^2$$

$$f(r) = 1 - \frac{R_s}{r}$$

A null-orbit calculation

In the Schwarzschild comparison metric, the squared impact parameter for a turning point is r squared divided by one minus R_s over r. Its critical extremum occurs at r equal to three halves R_s. Substitution gives the critical impact parameter three square root of three G M over c squared.

This is an exact reference calculation within that specified geometry. It supplies a concrete difference between horizon radius and optical-shadow scale. It does not derive the V.A.S.K. hypersphere's physical projection.

The proposed map would need to reproduce the relevant lensing and dynamical observables or calculate a measurable deviation under stated conditions.

$$b^2 = \frac{r^2}{1 - R_s/r}$$

$$r_{\mathrm{ph}} = \frac{3}{2} R_s, \qquad b_c = \frac{3\sqrt{3} GM}{c^2}$$

Mass and higher dimensions

Mass is inferred through dynamical and gravitational effects; a black hole need not be a visible material ball for those effects to be measurable. A higher-dimensional label does not imply that its influence is instantaneous or everywhere at once.

If the model defines a projected mass through activations, calculate how that mass enters the effective metric and stress-energy. If activation vanishes, the definition may give zero projected mass, but it does not establish a conserved invisible remnant without the enlarged dynamics.

The following module gives the projected-mass proposal a precise energy-accounting task. It retains the inactive-mass language as a defined interpretation with explicit observable conditions.

CHECK: Inspection case: the observed optical-shadow scale is equated with the horizon radius. Calculate the null-orbit impact parameter in the chosen metric and include observer conditions. The hypersphere projection is a separate map requiring its own derivation.

Continue with: M38 / M41 / M44

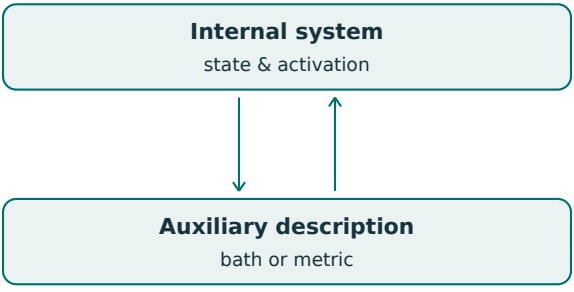
A defined projected mass

The source writes the effective black-hole mass as an activation-weighted sum of sector mass coefficients. This is a model definition. If all activations in that sum vanish, the defined projected mass vanishes. That limiting arithmetic does not determine the full gravitational solution.

Inactive mass or suspended mass can name the proposed interpretation. The hidden-energy claim needs a Hamiltonian or stress-energy description of the degrees of freedom retaining that energy. A sum of bare labels is not automatically a conserved total-energy operator.

The auxiliary bath is the proposed place to account for effective exchange and feedback while retaining a larger linear evolution. Its degrees of freedom and coupling must be specified.

$$M_{\mathrm{eff}} = \sum_a \alpha_a M_a^{(0)}$$



Continuous changes and jumps

For constant sector coefficients, differentiating the projected mass gives the weighted activation derivatives. A discontinuous activation change gives the corresponding finite mass jump. The source names an abrupt deactivation mass change Randa Suspension.

The jump formula defines the change; it does not supply a transition duration, energy flux or causal propagation law. An instantaneous idealisation may be useful in a model, but its regularisation and observational consequences must be calculated.

If accretion, radiative losses or other processes also change the mass, include them consistently in the effective evolution and in the total energy balance. They must not be counted twice through both activation and an independent loss term.

$$\dot{M}_{\mathrm{eff}} = \sum_a \dot{\alpha}_a M_a^{(0)}$$

$$\Delta M_{\mathrm{eff}} = \sum_a \Delta\alpha_a M_a^{(0)}$$

The enlarged conservation test

For a closed system with a time-independent full Hamiltonian, its expectation value is conserved under unitary evolution. With explicit time dependence, its derivative includes the expectation of the Hamiltonian's explicit derivative. Merely enlarging the state space does not remove that term.

To show transfer into a bath, define H_system, H_bath and H_interaction and calculate their energy derivatives. Their sum must match the full conservation relation. In a spacetime description, the corresponding covariant stress-energy balance must also be shown.

This is the calculational meaning of conserved on the enlarged space. It cannot be replaced by declaring that energy is stored outside the visible projection.

$$H_{\text{total}} = H_S + H_K + H_{SK}$$

$$\frac{d\langle H_{\text{total}}\rangle}{d\tau} = \left\langle \frac{\partial H_{\text{total}}}{\partial \tau} \right\rangle$$

PROPOSED

M44 / 4 OF 4

Gravitational memory as a proposed signal

A permanent strain change is a gravitational-memory observable. A proposed deactivation event needs its spacetime source, outgoing flux, angular distribution and distance-dependent waveform before a memory amplitude can be calculated.

Declaring an auxiliary bath equivalent to gravitational memory does not specify that source. A spherically symmetric mass change alone is not an arbitrary tensor gravitational-wave burst. The emitted or transferred degrees of freedom must be part of the calculation.

The trial manual records the signature as proposed. A completed model would connect activation evolution, energy balance and the detector readout, with finite duration and causal propagation explicitly stated.

CHECK: Inspection case: a projected mass drops and total conservation is declared from the bath label. Specify H_S, H_K and H_SK and calculate the exchange. If the full Hamiltonian depends explicitly on time, retain that derivative in the energy relation.

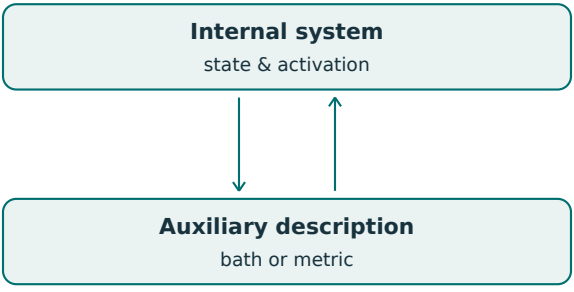
Continue with: M20 / M42 / M50

Epochs as dynamical regimes

The source labels its scenario Epoch 7 (Higgs ON), Epoch 8 (Higgs OFF) and Epoch 9 (Higgs ON). These labels identify the intended regimes. A cosmological model must calculate the background geometry, field evolution and transitions that make the scenario an actual solution.

The proposed passage of earlier photons through an intervening epoch also requires a propagation calculation. The model needs to specify the metric, redshift relation, interactions and matching conditions across the transition. A mature-looking early galaxy alone does not identify a particular preceding epoch.

The manual therefore places epoch history in the test programme. It is connected to the activation action and effective stress-energy, not established by the ordering of labels.



A homogeneous effective description

In a homogeneous cosmological approximation, activation fields may depend on time, and their energy density and pressure contribute to the background equations. For a canonical scalar with potential V, kinetic energy adds positively to density and positively to pressure, while V enters pressure with the opposite sign.

The equation-of-state ratio depends on those two quantities. A sector occupation or mixing probability is not automatically a vacuum-energy fraction. The relation must be derived from the effective stress-energy and its cosmological solution.

A non-minimal coefficient F introduces additional terms beyond the simplest constant-gravity equations. Those terms must be retained when the geometric bridge is used.

$$\rho_\alpha = \tfrac{1}{2} f^2 \dot{\alpha}^2 + V$$

$$p_\alpha = \tfrac{1}{2} f^2 \dot{\alpha}^2 - V$$

The two-level mixing calculation

The source's gravity-dark subsystem can be analysed as a two-level Hamiltonian when its off-diagonal coefficient is an energy and the diagonal energy difference is Delta. Starting in one level, the transfer probability includes a detuning-dependent amplitude and frequency.

The probability reaches the simple full-amplitude oscillation only when the detuning is zero. Otherwise the prefactor limits the maximum transfer. A small dimensionless angle needs an energy scale before it can be substituted for the off-diagonal coefficient.

This internal probability is calculable, but identifying it with a cosmological density fraction needs an additional stress-energy map. The two calculations must not be conflated.

$$P_D = \frac{4\varepsilon^2}{\Delta^2 + 4\varepsilon^2} \sin^2\left(\frac{\sqrt{\Delta^2 + 4\varepsilon^2}\,\tau}{2\hbar}\right)$$

From galaxies to a falsifier

Define the observable affected by the proposed changing activation: spectral lines, stellar populations, expansion history or another measured quantity. Calculate the effect using a specified mass and coupling model. Include uncertainties from the astrophysical interpretation.

A claim about changing quark masses needs a mass definition and scale, a redshift relation and a link to the measured spectrum. Metallicities or luminosities depend on several physical processes and do not directly measure a quark-mass ratio without that analysis.

The same discipline applies to proposed CMB angular features. Derive a correlation statistic and its amplitude from the field dynamics before comparing with a sky map. Geometry alone does not specify that statistic.

CHECK: Inspection case: a two-level occupation is assigned directly to a cosmological density fraction. Derive the state-to-stress-energy map and solve the background equations. Retain detuning and the energy scale in the internal mixing probability.

Continue with: M22 / M24 / M49

VERIFIED

M46 / 1 OF 4

State the fermion spectrum first

Anomaly calculations concern the effective chiral fields and their gauge representations. A sum of sector projector ranks does not supply that spectrum. The source selects one internal Spin10 spinor for each proposed family; its physical field assignment must be stated before the anomaly trace is evaluated.

For the standard all-left-handed family with a sterile neutrino, the representation list contains the quark doublet, conjugate up and down singlets, lepton doublet, conjugate charged-lepton singlet and sterile singlet. The dimensions total sixteen.

The following checks verify that stipulated family. They do not derive the family from the full E8 construction or establish that all other states are physically dormant.

Q_L | (3,2) | Y=1/6

u^c | (3bar,1) | Y=-2/3

d^c | (3bar,1) | Y=1/3

L_L | (1,2) | Y=-1/2

e^c, nu^c | (1,1) | Y=1, 0

Nonabelian and mixed coefficients

For the cubic colour anomaly, the quark doublet contributes two triplets, while the two conjugate singlets each contribute one antitriplet. The coefficient therefore vanishes. The weak multiplicity must be counted; counting the doublet as only one triplet gives an incorrect result.

The colour-squared hypercharge coefficient uses the two doublet components and the two singlet hypercharges. The weak-squared hypercharge coefficient uses three colour copies of the quark doublet and one lepton doublet. Both sums vanish, with the common fundamental index factor suppressed.

The listed fractional hypercharges use the convention Q equals T3 plus Y. If Q is instead written T3 plus Y over two, those hypercharge labels must be doubled consistently.

$$A_{SU3^3} = 2 - 1 - 1 = 0$$

$$A_{SU3^2Y} = 2\left(\tfrac{1}{6}\right) - \tfrac{2}{3} + \tfrac{1}{3} = 0$$

$$A_{SU2^2Y} = 3\left(\tfrac{1}{6}\right) - \tfrac{1}{2} = 0$$

Abelian and gravitational sums

The hypercharge-cubed coefficient sums Y cubed over every left-handed field component, including colour and weak multiplicities. The mixed gravitational-hypercharge coefficient sums Y over those same components. The sterile neutrino contributes zero to both sums.

The exact fractions on this page give zero for the cubic coefficient. The linear sum is one minus two plus one minus one plus one, also zero. These are the abelian checks that must accompany the nonabelian calculation.

There are four weak doublets when colour copies are counted: three quark doublets and one lepton doublet. The even count passes the usual SU2 global-anomaly parity test for this spectrum.

$$A_{Y^3} = \frac{1}{36} - \frac{8}{9} + \frac{1}{9} - \frac{1}{4} + 1 = 0$$

$$A_{\mathrm{grav}^2 Y} = 1 - 2 + 1 - 1 + 1 = 0$$

VERIFIED

M46 / 4 OF 4

What the Z permutation preserves

A permutation of identical families leaves these gauge representations and anomaly sums unchanged when it acts only on the family label. Each stipulated family already cancels, so three copies cancel without a cancellation between different families.

This is a consistency result for the chosen low-energy content. It does not establish a full E8-to-chiral-spectrum derivation. That requires Lorentz assignments, the treatment of the other blocks, gauge-invariant interactions and the claimed activation selection.

The trial manual records the anomaly calculation as VERIFIED within this narrow scope. The spectrum-emergence and dormancy connections remain PROPOSED and are recorded in the claim ledger.

CHECK: Inspection case: the quark doublet is counted as one colour triplet in the cubic anomaly. Count both weak components. The coefficient is two minus one minus one, while the hypercharge sums require their own component multiplicities.

Continue with: M15 / M16 / M34

Where a mass prediction begins

A scalar mass calculation needs a potential, a stationary configuration and a canonically normalised fluctuation. A fermion mass calculation needs an effective mass matrix and its singular values. Both require a scale and specified coefficients.

The source proposes geometric and bath-based ways to determine those coefficients. Their derivations must retain operator ordering, units and the distinction between a potential density and a Hamiltonian energy. A formula made to reproduce an observed mass is a calibration unless its coefficients were independently fixed.

This module gives two finite checks useful for that programme: the canonical scalar relation and a countercheck on a Gaussian matrix shortcut.

$$m_\phi^2 = \frac{V''(\alpha_*)}{f^2}$$

The standard Higgs comparison

For a canonically normalised Standard Model Higgs doublet with its usual quartic potential, the tree-level relation is mass squared equal to two lambda_H times v squared. This supplies a comparison relation; it does not determine lambda_H from V.A.S.K. geometry.

To use a proposed activation potential for this purpose, specify the map between the activation fluctuation and the physical Higgs field. Include mixing and normalisation. A dimensionless geometric coefficient can enter only through a stated relation that has been derived or defined.

Renormalised masses and couplings also require a scheme and scale. Running a parameter means calculating its scale dependence in a specified effective theory, not changing it to match a target number.

$$m_H^2 = 2\lambda_H v^2$$

A Gaussian matrix countercheck

Let H equal x sigma_x plus y sigma_z, with independent centred Gaussian variables of variance sigma squared. The Pauli anticommutation relation gives H squared equal to x squared plus y squared times the identity.

The averaged second moment is two sigma squared. The fourth moment is eight sigma to the fourth. Expanding the averaged exponential therefore gives a fourth-order coefficient sigma to the fourth over three. Exponentiating only the averaged second-order term would instead give one half.

The mismatch shows that a scalar Gaussian exponential shortcut is not generally valid for noncommuting random matrices. It does not prevent a properly ordered calculation of the proposed bath reduction.

$$H^2 = (x^2 + y^2)I$$

$$\langle H^4 \rangle = 8\sigma^4 I$$

$$\langle e^{\beta H} \rangle = I + \beta^2\sigma^2 I + \tfrac{1}{3}\beta^4\sigma^4 I + \cdots$$

Moments, cumulants and a completed coefficient

For a centred scalar Gaussian, the fourth moment is three times the squared variance, while the fourth cumulant is zero. They are different quantities. A derivation that invokes a fourth cumulant must not insert the fourth moment in its place.

To determine a quartic coefficient, specify the variables, operator ordering, covariance and coarse-graining prescription. Carry the expansion to the required order and retain all terms that contribute. Then connect the coefficient to a canonically normalised effective field.

The trial edition supplies the countercheck and the completion procedure. It does not promote an uncomputed quartic to a derived Higgs mass.

$$\kappa_4 = \langle x^4 \rangle - 3\langle x^2 \rangle^2 = 0$$

CHECK: Inspection case: a fourth Gaussian moment is inserted as a fourth cumulant. Subtract three times the squared second moment. The cumulant vanishes for the centred Gaussian, while the matrix exponential still requires operator-ordering checks.

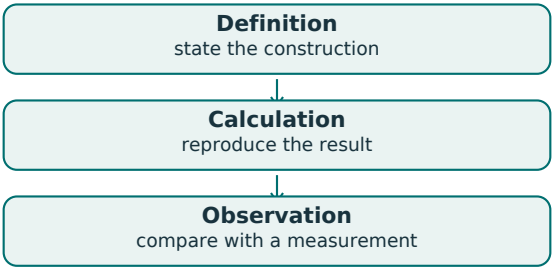
Continue with: M23 / M32 / M49

An engineering doctrine with measurable outputs

The 8i doctrine is MAXIMAL WORK on LIMITED POWER using MINIMAL ENERGY. It states an engineering aim for organising computation. To assess it, define the work completed, resource limits and energy or power measurements rather than relying on a slogan or a completed-looking interface.

The source describes internal-state engines and rule systems associated with the project. A software demonstration can establish that those rules execute as specified. It cannot establish the physical truth of the rules without a separate observational comparison.

The trial PDF includes reproducible finite calculations and an editable manuscript attachment. It does not certify unavailable source software as an independently run 8i implementation.



M48 / 2 OF 4

A reproducibility record

Record the source version, execution environment, precision, input matrices, parameter values and output files. For performance comparisons, record the hardware, workload, warm-up conditions, repeated measurements and energy method. Avoid mixing compile time with steady-state runtime without explanation.

Finite exact algebra can use integers or rational arithmetic where appropriate. Matrix exponentials and differential equations generally need numerical methods and error checks. The selected method should follow the calculation's properties rather than a preference for a language name.

An implementation status belongs to a particular executable path and version. A code fragment displayed in a source draft is not automatically an implemented and tested system.

CHECK: Separate correctness, performance and physical validation into different records.

The finite Z checks

The forward three-label matrix has integer entries. Its cube, inverse and projector cycle can therefore be checked exactly. The generation Hamiltonian's eigenvectors and the full candidate multiplicity count also have exact algebraic checks.

The continuous symmetric evolution can be checked against its closed solution. Verify unitarity, the equality of the two transfer probabilities and their sum with the stay probability. These checks test the mathematical implementation rather than a proposed detector signal.

The source scripts retained with the draft use these narrow scopes. Their outputs should be read together with the stated matrix definitions and assumptions, not as a global verification flag for the framework.

$$Z^3 = I, \qquad U^\dagger U = I$$

$$P_{1\to 1} + P_{1\to 2} + P_{1\to 3} = 1$$

M48 / 4 OF 4

A useful demonstration target

Choose one specified dynamical subsystem with a defined observable. Implement it, compare the numerical output with an exact limit where available, and report residuals. Then test the genuinely new regime without hiding parameter choices or unstable integration.

For activation fields, report domain preservation, step-size convergence and energy accounting. For an auxiliary bath, specify the truncation and check how the reduced result changes when it is refined. For a proposed experiment, retain the full readout calculation.

This route makes the software useful for research and public explanation. It also respects the engineering doctrine by measuring the work and resources actually involved.

CHECK: Inspection case: a successful script is called physical confirmation. Record the source version, inputs and output as an implementation result. Validate any physical interpretation through a separately specified measurement and uncertainty calculation.

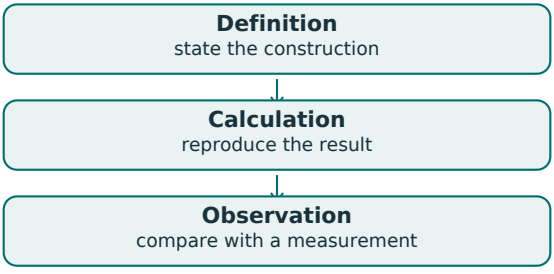
Continue with: M20 / M31 / M49

Choose a finite target

A prediction programme should begin with one observable whose complete calculation can be written. A scalar mass, a transition probability or a coupling drift can be a suitable target when its inputs and readout are sufficiently specified.

The model must freeze the relevant action and parameter definitions before using the observation to judge the output. If the observation is used to fit a coefficient, record that coefficient as fitted and reserve an independent observable for testing.

The public manual should show the entire chain. An unexplained geometric ratio at the final step is not an end-to-end derivation, even if the resulting number is familiar.



The required input map

List the internal representation, sector projectors, permission weights, activation potential, kinetic normalisations, coupling scales and state or background conditions relevant to the target. Mark each input as derived, defined, measured or fitted.

For a mass prediction, include the field map and the scale at which the mass is defined. For a transition, include the initial state and duration. For a cosmological observable, include the metric solution, redshift map and detector or astrophysical interpretation.

This input map reveals any remaining freedom. A zero-parameter claim becomes checkable only when the map leaves no unexplained physical coefficients, functions or conditions relevant to the prediction.

CHECK: A choice of units cannot remove undetermined dimensionless physical ratios.

An activation-drift route

If the bare coupling and permission weight are constant and the activation is nonzero, the logarithmic time derivative of the effective coupling equals the logarithmic derivative of activation. This is an exact consequence of the product rule.

To predict a clock observable, the activation equation must supply that derivative, and the clock's frequency sensitivity to the relevant constants must be calculated. Multiple constants can contribute with different sensitivity coefficients.

This example shows what an end-to-end target needs without assigning a fabricated drift number. The algebraic first step is available; the field solution and readout coefficients determine the actual observable.

$$\frac{\dot{g}_{pa}}{g_{pa}} = \frac{\dot{\alpha}_a}{\alpha_a}$$

Uncertainty and an independent test

Propagate uncertainty from measured inputs, numerical approximation and the effective-model regime. If a coefficient is derived through a truncation, report the omitted terms or a convergence check. If several parameter sets fit the calibration, retain that range in the prediction.

Then specify the measurement that can distinguish the predicted result from alternatives. A useful test has a finite sensitivity and a decision rule chosen before looking at the outcome. Failure should identify which model assumption is rejected.

The trial edition records this target procedure as the next practical route to a physical result. The finite Z calculations provide a starting point, but they do not replace the observable-specific chain.

CHECK: Inspection case: the target observation fixes an otherwise unknown coefficient. Record the fit. Seek a separate observable from the calibrated model, with its scale and uncertainty stated before comparison.

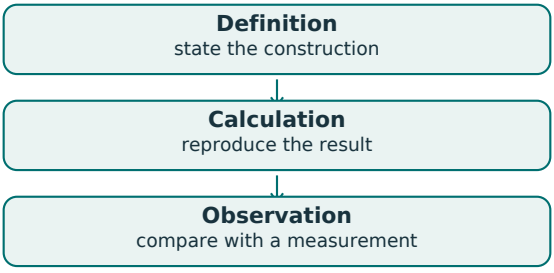
Continue with: M24 / M47 / M50

A prediction must meet a measurement

The source lists proposed signals in neutrino physics, coupling variation, cosmology and particle production. Each needs a complete observable calculation and a sensitivity statement. A list of signal names does not establish that an experiment can already falsify the model.

Separate an exact selection rule from a small predicted effect. A null prediction needs a symmetry or operator argument that forbids the process. A small effect needs its amplitude, uncertainty and experimental conditions. Both can be useful, but they are tested differently.

Discarded numerical forecasts are not restored in this trial edition. The test programme retains the observable categories and the calculations required to make them sharp.



The neutrino selection-rule check

Orthogonal neutrino and antineutrino state labels do not alone forbid an interaction that connects them. An off-diagonal operator can have a nonzero matrix element between orthogonal basis states. The interaction terms and conserved charges determine whether the process is allowed.

To derive an exact null neutrinoless-double-beta-decay result, identify the lepton-number structure and exclude the relevant violating operators under the stated symmetry and field content. Orthogonality of labels is only one property of the state basis.

The model must also specify its neutrino mass mechanism. A mass matrix, effective operator and symmetry argument can supply a real selection rule; the keychain names cannot supply it by themselves.

$$\langle \nu | \bar{\nu} \rangle = 0$$

$\langle \nu | O | \bar{\nu} \rangle$ need not vanish

Non-observation and sensitivity

A missing signal is a falsifier only when the observation was capable of detecting the predicted effect. For a collider process, the expected event count depends on luminosity, cross-section, branching fraction and efficiency. Backgrounds and statistical fluctuations also affect the decision rule.

For an astronomical test, selection effects and interpretation uncertainties must be included. For a clock test, the relevant sensitivity to the changing parameter must be stated. An unspecified nonzero effect can always lie below a finite instrument's sensitivity.

The source's proposed observables become scientifically useful when those ingredients are fixed. The book's ledger records their present status and the missing calculations.

$$N_{\mathrm{exp}} = \mathcal{L}\,\sigma\,\mathcal{B}\,\varepsilon_{\mathrm{det}}$$

Independent review and publication

Ask reviewers to inspect a defined claim and its supporting calculation. A matrix identity, spectrum construction or effective-action derivation gives a clear review target. A claim of complete unification requires every bridge relevant to that scope to be supported.

Publication, an ISBN and a checksum establish a record of the edition. They do not independently validate its physics. Likewise, an AI response is not an experimental confirmation or a peer-review decision. The manual can be published as a clearly scoped theoretical proposal.

The final reference material makes the edition usable for that purpose. It supplies symbols, equation locations, calculation statuses, outstanding tasks and source provenance within the same volume.

CHECK: Inspection case: a signal was not observed but the detector threshold is unstated. Calculate the predicted readout and measurement sensitivity. A finite non-observation can reject the model only when that model predicted an observable signal under the tested conditions.

Continue with: M03 / M34 / M49

GLOSSARY & SYMBOLS

Glossary / 1 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Amplitude | A complex state coefficient. Its phase can affect interference. A probability follows only after a state and measurement rule are specified. Location: M10, M18.

Activation | The independently defined local field alpha_a in the selected field formulation. Its dynamics needs an action or evolution law; it is distinct from occupation. Location: M11, M19.

Adjoint | A representation in which the algebra acts on itself by the bracket. The chosen complex E8 adjoint block has dimension 248. Location: M13, M14.

Arrow of time | A proposed ordering or irreversible behaviour requiring dynamical and boundary information. A reversible order-three operator alone does not establish it. Location: M33.

Auxiliary bath | Additional degrees of freedom introduced to account for effective exchange or feedback. Its Hamiltonian, coupling and reduction rule must be specified. Location: M44.

GLOSSARY & SYMBOLS

Glossary / 2 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Bare coupling | The scale g_a^(0) appearing before the permission and activation factors. It is an input until a separate derivation fixes it. Location: M07, M49.

Basis | An ordered set of independent vectors used to express states and operators. A change of basis transforms every relevant object consistently. Location: M27, M28.

Block | A selected representation subspace in a branching. Its dimension is not necessarily a physical particle count and its Lorentz role must be assigned. Location: M15, M16.

Branching | The decomposition of a representation under a subgroup. The component dimensions add to the original representation dimension. Location: M14-M16.

Canonical normalisation | A field redefinition giving the kinetic term its stated standard coefficient. The scalar mass depends on this normalisation as well as potential curvature. Location: F03, M23.

GLOSSARY & SYMBOLS

Glossary / 3 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Cartan directions | The commuting directions organising the root description. E8 has rank eight; these directions combine with the 240 roots to give 248 generators. Location: M13.

Casimir | A representation-dependent invariant operator constructed from generators in a fixed normalisation. The full irreducible adjoint Casimir is scalar. Location: M14, M16.

Causality | The propagation and signal constraints of a specified effective spacetime theory. Internal dimensions or inactive coupling labels do not determine signal speeds alone. Location: M33, M41.

Cell measure | An area, volume or other geometric quantity with stated units and length convention. Its use in an energy formula requires a defined coupling. Location: M36, M37.

Conditional observable | An expectation after a specified filter or selection. Its denominator is the squared norm of that filtering operation when nonzero. Location: M12.

GLOSSARY & SYMBOLS

Glossary / 4 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Density matrix | A positive unit-trace operator describing a state or ensemble. Closed unitary evolution preserves its trace and spectrum. Location: M10, M18.

Dormancy | A model regime in which selected activations or couplings vanish or remain small. Hidden energy, localisation and observability need separate equations. Location: M19, M44.

Effect | A positive operator bounded by the identity that supplies an outcome probability. It need not be an idempotent projector or determine a unique state update. Location: M09, M12.

Eigenspace | The subspace with a specified eigenvalue. The Z phase eigenspaces are not the same decomposition as the three generation-label subspaces. Location: M28, M30.

Emergence map | The rule connecting the proposed primary description to effective fields or geometry. Its input, target, approximation and dynamics must be stated. Location: F02, M02.

GLOSSARY & SYMBOLS

Glossary / 5 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Epoch | A proposed long-lived activation regime. A cosmological epoch requires field evolution, background geometry and a transition calculation. Location: M19, M45.

Filter | An operator K used to select or modify a state. Its success norm contains K dagger K; a general filter is not automatically a projector. Location: M09, M12.

Fourier basis | The eigenbasis that diagonalises a cyclic shift. It mixes the generation labels and transforms their projectors with the same basis change. Location: M28.

Generation block | The selected three copies of a sixteen-dimensional internal space. Its dimension is 48; a full Z action also specifies the complement. Location: M25, M29.

Hessian | The matrix of second derivatives of a potential at a stationary configuration. The kinetic matrix must be included to identify physical fluctuation masses. Location: M23.

GLOSSARY & SYMBOLS

Glossary / 6 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Hypersphere | A sphere in a specified higher-dimensional geometry. The Euclidean S3 measure has length-cubed units and is not automatically a Lorentzian horizon area. Location: M38, M43.

IETM-inspired | A modular, navigable manual structure with defined procedures and cross-references. This edition does not claim certification under a technical-documentation standard. Location: Preliminary iv.

Intertwiner | A map relating two specified operator actions. Physical identification may require it also to preserve named gauge or Lorentz structures. Location: M34.

Keychain | The organising permission picture for a species. Its mathematical translation is a weighted combination of sector operators with stated algebraic properties. Location: M04, M09.

Kinetic scale | The coefficient f carrying the scale needed for a dimensionless activation’s kinetic term. It enters a canonically normalised scalar mass. Location: F03, M23.

GLOSSARY & SYMBOLS

Glossary / 7 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Leech lattice | The specified rootless even unimodular lattice in 24 Euclidean dimensions. It is distinct from the rank-24 direct sum E8 cubed. Location: M40.

Locking term | A proposed diagonal energy assignment to sectors. Closed diagonal evolution changes phases and does not by itself relax occupations to a minimum. Location: M20, M21.

Mass matrix | An effective field-theory object whose singular values give Dirac masses after canonical normalisation. An internal signed spectrum is not automatically this matrix. Location: M32.

Occupation | The probability P_a obtained from a normalised state and projector. Complete orthogonal occupations sum to one. Location: M10.

Permission | The specified access of a species to a sector. Permission weights enter a coupling definition and are not automatically measured probabilities. Location: M07.

GLOSSARY & SYMBOLS

Glossary / 8 of 8

The terms on this page use the conventions of this trial edition. The locations identify the modules in which the definitions and their scope are developed.

Projection | An operation with a defined domain, target and map. A vector projection, spatial slice and optical black-hole shadow are different constructions. Location: M35, M38, M43.

Randa Suspension | The source’s label for abrupt projected-mass loss when activation changes. A physical mechanism also needs a transition and energy-flux calculation. Location: M44.

Root | A vector in the algebra’s root-space description. E8 has 240 roots in its eight-coordinate standard construction; roots are not all 248 adjoint directions. Location: M13.

Triality | An order-three relationship in a stated algebraic construction. Matching names or orders does not identify particular operators or physical generation assignments. Location: M34.

Z-gate | The specified unitary cyclic internal operation. The block action, full-space extension and Hamiltonian use are defined and inspected separately. Location: M25-M34.

EQUATION REGISTER

Equation register / 1 of 4

Register IDs locate a formula in its four-page unit. Read that unit for definitions, assumptions and interpretation before using the expression.

E01 / Internal block | F01, manual 001

$$\mathcal{H}_{\mathrm{int}} \simeq \mathbb{C}^{248}$$

E02 / Normalised state | M18, manual 085

$$\langle \Psi | \Psi \rangle = 1$$

E03 / Sector projector | M08, manual 045

$$\Pi_a^2 = \Pi_a, \quad \Pi_a^\dagger = \Pi_a$$

E04 / Composite permission | M09, manual 049

$$K_p = \sum_a w_{p,a} \Pi_a$$

E05 / Occupation | M10, manual 053

$$P_a = \langle \Psi | \Pi_a | \Psi \rangle$$

E06 / Completeness constraint | M10, manual 053

$$\sum_a P_a = 1$$

E07 / Effective coupling | M11, manual 057

$$g_{pa} = g_a^{(0)} w_{p,a} \alpha_a$$

E08 / Conditional filter norm | M12, manual 061

$$\| K\Psi \|^2 = \langle \Psi | K^\dagger K | \Psi \rangle$$

EQUATION REGISTER

Equation register / 2 of 4

Register IDs locate a formula in its four-page unit. Read that unit for definitions, assumptions and interpretation before using the expression.

E09 / Root count | M13, manual 065

$$112 + 128 = 240, \quad 240 + 8 = 248$$

E10 / Projector from columns | M17, manual 081

$$\Pi = B(B^\dagger B)^{-1} B^\dagger$$

E11 / Covariant evolution | M21, manual 097

$$i\hbar D_\tau \Psi = H\Psi$$

E12 / Sector transfer | M20, manual 093

$$\dot{P}_a = \tfrac{i}{\hbar}\langle [H, \Pi_a] \rangle$$

E13 / Potential curvature | M23, manual 105

$$V'' = K - r + 3u\alpha^2 + \tfrac{K}{\alpha(1-\alpha)}$$

E14 / Canonical scalar mass | M23, manual 105

$$m_\phi^2 = V''(\alpha_*)/f^2$$

E15 / Curvature bound | M24, manual 109

$$V'' \geq 5K - r \quad (u \geq 0)$$

E16 / Z block | M26, manual 117

$$Z = P \otimes I_{16}, \quad Z^3 = I$$

EQUATION REGISTER

Equation register / 3 of 4

Register IDs locate a formula in its four-page unit. Read that unit for definitions, assumptions and interpretation before using the expression.

E17 / Inverse operation | M27, manual 121

$$Z^{-1} = Z^2 = Z^\dagger$$

E18 / Cube-root phases | M28, manual 125

$$\omega = e^{2\pi i/3}, \quad 1 + \omega + \omega^2 = 0$$

E19 / Full candidate spectrum | M30, manual 133

$$(m_1, m_\omega, m_{\omega^2}) = (134, 57, 57)$$

E20 / Symmetric generator | M31, manual 137

$$H_{\text{gen}} = \kappa(Z + Z^\dagger)$$

E21 / Transfer probability | M31, manual 137

$$P_{1\to 2} = P_{1\to 3} = \tfrac{4}{9}\sin^2(3s/2)$$

E22 / Quark mixing | M32, manual 141

$$V_{\text{CKM}} = U_{uL}^\dagger U_{dL}$$

E23 / Spatial projection | M35, manual 153

$$x = Qr, \quad Q : \mathbb{R}^8 \to \mathbb{R}^3$$

E24 / Geometric locking proposal | M37, manual 161

$$\mu = \hbar c\, A/V$$

EQUATION REGISTER

Equation register / 4 of 4

Register IDs locate a formula in its four-page unit. Read that unit for definitions, assumptions and interpretation before using the expression.

E25 / S3 intrinsic measure | M38, manual 165

$$\mathcal{V}(S^3) = 2\pi^2 R^3$$

E26 / S3 radial response | M38, manual 165

$$d\mathcal{V}(S^3)/dR = 6\pi^2 R^2$$

E27 / E8 packing density | M39, manual 169

$$\Delta_{E8} = \pi^4/384$$

E28 / Leech packing density | M40, manual 173

$$\Delta_{\text{Leech}} = \pi^{12}/12!$$

E29 / Effective dispersion | M41, manual 177

$$E^2 = m^2c^4 + p^2c^2$$

E30 / Schwarzschild comparison | M43, manual 185

$$R_s = 2GM/c^2$$

E31 / Projected mass | M44, manual 189

$$M_{\text{eff}} = \sum_a \alpha_a M_a^{(0)}$$

E32 / Coupling drift | M49, manual 209

$$\dot{g}_{pa}/g_{pa} = \dot{\alpha}_a/\alpha_a$$

CLAIM LEDGER & OPEN TASKS

Claim ledger / 1 of 8

Current scope and completion conditions. The locations identify the supporting modules.

A1 / Mirror-sector dormancy / PROPOSED

Specify the complete chiral spectrum, the sector operator and the activation dynamics. The full-adjoint Casimir trace is scalar and does not supply the claimed selective ratios. A restricted operator needs a new, explicit definition and calculation. Locations: M16, M24, M46.

A2 / Gravity-sector content / PROPOSED

Construct the Lorentz and frame variables, their internal relationship and the effective metric equation. A named gravity projector does not by itself reproduce spacetime spin, a metric kinetic term or a gravitational field theory. Locations: M21, M41, M42.

A3 / Dark-sector content / PROPOSED

Identify representations, spins, kinetic terms, masses and interactions of the proposed sterile or dark states. A complement of selected sectors is a subspace definition, not automatically the observed dark-matter or dark-energy stress-energy. Locations: M15, M44, M45.

A4 / Electroweak scale / PROPOSED

Derive or specify the physical scale and its relation to the reference cell length. A choice of units cannot determine the dimensionless ratio between independent physical scales. Keep measured inputs distinct from derived quantities. Locations: F03, M37, M47.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 2 of 8

Current scope and completion conditions. The locations identify the supporting modules.

A5 / Fine-structure constant / PROPOSED

Supply the gauge-field normalisation, matter representation, coupling input and scale dependence. A projector rank or occupation alone does not determine a renormalised electromagnetic coupling at a specified physical scale. Locations: M07, M41, M49.

A6 / Formal 0Z limit / DEFINED / PROPOSED

Zero generation-mixing coefficients define the inactive mixing regime. Equivalence to a particular older E8 field theory additionally requires the full action, field content, real form and dynamical mapping. Constant activation need not freeze all evolution. Locations: M21, M27, M34.

B1 / CKM and PMNS matrices / PROPOSED

Provide the effective Yukawa and neutrino mass structures and their canonical normalisation. Compute singular values, diagonalising bases and physical phase invariants. The symmetric Z term alone retains a degeneracy and does not determine measured mixing. Locations: M31, M32.

B2 / Activation-kernel quartic / PROPOSED

Derive the coefficient with a stated covariance, operator ordering and reduction scheme. The Gaussian matrix countercheck rejects a general scalar-exponential shortcut. Retain moments and cumulants as distinct quantities before connecting the result to a scalar mass. Locations: M23, M47.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 3 of 8

Current scope and completion conditions. The locations identify the supporting modules.

B3 / Randa Suspension energy balance / PROPOSED

Define the bath, interaction Hamiltonian and spacetime flux. Show that the effective mass change is balanced in the full dynamics. A gravitational-memory amplitude also needs a source, angular structure, duration and detector readout. Locations: M43, M44.

B4 / Cosmological epoch sequence / PROPOSED

Solve the coupled activation and background equations with initial and matching conditions. Calculate transition rates and durations. Epoch labels identify intended regimes but do not supply the scale factor, thermal history or photon propagation. Locations: M22, M45.

B5 / CP-Higgs asymmetry / PROPOSED

Specify the CP-violating interaction and integrate its evolution under the relevant conditions. Relate internal population differences to baryon number and photon density. A normalised two-level asymmetry is not automatically the cosmological baryon-to-photon ratio. Locations: M41, M45, M49.

B6 / Leakage floor / PROPOSED

Define which dormant coupling remains nonzero and why. Calculate its scale dependence and observable effects. A strict zero and an unspecified small nonzero value support different falsification statements and must not be used interchangeably. Locations: M11, M24, M50.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 4 of 8

Current scope and completion conditions. The locations identify the supporting modules.

C1 / 8i implementation / DEFINED / PROPOSED

Provide the executable source version, inputs, output and environment. Verify correctness before comparing resources. Measure work, runtime and energy under documented conditions. Unavailable software has not been certified as an independently run implementation here. Locations: M48.

C2 / Cell hierarchy / PROPOSED

State the cell shapes, coordinates, adjacency and scale relation. Derive measures at each level with a fixed length convention. A hierarchy drawn from powers alone does not establish a physical energy spectrum or uniquely selected spatial packing. Locations: M35-M37.

C3 / Earlier-epoch galaxy interpretation / PROPOSED

Calculate photon propagation, redshift and survival across the proposed transitions. Compare predicted spectra and populations with astrophysical uncertainties. High-redshift maturity by itself does not identify light from an earlier epoch. Locations: M45, M50.

C4 / Lattice branch / PROPOSED

Supply a generating rule, metric, allowed configurations and dynamics for the source lattice programme. Demonstrate how the branch connects to the canonical projector and field definitions. A symbolic branch label is not yet a physical solution. Locations: M35, M40.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 5 of 8

Current scope and completion conditions. The locations identify the supporting modules.

C5 / Viazovska and Leech connection / VERIFIED / PROPOSED

The cited packing results are established mathematical background. Their role as physical activation minima needs a specified energy functional and configuration map. E8 cubed and the Leech lattice are distinct structures despite equal rank. Locations: M39, M40.

C6 / KEYCHAIN acronym / DEFINED

The source expansion and permission language are retained in the lineage module. An acronym is an identifier, not an equation. Keep historical expansions labelled so the canonical edition does not assign incompatible meanings to the same name. Locations: F04, M04.

C7 / KEYCHAIN to V.A.S.K. / DEFINED

The effective coupling rule gives the documented permission-times-activation connection. Occupation, activation and operator type are separated in this edition. Further dynamical conclusions require the corresponding actions and readout maps. Locations: M04, M09-M12.

D1 / Scale hierarchy / PROPOSED

Derive the relation between the physical scales used in the model and test its stability under the stated effective dynamics. A reference length fixed from one scale does not independently explain all other scales or their dimensionless ratios. Locations: F03, M37, M47.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 6 of 8

Current scope and completion conditions. The locations identify the supporting modules.

D2 / Strong CP question / PROPOSED

State the effective CP-sensitive operators and the mechanism constraining their coefficients. A small internal misalignment needs a defined origin and physical mapping. It does not automatically determine the strong-sector CP observable. Locations: M41, M49.

D3 / Vacuum-energy question / PROPOSED

Calculate the renormalised stress-energy and its cosmological solution. Internal probabilities are not energy densities by definition. Any cancellation, suppression or geometric selection must be evaluated in the stated effective theory. Locations: M42, M45.

D4 / Neutrino masses and mixing / PROPOSED

Specify the mass mechanism, lepton-number structure and effective operators. Calculate the mixing matrix and physical masses. Orthogonal neutrino labels alone do not forbid operators that connect them or establish an exact null decay result. Locations: M32, M50.

D5 / Muon magnetic moment comparison / PROPOSED

Choose and document the experimental input and Standard Model reference calculation before comparing a new contribution. This edition assigns no current discrepancy significance. A proposed correction needs an effective interaction and uncertainty calculation. Locations: M41, M49.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 7 of 8

Current scope and completion conditions. The locations identify the supporting modules.

D6 / Black-hole information / PROPOSED

Define the state space, observable algebra and complete evolution across the proposed process. Show which information is retained, accessible or transferred. A geometric shadow and an auxiliary bath label do not establish a unitary evaporation mechanism. Locations: M43, M44.

D7 / Arrow of time / PROPOSED

Specify the clock subsystem, observable, scale and conditions supplying effective irreversibility. The cyclic operator is reversible. The argument of an anti-Hermitian expectation is not a continuously advancing clock readout. Locations: M33, M40.

D8 / Measurement problem / PROPOSED

State the outcome probabilities and state-update instrument. The internal permission can be a projector, filter or effect, with different normalisation requirements. A complete measurement interpretation needs more than a selected expectation formula. Locations: M09, M12.

D9 / Other quantum-gravity programmes / PROPOSED

Define a concrete comparison with another framework: its degrees of freedom, observables and limiting equations. Similar names, dimensions or diagrams do not establish equivalence to string, holographic or loop constructions. Locations: M02, M41.

CLAIM LEDGER & OPEN TASKS

Claim ledger / 8 of 8

Current scope and completion conditions. The locations identify the supporting modules.

D10 / Hamiltonian constraints / PROPOSED

Construct the constrained gravitational system and its gauge meaning. A Wheeler-DeWitt-type constraint differs from ordinary proper-time evolution under an unconstrained internal Hamiltonian. Locations: M18, M33, M42.

E1 / Global anomaly-free claim / VERIFIED / PROPOSED

The stipulated family passes the finite anomaly checks. Deriving that family and the treatment of every other state from E8 remains a separate spectrum-completion task. Locations: M46.

E2 / Exact-filter claim / PROPOSED

Calculate minima, cutoffs and transitions using the exact potential derivatives. The source inequality alone does not prove a first-order transition or a unique present gauge group. Locations: M23, M24.

E3 / Zero-parameter claim / PROPOSED

List coefficients, functions, conditions and scales with their origins. Units do not remove dimensionless freedom. Keep a coefficient identified as fitted when observations determine it. Locations: M49.

E4 / Resonance relation / PROPOSED

Derive the particle state, mass relation, production and decay readout. Discarded absolute forecasts are not restored or replaced by a new fitted geometric number. Locations: M32, M49, M50.

ANNOTATED REFERENCES

Source record & attribution

R00 / Magnus Randa. K.E.Y.C.H.A.I.N. and V.A.S.K. source collection, working drafts and chapter material, September-October 2026. The attached publication assessment was supplied for this trial edition on 14 October 2026. These sources define the project and its lineage.

The source packet includes chapter plans, mathematical formulations, the completeness audit, a dormancy appendix and a condensed final draft. Earlier chat-derived passages contain hypotheses and alternative formulations. Their inclusion in the record does not independently verify a physical claim.

The manual consolidates the selected definitions and finite checks. It retains the audit as a completion register and replaces screenshots with diagrams drawn for this edition. The original source bytes remain separate records.

R00 is the source for the model definitions. The following reference pages identify mathematical background and production standards. Readers can follow the manual without accessing the original conversation.

ANNOTATED REFERENCES

Lisi: current triality background

R01 / A. Garrett Lisi. Division Algebras, Triality, and Exceptional Magic. Advances in Applied Clifford Algebras 36, 45 (2026). arXiv:2609.12112. https://arxiv.org/abs/2609.12112

This is primary comparison material for the triality and exceptional-algebra programme. The manual does not assert an identification of its selected Z with a specific operator in the paper. That identification needs the full action and intertwining conditions in M34.

R02 / A. Garrett Lisi. C, P, T, and Triality. arXiv:2407.02497 (2024). https://arxiv.org/abs/2407.02497

Use explicit operators and sign conventions when comparing CPT-related constructions with the project. A shared order-three operation or the name triality does not replace a complete correspondence of representations and physical assignments.

These references establish the comparison context, not endorsement of V.A.S.K. The authorial proposal and the cited research remain separately attributed.

ANNOTATED REFERENCES

Representation-theoretic scope

R03 / Jacques Distler and Skip Garibaldi. There is no "Theory of Everything" inside E8. Communications in Mathematical Physics 298, 419-436 (2010); arXiv:0905.2658. https://arxiv.org/abs/0905.2658

The paper analyses representation-theoretic requirements in specified E8 embeddings. The trial manual treats a dynamical projector description as a proposal whose chiral low-energy spectrum still needs to be constructed. A change of terminology does not itself prove that the relevant obstruction is bypassed.

The anomaly module performs explicit finite sums for a stipulated family. Its result is deliberately narrower than a full E8 spectrum derivation. Chirality, Lorentz content and the treatment of the remaining states belong in that larger calculation.

R15 / Edward Witten. An SU(2) anomaly. Physics Letters B 117 (1982), 324-328. https://doi.org/10.1016/0370-2693(82)90728-6 The weak-doublet parity check in M46 uses this global-anomaly background; the stipulated family contains four doublets including colour copies.

ANNOTATED REFERENCES

Sphere packing: 8D and 24D

R04 / Maryna Viazovska. The sphere packing problem in dimension 8. Annals of Mathematics 185 (2017), 991-1015; arXiv:1603.04246. https://arxiv.org/abs/1603.04246

This establishes the optimality background for the E8 lattice sphere packing. M39 calculates the density in the stated normalisation and distinguishes that geometric result from the proposed activation-vacuum interpretation.

R05 / Henry Cohn, Abhinav Kumar, Stephen D. Miller, Danylo Radchenko and Maryna Viazovska. The sphere packing problem in dimension 24. Annals of Mathematics 185 (2017), 1017-1033; arXiv:1603.06518. https://arxiv.org/abs/1603.06518

This supplies the Leech-lattice optimality background. The manual attributes the twenty-four-dimensional result to the collaboration. M40 retains the distinction between the Leech lattice and the direct sum of three E8 lattices.

ANNOTATED REFERENCES

Hashing and text encoding

R06 / National Institute of Standards and Technology. Secure Hash Standard, FIPS PUB 180-4 (2015). https://doi.org/10.6028/NIST.FIPS.180-4

SHA-256 is used here to identify byte sequences. The source assessment digest and the separate source manifests support reproducibility. A hash does not prove the truth of the contents or supply a publication timestamp by itself.

R07 / Unicode Consortium. CP437 mapping supplied in the vendor mapping archive. https://www.unicode.org/Public/MAPPINGS/VENDORS/MICSFT/PC/CP437.TXT

The public edition uses Unicode mathematical typesetting. The archival convention for unsupported characters must be stated separately from strict CP437 encoding. C0 byte values interpreted as control characters in a text codec are distinct from the visible glyphs a historical display font might show.

The two provenance modules explain the byte and rendering distinctions used in this trial.

ANNOTATED REFERENCES

Reproducible code references

R08 / Python Software Foundation. hashlib: Secure hashes and message digests. https://docs.python.org/3/library/hashlib.html

R09 / Python Software Foundation. codecs: Codec registry and base classes. https://docs.python.org/3/library/codecs.html

These implementation references support hashing and explicit text conversion. They do not supply a physical model. Record the actual execution version and codec in a reproducibility record rather than assuming the current documentation version matches an earlier run.

The PDF contains embedded manuscript and calculation material so a future revision can recover the drafted text and the scope of its checks. The matrix identities use exact finite operations where possible; numerical evolution requires precision and convergence checks.

For a software demonstration, keep source identity, environment, input, output and interpretation together. M48 supplies the engineering inspection procedure; the final provenance page records what this PDF contains.

ANNOTATED REFERENCES

Gravitation comparison sources

R10 / Karl Schwarzschild. Über das Gravitationsfeld eines Massenpunktes nach der Einsteinschen Theorie. Sitzungsberichte der Preussischen Akademie der Wissenschaften (1916), 189-196. English translation: arXiv:physics/9905030. https://arxiv.org/abs/physics/9905030

The historical metric provides the nonrotating comparison used in M43. The translator's foreword and the original derivation are distinct; this edition does not adopt commentary denying black holes. The model comparison uses the stated effective metric and its calculated null-orbit scale.

R11 / C. Brans and R. H. Dicke. Mach's Principle and a Relativistic Theory of Gravitation. Physical Review 124 (1961), 925-935. https://doi.org/10.1103/PhysRev.124.925

This is historical scalar-tensor background. M42 writes and varies its own specified effective action; it does not claim that the historical theory derives the proposed E8 or cell-geometry interpretation.

ANNOTATED REFERENCES

Edition and publication records

R12 / KDP. Content Guidelines; Set Trim Size, Bleed, and Margins. https://kdp.amazon.com/en_US/help/topic/G200672390 https://kdp.amazon.com/en_US/help/topic/GVBQ3CMEQW3W2VL6

R13 / arXiv. Content Moderation and Endorsement. https://info.arxiv.org/help/moderation/index.html https://info.arxiv.org/help/endorsement.html

R14 / Nasjonalbiblioteket. ISBN Norge. https://www.nb.no/tjenester/standardnummerering/isbn/

These are edition-process references, checked in the preceding assessment. A distributor’s current requirements must be rechecked before an actual upload. This 4 x 9 inch trial is not presented as an already accepted print-platform file.

An ISBN identifies a format and edition. arXiv moderation is not peer review. A published record and a checksum do not independently establish the physics. AI-generated material must be described honestly wherever the selected publication process requires it.

ENCODING & PROVENANCE

CP437, Unicode & reversible text

The source collection uses CP437 styling and modern mathematical symbols. Strict CP437 is a single-byte codec with a limited repertoire. A file containing arbitrary Unicode mathematics is not strict CP437 merely because it includes box-drawing characters.

An escaped archival format can preserve unsupported characters while using encodable text bytes. Such a format needs an explicit escape rule, a rule for literal escape characters and a decoder. Reversibility means recovering the original content or bytes according to the declared convention.

The preceding source pack records a reversible TEXTCP437 convention. The trial PDF uses embedded fonts and vector equations for public reading. The two roles are separate: archive representation and printed appearance.

Line endings, byte-order marks and final newlines affect byte identity. Do not normalise an original file without recording the conversion and preserving the original. A visually identical file can have a different SHA-256 digest.

C0 byte positions in a text codec can be controls even when a historical display font drew symbols there. A visible glyph chart and a text-decoding table therefore answer different questions.

ENCODING & PROVENANCE

SHA-256 and edition identity

A SHA-256 digest contains 256 bits, conventionally written as 64 hexadecimal characters. It identifies the hashed byte sequence for practical integrity checking. It does not evaluate the truth of an equation in that sequence.

The supplied assessment is byte-identical to the earlier reviewed assessment. Its digest is recorded below in two consecutive 32-character lines. Concatenate those lines when comparing the 64-character hexadecimal digest.

```
ead0a4aa52af0e031c68e044eb41f6b3
0681cf36968741c6bdc08c3cdbb55788
```

Place a file digest in a separate manifest when preserving that file’s identity. Inserting a newly calculated digest into the file itself changes the bytes being hashed. A self-hash strip therefore requires a stated exclusion rule or another explicit convention.

A dated public deposit and a content hash answer different questions. A deposit can provide an inspectable record of availability; the digest binds that record to specific bytes. Neither is an independent proof of a physical discovery.

ENCODING & PROVENANCE

Source coverage and lineage

The earlier eleven text items supplied plans, introductory matter and chapter drafts. The prior review counted approximately 39,941 words across the nine main body chapters. Four latest drafts add the letter, completeness audit, A1 dormancy appendix and condensed formulation.

All four latest screenshots were inspected. They contain overlapping explanations and cropped equations. The trial uses newly drawn diagrams rather than treating those screenshots as final print artwork.

The identity supremacy ultimatum archive contains 673 one-page PDFs. All were indexed for extracted text, with approximately 130,147 gross extracted words before deduplication. Thirty-four files had no extractable text. Selected relevant pages and representative scans were inspected; a complete visual read of every PDF is not claimed.

These counts describe source coverage, not a deduplicated manuscript length or independent experimental evidence. The book consolidates definitions and checked finite results while recording open physical bridges in the ledger.

Original sources are preserved separately. A revision should retain their identities and add a dated record of changes to canonical definitions, notation and calculations.

ENCODING & PROVENANCE

Trial production and next edition

The PDF contains eight preliminary pages and exactly 248 numbered manual pages. The manual comprises 54 four-page learning units followed by 32 glossary, equation, ledger, reference and provenance pages. The Z section occupies manual 113-152.

The layout uses a 4 x 9 inch trim, embedded fonts, vector equations, module bookmarks and PDF page labels. The preferred final Eurostile-family heading font was not supplied, so this trial embeds an available substitute rather than claiming to use that font.

Embedded attachments preserve the editable manuscript, module data and calculation or production checks. They are revision resources, not additional printed pages. The public argument remains within the numbered manual.

For the final edition, review authorial wording, select the canonical physical definitions, complete any calculations being promoted in status, and inspect a physical print proof. Recheck the selected distributor’s file and metadata requirements before submission.

No blank padding is used to obtain the count. Page length is an editorial choice associated with the selected adjoint dimension; it is not evidence for the framework. Future changes must preserve both the content and the explicit page-count requirement.