

Living Universe - Equation & Notation Key Ledger

Plain-language definitions for every major placeholder, letter, number, operator, and symbolic expression used in the Scientific Foundation & Methodology document

Purpose and authority. This ledger explains notation already used in the companion document. It does not create a new equation, alter the master equation, or assign new scientific authority to illustrative shorthand. Where the PDF uses ASCII notation such as $\rightarrow$, $\neq$, $\leq$, $\sum$, or π , the conventional mathematical symbol is shown in parentheses when helpful.

1. Master-equation notation

Printed notation	Read / formal form	Meaning in this document
Existence = Nonexistence	Master equation	The exact, immutable foundational equation of the Living Universe framework. The words Existence and Nonexistence are the authoritative terms. This is a framework identity, not an instruction to replace it with ordinary arithmetic such as $1 = 0$.
$0 \rightarrow 1$	zero to one	The continuous beginning-side realization described by the framework: from the nonexistence-side toward the existence-side. 0 and 1 are conceptual state symbols here, not measured quantities or Boolean values.
$1 \rightarrow 0$	one to zero	The continuous end-side realization described by the framework: from the existence-side toward the nonexistence-side. It occurs as part of the same nonterminal dynamic realization, not as a separate master equation or one-time final event.
while	simultaneously / concurrently	Plain-language connector indicating that $0 \rightarrow 1$ and $1 \rightarrow 0$ are aspects of the same continuous realization. It is not a mathematical operator.
=	equals / is identified with	Equality. In the master equation it expresses the framework identity. In secondary equations it has the ordinary contextual meaning defined by that equation.

2. State and dynamic-shorthand notation

Printed notation	Read / formal form	Meaning in this document
S	state	A generic symbol for the modeled system or universe state.
S(t)	state S at time t	The modeled state as a function of time.
t	time	A time parameter. Its actual unit must be defined by the specific experiment or model; the ledger does not assume seconds, years, or any other unit.
C[S(t)]	constraint applied to S(t)	Illustrative shorthand: C is a constraint/operator acting on the state. In a typeset mathematical version it is clearer to write calligraphic C (C-script) to distinguish it from experimental conditions.
C[S(t)] = 0	constraint residual equals zero	Illustrates that the global constraint is satisfied. Important: the 0 here means zero residual, not the nonexistence-side symbol used in $0 \rightarrow 1$.
dS/dt	rate of change of S	Derivative of the state with respect to time; it indicates how the state changes as time changes.
dS/dt $\neq$ 0	state is changing	The derivative is not zero, so the internal state is not static. This is illustrative shorthand showing that internal dynamics can continue while the global condition remains satisfied.
$\neq$	not equal to ($\neq$)	Logical/mathematical inequality. It means the expressions on either side must not be treated as identical.
[]	operator brackets	In C[S(t)], brackets show that the constraint/operator is being applied to the state expression S(t).
()	function/grouping parentheses	Used for function arguments, indexing expressions, or grouping; for example S(t) means S evaluated at time t.

3. Unknown, transition, and relationship notation

Printed notation	Read / formal form	Meaning in this document
A, B	generic states/entities	Placeholders for scientifically defined states, entities, products, or destinations. Their actual identity must be supplied by the specific research problem.
A -> B	A transitions to B	A supported directional relationship or transformation from A to B. The arrow does not by itself prove causation; the scientific meaning must come from the evidence/model defining the relationship.
A -> ?	A transitions to unresolved destination	The destination or continuation has not been scientifically resolved in the model. The question mark must remain explicit until evidence supports a destination.
?	unknown / unresolved	A deliberate placeholder for missing scientific resolution. It never means literal nonexistence and never authorizes the AI or simulator to invent a value or destination.
UNKNOWN != NONEXISTENCE	unknown is not nonexistence	A project invariant: lack of human/model knowledge is not treated as the disappearance of underlying reality.
UNRESOLVED DESTINATION != NONEXISTENCE	unresolved destination is not nonexistence	A project invariant: an unknown continuation remains unresolved rather than being converted into literal nonexistence.
->	arrow / directed progression	Context-sensitive symbol. In physical/model equations it indicates a modeled direction or transition; in workflow chains it means "next stage." It must be interpreted from context.

4. Discovery-resolution notation

Printed notation	Read / formal form	Meaning in this document
M0(S), M1(S), M2(S)	model descriptions at resolutions 0, 1, 2	Successively more resolved descriptions of the same underlying state S. The subscripts are resolution/version indices, not physical measurements.
M_n(S)	model M at resolution n	General form for the model description of S at resolution index n.
n	resolution index	Generic integer label for a model-resolution step or version in the conceptual sequence.
n + 1	next resolution	The next more detailed resolution after n.
M0(S) <= M1(S) <= M2(S)	coarse-to-finer resolution ordering	The printed <= is conceptual ordering, not ordinary numerical magnitude. It means later models are at least as resolved as earlier ones within the intended refinement relation.
<=	less-than-or-equal sign used as an ordering marker ($\leq$)	In this document it stands for a resolution/refinement ordering. It should not be read as saying one model has a smaller numerical value.
pi_n	projection / coarse-graining map (π_n)	A conceptual operator that maps a finer model back to the prior resolution n. "pi" here is a named projection symbol, not the number 3.14159.
pi_n(M_(n+1)) = M_n	project finer resolution back to prior resolution	Conceptual compatibility condition: where appropriate, the more detailed model at n+1 should coarse-grain back to the earlier valid model at n.
...	ellipsis / continuation	Indicates that the resolution sequence can continue beyond the explicitly written terms.
_	subscript marker in ASCII notation	Used in forms such as M_n, X_i, J_(j->i), and S0 to attach an index or qualifier to a symbol.

5. Internal transfer / balance notation

Printed notation	Read / formal form	Meaning in this document
X_i	quantity/state variable indexed by i	A generic modeled quantity associated with component/state i. Its physical meaning and units must be defined by the specific model.
i, j, k	indices	Generic labels used to distinguish components or nodes in a transfer network. j commonly labels incoming sources; k commonly labels outgoing destinations in the illustrative balance equation.

Printed notation	Read / formal form	Meaning in this document
$J_{(j \rightarrow i)}$	transfer/flux from j to i	A generic transfer quantity flowing into i from j. Its units depend on the modeled science.
$J_{(i \rightarrow k)}$	transfer/flux from i to k	A generic transfer quantity flowing out of i toward k.
sum_j	sum over j (Σ_j)	Add all incoming transfer terms indexed by j.
sum_k	sum over k (Σ_k)	Add all outgoing transfer terms indexed by k.
dX_i/dt	net rate of change of X_i	Derivative of X_i with respect to time.
$dX_i/dt = \text{sum}_j J_{(j \rightarrow i)} - \text{sum}_k J_{(i \rightarrow k)}$	generic internal transfer balance	Illustrative balance relation: rate of change equals total incoming transfer minus total outgoing transfer. It is a lower-level modeling relation, not the Living Universe master equation.
+ / -	addition / subtraction	Used for ordinary arithmetic or indexing. In the transfer equation, minus separates outgoing transfers from incoming transfers.

6. Experiment-model notation

Printed notation	Read / formal form	Meaning in this document
S_0	initial state	The starting modeled state for a particular experiment or simulation.
F	model/evolution function	A generic function or rule that maps the initial state, conditions, and time to a modeled state. F must be defined by the actual scientific model; the symbol alone supplies no physics.
C (in $S(t) = F(S_0, C, t)$)	experimental conditions	Here C means the set of experimental/model conditions. This is different from C in $C[S(t)]$. The PDF reuses the letter C contextually; future mathematical editions should distinguish these symbols more explicitly.
$S(t) = F(S_0, C, t)$	state produced by model F	Generic experiment notation: the modeled state at time t is determined by the initial state S_0 , conditions C , and evolution/model rule F .
MODEL DISCREPANCY -> RESEARCH QUESTION	workflow statement	A mismatch between modeled and observed behavior should become a research question rather than be hidden or automatically patched.

7. Research-workflow and provenance notation

Printed notation	Read / formal form	Meaning in this document
CLAIM -> SOURCE(S) -> METHODS / DATA -> UNCERTAINTY	evidence-provenance chain	A material scientific claim should be traceable to one or more sources, then to methods/data, and to the uncertainty/limitations associated with those sources.
SOURCE(S)	one or more sources	The parenthetical S means source or sources; it is plain-language notation, not a mathematical function.
/	slash	Context-sensitive. In METHODS / DATA it means "methods and/or data," while in dS/dt it appears inside derivative notation and should not be read as an ordinary prose slash.
QUESTION -> HYPOTHESIS -> ... -> REVISION	research workflow	A sequence of research stages. These arrows mean workflow progression, not physical transformations.
QUESTION -> INVESTIGATION -> EVIDENCE -> UNDERSTANDING -> RESEARCH SUMMARY	research-platform workflow	High-level intended research sequence. Each arrow means progression to the next research stage.
OPTIONAL: RESEARCH SUMMARY -> PROPOSAL -> REVIEW -> SANDBOX -> FUTURE AUTHORIZED DISCOVERY	optional governance path	A research result may optionally enter the proposal/review/sandbox process. The arrows do not mean automatic promotion; each boundary remains separately governed.

8. Research, proposal, authority, and identity notation

Printed notation	Read / formal form	Meaning in this document
R	complete retained research record	The full research workspace/record, including supported and unsupported material, hypotheses, notes, uncertainty, and unresolved items.
P	supported proposal packet	The deliberately constructed proposal containing only material eligible to cross from research into proposal form.

Printed notation	Read / formal form	Meaning in this document
P subset-of R	P is a subset of R ($P \subseteq R$)	Every proposal assertion must come from the retained research record; the proposal cannot contain unsupported material that does not exist in R.
RESEARCH != PROPOSAL != DISCOVERY	permanent separation	Research, proposal, and canonical discovery are distinct states/authorities. One must never be treated as automatically equal to another.
CHATGPT RESEARCH ASSISTANCE = TRUE	product capability flag	The project permits ChatGPT-assisted research functions such as explanation, search support, organization, comparison, and calculation assistance.
CHATGPT SCIENTIFIC AUTHORITY = FALSE	authority boundary flag	ChatGPT output does not by itself establish scientific truth, pass review, or create a canonical discovery.
TRUE / FALSE	logical design values	Boolean-style project flags expressing whether a capability or authority is allowed. They are not measurements or scientific confidence scores.
DISCOVERY-0001	canonical identifier	The identifier assigned to the Genesis Plant Growth Equation. The 0001 is an identity/sequence label, not a numerical coefficient in an equation.

9. Coverage notation

Printed notation	Read / formal form	Meaning in this document
7/9	seven of nine identified requirements	Example coverage display: seven of the nine requirements currently identified as applicable to the defined scope meet the stated support criterion. It is not a 77.8% probability that the science is true.
9/9	nine of nine identified requirements	All requirements in the currently identified requirement set meet the stated support criterion. It does not mean all possible requirements in reality have been discovered.
COVERAGE != TRUTH PROBABILITY	coverage is not probability of truth	Coverage measures how much of an identified requirement/evidence set is supported. It must not be interpreted as probability that a scientific claim is true.
IDENTIFIED REQUIREMENT COMPLETENESS != ONTOLOGICAL COMPLETENESS	identified set is not all of reality	Even complete coverage of the current requirement set does not establish that no additional requirement exists. Later research may increase the denominator.

10. Context-sensitive notation warnings

The symbol 0 has two different contexts. In $0 \rightarrow 1$ it is the conceptual nonexistence-side symbol in the dynamic explanation. In $C[S(t)] = 0$ it means a zero constraint residual. Those meanings must not be conflated.

The letter C is reused. In $C[S(t)]$ it denotes a constraint/operator. In $S(t) = F(S_0, C, t)$ it denotes experimental/model conditions. This is readable from context but should be differentiated in future formal mathematical editions.

The arrow $\rightarrow$ is overloaded by design. In $A \rightarrow B$ it is a modeled relationship/transition. In QUESTION $\rightarrow$ HYPOTHESIS it is workflow progression. The arrow alone never supplies scientific causation or authority.

The $\leq$ symbol is not numeric in the resolution chain. $M_0(S) \leq M_1(S)$ expresses a coarse-to-finer descriptive ordering, not a claim that one model is numerically smaller.

Illustrative letters are placeholders. A, B, S, X_i , J, F, C, M_n , P, and R have only the meanings assigned by the surrounding expression. They are not universal physical constants. Every real experiment must define its actual variables, units, conditions, equations, evidence, and uncertainty.

11. Quick read-aloud key for classrooms and presentations

Existence = Nonexistence: "Existence equals Nonexistence."

$0 \rightarrow 1$ while $1 \rightarrow 0$: "Zero to one while one to zero, continuously, as two explanatory aspects of the same master identity."

$C[S(t)] = 0$ while $dS/dt \neq 0$: "The global constraint on the state is satisfied while the internal state continues changing with time."

$A \rightarrow ?$: "A transitions toward an unresolved destination; the continuation is not yet known by the model."

$M_0(S) \leq M_1(S) \leq M_2(S) \leq \dots$: "The scientific description of the same state becomes progressively more resolved."

P subset-of R: "The proposal is a supported subset of the complete research record."

7/9 requirement coverage: "Seven of nine currently identified applicable requirements are sufficiently supported under the stated criteria."