

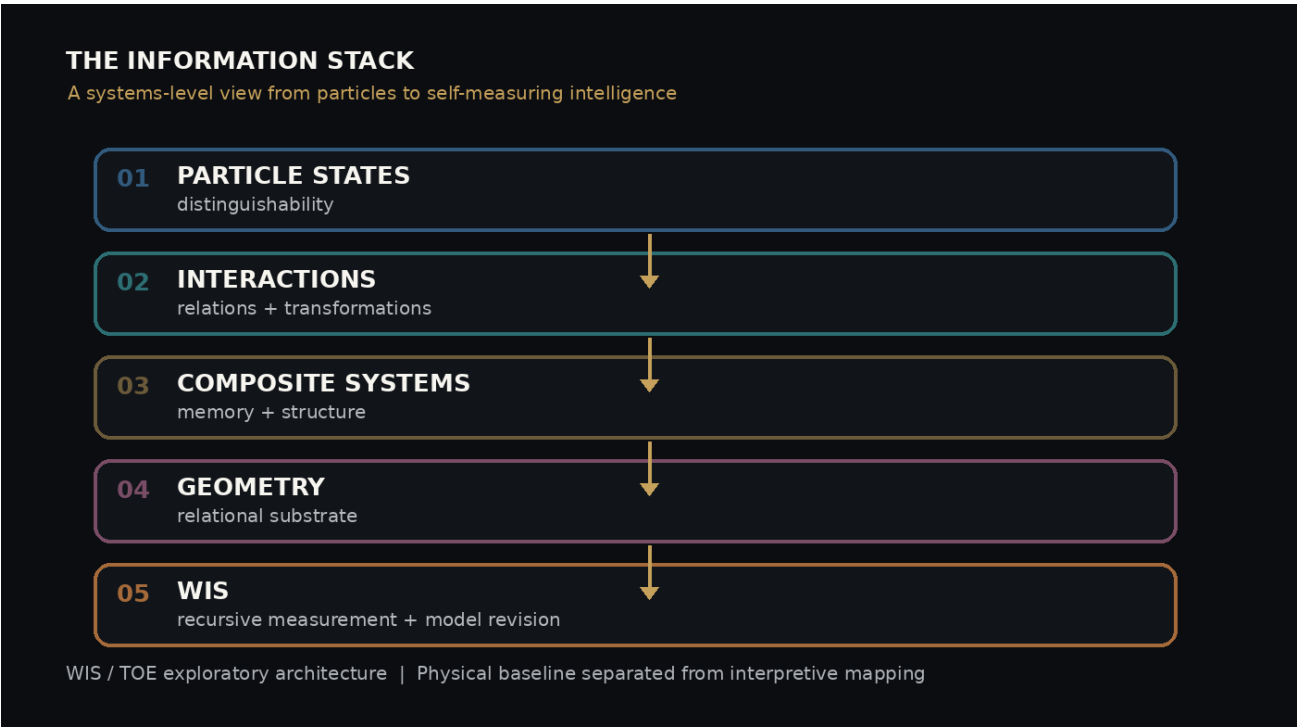
PARTICLE INFORMATION ARCHITECTURE

Fundamental particles as computational bits

A systems-science translation of the known particle inventory into an information-processing vocabulary, with a clearly marked speculative graviton extension.

THE SEPARATION RULE

Physical particle properties and interactions are reported as established physics. Computational names such as TRANSFER, COMPOSE, GEOMETRIZE, and qubit/qudit labels are an exploratory WIS/TOE interpretation - not standard particle-physics terminology.



Prepared as a working conceptual reference • Physical data anchored to the Particle Data Group and CERN • Current edition context: PDG Review of Particle Physics 2026

From particles to computation

The physical inventory comes first. The computational interpretation comes second.

The building blocks do not have to be invented. The systems question is what can be built by rearranging them.

In quantum field theory, a particle is best treated as an excitation of an underlying field rather than as a tiny classical bead. The Standard Model organizes known matter fields, gauge fields, and the Higgs field; the graviton is not part of the Standard Model and remains hypothetical. [1][2]

Three layers of meaning

Layer	Question	This document calls it
Physical	What is the excitation?	field excitation / particle
Relational	How can it interact and what state structure does it have?	state space + interaction channel
Computational	What information operation can the system-level abstraction assign it?	bit / qudit + systems opcode

The core WIS abstraction

Differentiate -> Relate -> Measure -> Model / revise

A computational particle ontology becomes useful only when the state labels, legal transitions, and interaction constraints are explicit enough to be simulated, criticized, and potentially falsified.

IMPORTANT ABOUT "BITS"

The qubit/qudit labels here are chosen to express distinguishable quantum state dimensions. They are not claims that nature literally implements ordinary digital bits inside particles.

Fundamental particle inventory

One compact map of the Standard Model plus the hypothetical graviton.

Particle	Class	Spin	State structure	Mass / bound	WIS bit label	Systems opcode
up (u)	quark	1/2	2 x 3	2.16 MeV*	Qubit x color qutrit	COMPOSE
down (d)	quark	1/2	2 x 3	4.70 MeV*	Qubit x color qutrit	COMPOSE
charm (c)	quark	1/2	2 x 3	1.273 GeV*	Qubit x color qutrit	COMPOSE
strange (s)	quark	1/2	2 x 3	93.5 MeV*	Qubit x color qutrit	COMPOSE
top (t)	quark	1/2	2 x 3	172.56 GeV*	Qubit x color qutrit	COMPOSE
bottom (b)	quark	1/2	2 x 3	4.183 GeV*	Qubit x color qutrit	COMPOSE
electron (e)	charged lepton	1/2	2	0.51099895 MeV	Qubit	IDENTIFY
muon (mu)	charged lepton	1/2	2	105.65838 MeV	Qubit	IDENTIFY
tau (tau)	charged lepton	1/2	2	1776.93 MeV	Qubit	IDENTIFY
nu_e / nu_mu / nu_tau	neutrino	1/2	2**	< 0.45 eV***	Qubit (channel model)	PROPAGATE
photon (gamma)	gauge boson	1	2 helicities	< 1e-18 eV	2-state helicity qubit	TRANSFER
gluon (g)	gauge boson	1	8 color states; 2 pol.	0	8-state color qudit	CONNECT
W+ / W-	gauge boson	1	3 spin states	80.369 GeV	3-state qutrit	TRANSFORM
Z0	gauge boson	1	3 spin states	91.188 GeV	3-state qutrit	CORRELATE
Higgs (H)	scalar boson	0	1 physical state	125.20 GeV	1-state scalar dit	PARAMETERIZE
graviton (G)†	hypothetical tensor	2	5 rep. states / 2 massless helicities	< 1.76e-23 eV††	5-state spin qudit†	GEOMETRIZE

Quarks: composition bits

Six flavors, spin-1/2, three color states; never observed as isolated free particles.

Quarks are fermionic fields with spin 1/2 and come in three color states. Quantum chromodynamics confines them into color-neutral composite states such as hadrons. In the computational mapping, that makes a quark less like a finished object and more like a compositional primitive whose information value emerges through relationships with other colored degrees of freedom. [1][4]

Symbol	Flavor	Charge	PDG mass	Information representation	Function
u	up	+2/3	2.16 +/- 0.07 MeV	spin qubit + color qutrit	COMPOSE
d	down	-1/3	4.70 +/- 0.07 MeV	spin qubit + color qutrit	COMPOSE
c	charm	+2/3	1.2730 +/- 0.0046 GeV	spin qubit + color qutrit	COMPOSE
s	strange	-1/3	93.5 +/- 0.8 MeV	spin qubit + color qutrit	COMPOSE
t	top	+2/3	172.56 +/- 0.31 GeV	spin qubit + color qutrit	COMPOSE
b	bottom	-1/3	4.183 +/- 0.007 GeV	spin qubit + color qutrit	COMPOSE

Systems-information interpretation

- COMPOSE: preserve a distinguishable primitive while allowing higher-order states to emerge from relational combinations.
- Color is not an ordinary visual color; it is an internal SU(3) gauge label. In the WIS mapping it acts naturally as a relational-address space.
- The six flavors provide repeated primitive structure across three generations: same basic spin architecture, different masses and couplings.

WHY NOT "A 6-STATE QUDIT"?

The phrase can be useful, but it should not erase the factorization. A quark has a 2-state spin degree and a 3-state color degree; the tensor-product label is naturally $2 \times 3 = 6$, not one primitive 6-state variable.

Leptons: identity and deep-channel bits

Charged leptons preserve a clear local identity; neutrinos carry information through weakly coupled channels.

Particle	Spin	Nominal state	Mass	WIS representation	Function	Observed behavior
electron e-	1/2	2	0.51099895000 MeV	2-state spin qubit	IDENTIFY	stable
muon mu-	1/2	2	105.6583755 MeV	2-state spin qubit	IDENTIFY	decays
tau tau-	1/2	2	1776.93 +/- 0.09 MeV	2-state spin qubit	IDENTIFY	decays
nu_e	1/2	2**	mass not individually resolved	2-state quantum label*	PROPAGATE	oscillates
nu_mu	1/2	2**	mass not individually resolved	2-state quantum label*	PROPAGATE	oscillates
nu_tau	1/2	2**	mass not individually resolved	2-state quantum label*	PROPAGATE	oscillates

* The WIS label is an information abstraction; neutrino flavor is not identical to a single mass eigenstate. Oscillation experiments establish nonzero mass-squared differences, while direct absolute masses remain bounded rather than fully measured. [5]

Systems-information interpretation

- IDENTIFY: a stable or persistent distinguishable matter state that can participate in local relationships and carry conserved quantum numbers.
- PROPAGATE: a low-interaction channel can still be information-rich because weak coupling allows the state to traverse large systems with relatively little disturbance.
- Generation structure suggests a repeated information architecture at multiple mass scales: a useful clue for hierarchical system design, even though this mapping remains interpretive.

ANTI-MISTAKE

"Information function" does not mean a particle has intent or a software instruction stored inside it. The function is a systems-level description of what information relationship the particle can instantiate.

Gauge bosons and the Higgs

Here the computational metaphor becomes most natural: interactions change relationships among states.

Excitation	Spin	Physical state structure	Mass	Physical interaction	WIS opcode	Systems reading
photon gamma	spin 1	2 physical helicities	<1e-18 eV	EM coupling to electric charge	TRANSFER	communication channel
gluon g	spin 1	8 color states x 2 pol.	0	QCD; self-interacting color field	CONNECT	relational network
W+ / W-	spin 1	3 spin states	80.3692 +/- 0.0133 GeV	charged weak current	TRANSFORM	state conversion
Z0	spin 1	3 spin states	91.1880 +/- 0.0020 GeV	neutral weak current	CORRELATE	state relation
Higgs H	spin 0	1 physical state	125.20 +/- 0.11 GeV	couples to fields; BEH sector	PARAMETERIZE	persistent scale

What the interaction network looks like

Interaction	Primary carriers	Matter touched	Computational reading
electromagnetic	photon	charged quarks + charged leptons	information transfer / signaling
strong	gluons	quarks + gluons	relational connectivity / confinement
weak	W and Z	quarks + leptons (chiral)	state transformation / correlation
Higgs sector	Higgs field / H	many massive fields through couplings	parameter setting / state scaling
gravity*	graviton*	stress-energy*	geometry / substrate coupling

CERN summarizes the Standard Model as covering the strong, weak, and electromagnetic interactions and their carrier particles; gravity is outside the Standard Model in its present form. [1][2]

What does "bit" mean here?

A disciplined translation between quantum state structure and systems information.

Bit, qubit, qutrit, qudit

Term	Literal information dimension	Use in this framework
bit	2 classical states	ordinary binary abstraction
qubit	2-dimensional quantum state space	e.g. a two-state helicity or spin label
qutrit	3-dimensional state space	e.g. three spin projections of a massive spin-1 boson
qudit(d)	d-dimensional quantum state space	generalized state register, e.g. color octet or spin-2 representation

Critical distinction: representation states vs physical polarizations

For a massive spin-s particle in 3+1 dimensions, the ordinary spin representation has $2s+1$ states. Massless gauge particles are different: gauge symmetry removes unphysical components, leaving only physical helicity states. A photon therefore has two physical helicities, while a massive spin-1 W or Z has three physical polarization states. [6]

The useful computational label is the smallest state space that preserves the distinctions relevant to the operation being modeled.

The WIS systems-opcode vocabulary

The working vocabulary used throughout this document is: READ, MEASURE, TRANSFER, CONNECT, TRANSFORM, CORRELATE, IDENTIFY, COMPOSE, PROPAGATE, PARAMETERIZE, GEOMETRIZE*, and REVISE (RV). The full machine-language form appears in Section 9.

NO SACRED VARIABLES

None of these computational assignments is exempt from the reality veto. If an experiment contradicts the mapping, the mapping changes. The point is to generate a testable information model, not to protect a preferred metaphor.

The graviton: geometry as information

This is where the particle-bit metaphor becomes a proposed substrate-level computation.

The Standard Model does not contain the graviton, and no graviton has been experimentally detected. CERN describes it as the putative carrier of gravity, while the PDG lists a graviton entry with $J=2$ and an extremely small mass bound. [1] [3]

Why the number five matters - and why it also needs a footnote

Description	State count	Meaning
massive spin-2 representation	5	$2s+1 = 5$ spin projections
massless 4D graviton in GR / linearized theory	2	physical helicities +2 and -2
WIS spin-qudit hypothesis	5	treat the full spin-2 representation as a 5-state computational register*

* This is a deliberate modeling choice in the WIS/TOE framework, not the standard physical degree-of-freedom count for a massless 4D graviton. Standard analyses of massless spin-2 give two propagating degrees of freedom; a massive spin-2 field has five. [6][7]

Systems-information function: GEOMETRIZE

- Ordinary interaction primitives modify states or relationships inside an existing geometry.
- GEOMETRIZE, in the hypothesis, would modify the relational geometry that defines which states can be adjacent, connected, or causally related.
- That makes gravity qualitatively different in the computational hierarchy: it would be a candidate substrate-level operation rather than merely another message carried across the substrate.

THE BOLD HYPOTHESIS

If gravitational degrees of freedom were controllable and programmable, geometry itself could become an information-bearing medium. That would turn the phrase "program spacetime" from metaphor into a physical engineering question. Nothing in current experiments establishes that capability.

From smooth manifold to "Braille" geometry

A visual analogy for an abstract principle - not a literal claim about topology.

The human brain reasons much more effectively with spatial structure than with high-dimensional tensor spaces. A visual analogy can therefore preserve the important relationships without pretending the picture is the object.

Visual analogy	Systems-information reading
smooth surface / manifold	background relational geometry
raised or recessed pattern	locally distinguishable state perturbation
arrangement of bumps	structured information
pattern grammar	relationships among states
reader	measurement + model-building system
writing new pattern	hypothetical programmable geometry

The message is not written on the manifold. In the analogy, the structured geometry is the message.

The epistemic point

An embedded intelligence never has total access to the reality it models. It receives a finite projection through measurement. A useful representation therefore need not resemble reality; it must preserve the relationships required to infer, predict, compare, and revise.

Reality -> Measurement -> Representation -> Model -> Self-model

WIS TARGET

Maximize recoverable structure and meaning from finite access to reality - while preserving uncertainty, provenance, contradiction, and the possibility of revision.

PIIS: Particle Information Instruction Set

A compact grammar for turning the ontology into something that can be simulated.

Instruction frame

[SOURCE] [OPCODE] [TARGET] [STATE] [CONSTRAINT]

The opcode says what information transformation is modeled; the constraint field is non-negotiable. In the physical system, conservation laws, gauge symmetry, quantum rules, causality, and thermodynamic constraints define the legal program space.

Opcode	Pseudo-instruction	Interpretation
RD	RD source	read accessible state
ME	ME source -> record	create measurement record
TR	TR source -> target	transfer distinguishable information
CN	CN source <-> target	create relation / connectivity
TF	TF source -> state2	allowed state transformation
CR	CR source <-> target	create or update correlation
ID	ID source	preserve identity label
CP	CP A + B -> C	compose higher-order structure
PR	PR source -> channel	propagate through weakly coupled route
PA	PA field -> parameter	parameterize persistent behavior
GE*	GE geometry -> geometry2	hypothetical geometric rewrite
RV	RV model <- evidence	epistemic revision

Minimal legal cycle

READ -> MEASURE -> REPRESENT -> TRANSFORM -> CORRELATE -> PROPAGATE -> READ

With the speculative gravity instruction inserted:

READ -> MEASURE -> GEOMETRIZE* -> PROPAGATE -> READ

The point is to make the hypothesis explicit enough that physics can constrain, test, or reject it.

A particle ontology that can grow into a systems theory

The physics inventory stays grounded while the computational layer remains explicitly provisional.

The useful result is not the claim that particles are literally software instructions. It is a disciplined translation that asks whether known state spaces and interaction channels can be represented as information primitives with composable operations.

The hierarchy

Level	Primitive	Information role
I	particle state	differentiate
II	interaction	relate / transform
III	composite structure	compose / persist
IV	geometry	organize the relations
V	WIS	measure, model, revise itself
VI*	programmable geometry	hypothetical substrate-level computation

The universe supplied the building blocks. The systems problem is discovering the legal ways to rearrange them.

Source discipline

Physical claims are anchored primarily to CERN and the Particle Data Group. The computational functions, opcodes, and bit assignments are exploratory WIS/TOE interpretations. The graviton remains hypothetical; the five-state label is a model choice distinct from the two physical helicities of a massless 4D graviton.

References and validation trail

Primary physical-data sources used for the baseline particle inventory. The WIS computational mapping remains interpretive.

- [1] Particle Data Group (2026), Review of Particle Physics, current edition; particle property tables and listings. <https://pdg.lbl.gov/2026/>
- [2] CERN, The Standard Model. <https://home.cern/science/physics/standard-model/>
- [3] Particle Data Group (2025), Gauge & Higgs Boson Summary Table; includes photon, gluon, graviton, W, Z and Higgs entries. <https://pdg.lbl.gov/2025/tables/rpp2025-sum-gauge-higgs-bosons.pdf>
- [4] Particle Data Group (2025), Quark Masses review and summary tables. <https://pdg.lbl.gov/2025/reviews/rpp2025-rev-quark-masses.pdf>
- [5] Particle Data Group (2025), Neutrino Masses, Mixing, and Oscillations; current direct tritium bound quoted for the electron-flavor effective mass. <https://pdg.lbl.gov/2025/reviews/rpp2025-rev-neutrino-mixing.pdf>
- [6] Hertzberg, M. P. & Litterer, J. (2020), Phys. Rev. D 102, 025023 / 085007, discussions of massless and massive spin-2 degrees of freedom.
- [7] U.S. Department of Energy OSTI-hosted review material, Degrees of Freedom section: massless spin-2 has two helicity degrees of freedom; massive spin-2 has five.

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