HSM – Executive Summary

Starting point. HSM (*Meshed Hypersphere*) is a deterministic theory built on a hypersphere $\mathbb{S}^3$ endowed with an internal mechanical structure.

Its starting point is based on a simple idea: in certain nonlinear mechanical systems, localized excitations can become stable, non-dispersive solutions. Sine–Gordon-type equations provide a classical example of this phenomenon. They admit localized solutions, bound states, propagating modes and interactions between solutions.

HSM takes this general idea and extends it to a much richer support: a meshed hypersphere whose elements can vibrate tangentially, locally deform the radius of the support, and satisfy global closure conditions on $\mathbb{S}^3$.

The question addressed is therefore the following: can such a mechanical structure generate, as properties of its solutions, objects identifiable with particles, interactions and the physical regimes observed in nature?

Why geometry matters. Two properties play a central role.

The first is the nonlinearity induced by the coupling between tangential vibrations and the radial response of the support. This nonlinearity allows the existence of stable localized solutions, massless modes, bound states and composite structures.

The second is the compactness of $\mathbb{S}^3$. Solutions do not evolve on an open space but on a closed one. They must satisfy global constraints of closure, return and geometric consistency.

This compactness also allows the existence of multi-centre global solutions, in which several localized centres belong to a single mechanical solution.

Structural results obtained before calibration. Before any numerical comparison with observations, the analysis of HSM solutions reveals several discrete properties that are not introduced as initial assumptions:

- a family of relative charges identifiable with 1, 2/3 and 1/3;
- three admissible levels for the families associated with leptons and quarks;
- a unique admissible level for the solutions associated with the W and Z^0 bosons;
- a massless photon-like sector with two physical polarizations;

- four interaction channels identifiable, in the appropriate regimes, with the gravitational, electromagnetic, weak and strong sectors;
- an emergent fine-structure constant,

$$\alpha_{\mathrm{HSM}}^{\mathrm{LO}} \simeq 7.2846 \times 10^{-3} \approx \frac{1}{137.28},$$

  obtained from a family of solutions whose effective properties are identified with the electromagnetic sector.

The catalogue of HSM solutions also contains structures that extend beyond the current inventory of the Standard Model.

Fundamental constants of the model. The closure of the HSM framework relies on a limited set of fundamental mechanical constants:

- ℓ_0: characteristic length of the elementary mesh cell;
- T: effective tension of the support;
- ρ: volumetric inertial density;
- R_0: radius of the hypersphere;
- κ_r: radial response coefficient;
- κ_μ: local radial confinement coefficient;
- χ: global geometric closure parameter.

From these constants, HSM reconstructs the internal scales of the model, the solution families, masses, charges, couplings, effective fields and composite structures.

Calibration inputs. The fundamental HSM constants are not adjusted freely. They are determined from a limited set of reference observables:

- Planck's constant;
- the speed of light;
- the mass of the W boson;
- the vacuum impedance;

- the gravitational constant G_N;
- the mass hierarchy of the charged leptons.

These six inputs are used to determine the fundamental constants of the model. The masses, couplings, composite structures and other observables presented afterwards are not used in this calibration and therefore constitute outputs of the HSM framework.

Main quantitative outputs. Once the calibration has been fixed, HSM produces, among others:

- the mass of the solution associated with the electron;
- the mass of the neutral solution associated with the Z^0;
- the mass of the radial sector associated with the Higgs boson;
- the masses of composite structures identifiable with several observed baryons;
- the mass splittings of the neutrino-like sector;
- the PMNS mixing angles;
- the properties of the photon-like sector.

In several major chains, the deviations from observed values are below or of the order of one percent.

Effective readings. In the appropriate regimes, HSM admits:

- an effective quantum-mechanical reading;
- an effective field-theory reading;
- an effective general-relativistic reading.

These structures do not appear as fundamental postulates of the model, but as effective organizations of the underlying mechanical dynamics.

Falsifiability. HSM produces masses, ratios, spectral levels, coupling structures, admissible or forbidden families, and effective constants.

Any observation incompatible with these outputs, or the demonstration of a branch explicitly excluded by the closure conditions of the model, would directly contradict the corresponding chains.

How to read the manuscript. The complete manuscript is organized as a continuous chain:

$$\begin{aligned}&\text{mechanical assumptions} \to \text{equations} \to \text{solutions}\\&\to \text{effective fields} \to \text{closures} \to \text{numerical comparisons.}\end{aligned}$$

The goal is to provide a theory in which every result can be traced explicitly to an assumption, an equation, a closure condition or a normalization that is clearly identified.