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From operators to observables

What the octonionic framework aims to explain numerically

Key Insight. After three weeks of structural work, it is natural to ask: which observable numbers are meant to follow from the octonionic operator picture? The mass ladder, shadow spectrum, near-critical electroweak scale and fixed charge patterns all suggest that scales, charges and mixings could be read from the spectrum of a single octonionic Dirac operator.

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Any unification attempt is only as good as the list of observables it can address. In the past days, several such targets have appeared:

- scales on the mass ladder, from the QCD scale up to high octonionic scales;
- particle masses and hierarchies;
- charge and quantum-number patterns;
- possible dark or shadow sectors.

Spelling these out explicitly helps to see what the operator framework intends to explain as spectral data.

Mass scales and hierarchies

The characteristic bands on the ladder can be viewed as clusters of eigenvalues of the internal Dirac operator D_F:

- **High scales:** octonionic scales such as $M_8 \sim 10^{16}$–10^{18} GeV and intermediate compressor scales $M_{C2} \sim 10^{12}$–10^{14} GeV, $M_{C1} \sim 10^{9}$–10^{11} GeV;
- **Electroweak scale:** $v \approx 246$ GeV and weak-boson masses $m_W \approx 80$ GeV, $m_Z \approx 91$ GeV;
- **Low scales:** the QCD scale $\Lambda_{\mathrm{QCD}} \sim 200$ MeV and hadronic masses.

The octonionic mass operators R, L and their compressors organise these into a ladder. A quantitative programme would compute ratios like $M_8/\Lambda_{\mathrm{QCD}} \sim 10^{20}$ from this spectrum.

Masses, families and mixings

Beyond scales, the internal spectrum of D_F is supposed to encode three fermion generations, mass hierarchies, and mixing matrices. On the structural level, the octonionic model naturally accommodates three generations and right-handed neutrinos. Turning this into numbers would mean deriving mass ratios such as

$$\frac{m_\mu}{m_e} \approx 207, \quad \frac{m_\tau}{m_\mu} \approx 17, \quad \frac{m_t}{m_b} \approx 40$$

from eigenvalue structures and computing mixing angles as overlaps between eigenbases. The CKM matrix elements, for instance, range from $|V_{ud}| \approx 0.974$ to $|V_{ub}| \approx 0.004$, while PMNS angles span from $\theta_{12} \approx 33^\circ$ to $\theta_{13} \approx 8.6^\circ$.

Charges and dark sectors

From the internal generators of D_F, charge assignments emerge as eigenvalues on different subspaces. The same construction that distinguishes quarks from leptons also leaves room for states neutral under visible charges. In the ladder picture, these appear as shadow or dark states: eigenvectors of D_F whose couplings to visible fields are suppressed. The observables of interest are predicted mass windows — light shadow states in the GeV–TeV range, heavy shadow states near M_{C2} or M_8 — and coupling strengths for such dark candidates.

A map for future work

The operator framework comes with a concrete checklist: specify D_F in an octonionic model, compute its spectrum, extract predictions for mass ratios and mixing angles, and confront these with data. The calendar does not carry out this programme, but it narrows down the question to a list of observables that should be encoded in the spectrum of an octonionic master equation.

References

[1] I. Esteban *et al.*, *The fate of hints: updated global analysis of three-flavor neutrino oscillations*, J. High Energy Phys. **2020**, 178 (2020), updated results at `http://www.nu-fit.org`.

The octonionic operator picture comes with a concrete list of target observables, which now must be computed and compared to data.

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