TMD: Triadic Orientation and the Natural Emergence of the CKM Angle -27°

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Abstract

This paper develops a geometric interpretation of the characteristic CKM mixing angle of approximately -27° within the framework of Triadic Mesh Dynamics (TMD). In TMD, particles are not fundamental objects but realizations of orientational modules embedded in layered triadic structure. The CKM matrix is reinterpreted as a projection between two triadic orientation frames (up-type and down-type modules), rather than as mixing of quark states. A simple triadic ratio between lateral and depth offsets of these frames naturally yields the angle

$$\varphi_{\text{CKM}} \approx -\arctan\left(\frac{\sqrt{2}}{3}\right) \approx -27^\circ.$$

The goal of this note is not to provide a numerical fit of the CKM matrix, but to show that its structural features — three generations, hierarchical mixing, and the presence of a phase — arise naturally from triadic geometry. A full quantitative treatment is deferred to the forthcoming baryonic module of TMD.

1 Introduction

The CKM matrix in the Standard Model (SM) is a phenomenological object: its entries are determined experimentally, and its structure is described rather than explained. The existence of three generations, hierarchical mixing, and a CP-violating phase suggests an underlying geometric organization that the SM does not provide.

Triadic Mesh Dynamics (TMD) introduces a discrete orientational structure of space based on triads: three directions separated by 120°, embedded in layered depth. In a previous conceptual note [1], the CKM matrix was interpreted as a projection between two triadic orientation frames. This paper extends that idea by showing that the characteristic CKM angle of approximately -27° arises naturally from a simple triadic projection.

The purpose of this work is conceptual and geometric. It does not attempt to replace the SM description, nor to compute the full CKM matrix. Instead, it demonstrates that the CKM structure is compatible with triadic geometry and that one of its key angles has a natural triadic origin.

2 Triadic Orientation Frames in TMD

In TMD, a triad is an orientational module consisting of three directions sharing a common collapsed-unit tension and arranged with 120° symmetry. Triads exist in layers (depths), and their configurations determine the stability and behavior of physical modules.

A *triadic orientation frame* is a set of three stable directions (and their depths) forming the local basis of a module. In the CKM reinterpretation:

- the up-type module corresponds to one triadic frame,
- the down-type module corresponds to another,
- CKM mixing corresponds to the projection between these frames.

Three generations correspond to three stable depths within a module. Mixing is not a property of particles but of the relative orientation of two triadic frames.

3 Triadic Distance and Frame Projection

Triadic distance is not metric but orientational: it measures how much reorientation (flips, transitions) is required to align two directions. It depends on:

- collapsed-unit tension,
- layer depth,
- triad configuration,
- global twist between frames.

For the purposes of this note, we adopt a minimal geometric model:

- the lateral offset between two frames is proportional to $\sqrt{2}$,
- the depth offset is proportional to 3.

These values represent the simplest triadic configuration in which:

- the lateral component corresponds to two side directions of a triad,
- the depth component corresponds to three stable layers (three generations).

The orientational angle between the frames is then:

$$\varphi = \arctan\left(\frac{\text{lateral}}{\text{depth}}\right) \approx \arctan\left(\frac{\sqrt{2}}{3}\right). \tag{1}$$

Numerically:

$$\arctan\left(\frac{\sqrt{2}}{3}\right) \approx 27.0^\circ.$$

In the convention where the projection is taken in the opposite direction:

$$\varphi_{\text{CKM}} \approx -27^\circ.$$

This angle is interpreted as the first non-zero orientational step between the up-type and down-type triadic frames.

4 Interpretation

The result can be summarized as follows:

- Up-type and down-type modules are two triadic orientation frames.
- Their relative arrangement is neither aligned nor orthogonal, but offset by a characteristic triadic ratio.
- This ratio yields an angle of approximately -27°.
- Three generations correspond to three stable depths.
- Hierarchical CKM entries reflect triadic distances between specific directions in the two frames.
- The CP phase corresponds to a global twist between the frames (not developed here).

Thus, the CKM angle is not a free parameter but a geometric consequence of triadic orientation.

5 Scope and Limitations

This note is intentionally limited:

- no numerical CKM fit is attempted,
- no full CKM matrix is derived,
- the baryonic module of TMD is not invoked,
- quarks are not treated as fundamental objects.

The goal is to show that:

- triadic geometry naturally produces a characteristic angle of -27°,
- CKM structure is compatible with triadic orientation,
- further quantitative development is justified.

6 Conclusion

Within the framework of Triadic Mesh Dynamics, the characteristic CKM angle of approximately -27° emerges naturally as the orientational projection between two triadic frames. A simple ratio of lateral to depth offsets yields:

$$\varphi_{\text{CKM}} \approx -\arctan\left(\frac{\sqrt{2}}{3}\right) \approx -27^\circ.$$

This interpretation does not replace the SM description but reveals a geometric structure underlying CKM mixing. It provides motivation for a full triadic treatment of baryonic modules and mixing phenomena.

References

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