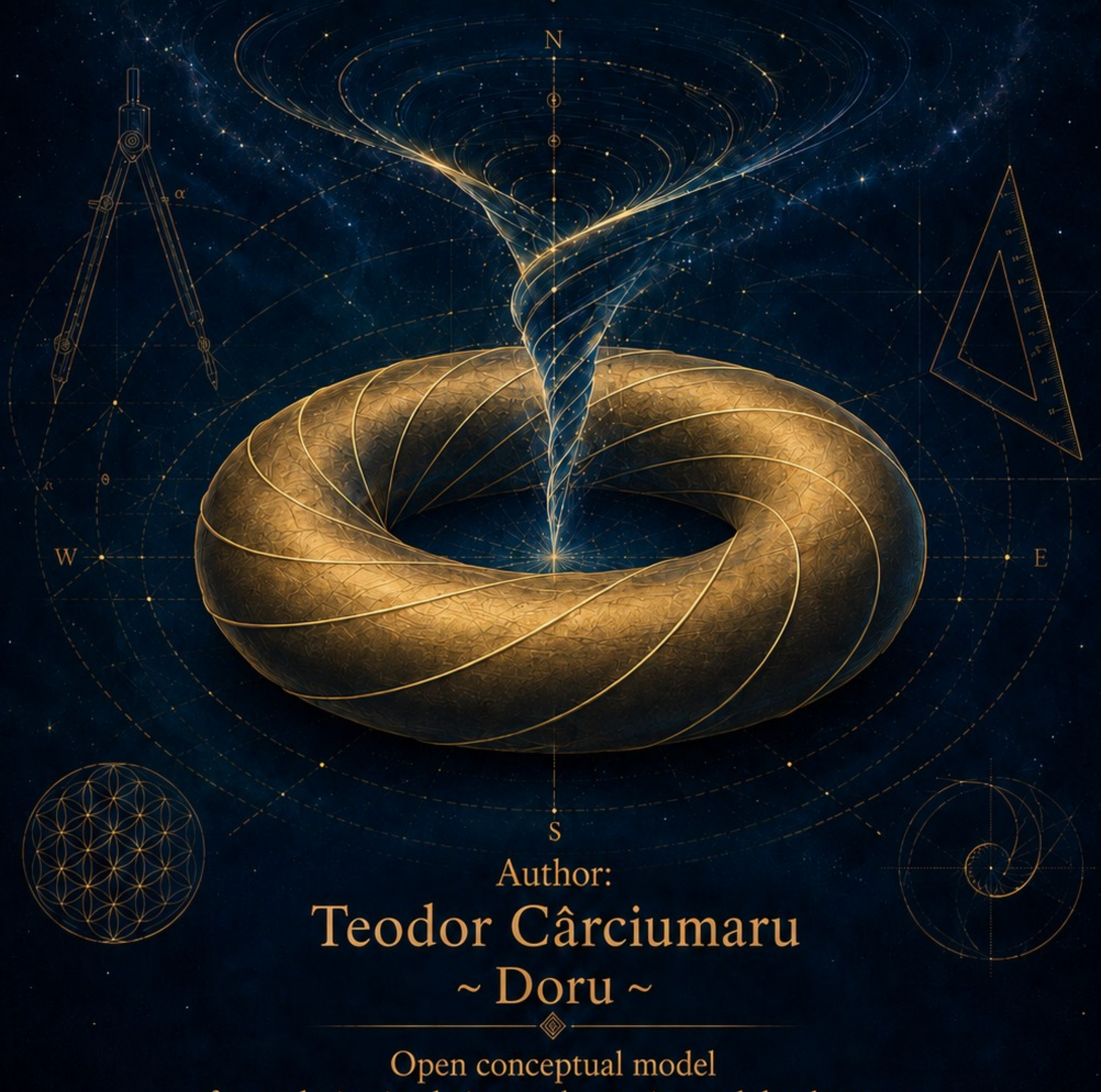
CYCLIC TWIST TOROIDS

TTC(n)

An architectural principle for toroidal structures
with cyclic closure and discrete monodromy



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Open conceptual model
for analysis, simulation, and experimental development

June 2026

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Item	Value
Author / concept	Teodor Cârciumaru ~ Doru ~
Document type	Open conceptual model
Field	Geometric topology, toroidal architecture, ideal magnetic extension
Version	Full English public version
Date	June 2026
Status	Formal/conceptual model; physical extensions require simulation and experiment

Methodological note

This document does not present a validated physical device. It defines a geometric and topological architecture, then formulates an ideal magnetic extension that can be tested numerically and experimentally. Geometry can be checked formally; fields, forces, induction, torque, losses, and material behavior require vector modeling, finite-element simulation, and measurement.

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1. Abstract

Cyclic Twist Toroids, denoted TTC(n), are proposed as a family of ideal toroidal structures in which an internal cyclic section is transported along the major toroidal circle with a discrete rotational monodromy. Unlike a classical torus, whose cross-section returns identically after one full revolution, a TTC(n) returns with a rotation of $2\pi/n$ and recovers the initial internal orientation only after n revolutions.

$$\mathrm{TTC}(n):\; X(s + 2\pi) = R(2\pi/n)\, X(s), \qquad X(s + 2\pi n) = X(s)$$

The central case discussed here is TTC(6), where the fundamental rotation is 60°. The associated ideal magnetic extension is MTTC(n): a TTC(n) equipped with a magnetization or magnetic-field distribution compatible with the same discrete monodromy. The document separates the geometric model, the topological rule, the ideal vector-field compatibility condition, and the later stages of numerical simulation and physical prototyping.

Keywords: cyclic twist toroid, TTC(n), TTC(6), monodromy, toroidal architecture, polygonal section, C1-Cn structure, MTTC(6), discrete helical compatibility.

2. Methodological status

The purpose of this document is not to claim a completed experimental technology, but to define a testable architecture. A definition may be formally consistent without implying an already validated physical implementation. Therefore the work is organized by levels:

- Definition: the formal object and its symbols.
- Geometry: the section, toroidal transport, and non-intersection assumptions.
- Topology: the cyclic gluing rule and finite monodromy.
- Ideal magnetic model: compatibility of M and B with the same rotation rule.
- Simulation: numerical checks of fields, flux, gradients, and metric effects.
- Experiment: prototyping, measurement, and validation or rejection.

The guiding rule is simple: geometric consistency is not the same as physical validation. The model is deliberately open to criticism, finite-element testing, and experimental refinement.

3. TC(1): the classical torus as reference

The point of departure is the classical torus TC(1). It is the standard toroidal surface obtained by rotating a circle around a coplanar axis that does not intersect the disk bounded by the circle. In standard parameters $R > r > 0$:

$$x(u,v) = (R + r \cos v) \cos u$$

$$y(u,v) = (R + r \cos v) \sin u$$

$$z(u,v) = r \sin v$$

with u, v in $[0, 2\pi)$. The ordinary torus has simple periodicity:

$$\text{TC}(1): \; X(s + 2\pi) = X(s)$$

Its surface is topologically $S^1 \times S^1$, while the solid torus is $S^1 \times D^2$. The role of TC(1) in this work is not novelty; it is the reference state from which the cyclic-twisted family is differentiated. The first conceptual jump from TC(1) to TTC(n) is replacing simple closure by rotated closure.

$$\text{TTC}(n): \; X(s + 2\pi) = R(2\pi/n) \, X(s)$$

4. Notation and conceptual grammar

The TTC/MTTC grammar uses a small set of symbols in order to avoid mixing geometry, topology, field modeling, and implementation.

Symbol	Meaning	Status
S^1	major toroidal path; transport parameter s	geometric
Σ or P_n	internal section transported along S^1	geometric
C1	global toroidal cycle	geometric/topological
Cn	internal cyclic symmetry of order n	geometric/topological
R(2π/n)	rotation applied after one full toroidal revolution	monodromy
M	magnetization distribution	ideal magnetic model
B	magnetic field distribution	field model / measurement
MTTC(n)	magnetic extension of TTC(n)	ideal model
PMTTC(n)	physical/prototypical materialization	constructive
CTTC(n)	central twist toroid core, if used	internal/central module

The core distinction is this: TTC(n) defines the geometric and topological support; MTTC(n) adds a field compatibility condition; PMTTC(n) introduces materials, tolerances, losses, joints, and fabrication constraints.

5. TPN(n): non-twisted polygonal torus

TPN(n) is the non-twisted polygonal torus. It is obtained by replacing the circular section of the classical torus with a regular polygon P_n(r), transported along the major circle without additional rotation. It is the geometric baseline for later twist.

$$TPN(n) = \text{toroidal transport of } P\_n(r) \text{ with } \psi(u) = 0$$

For a regular n-gon inscribed in a circle of radius r:

$$\alpha\_n = 2\pi/n, \qquad a\_n = 2r \sin(\pi/n), \qquad \rho\_n = r \cos(\pi/n)$$

$$P(P\_n) = 2\ n\ r \sin(\pi/n)$$

$$A(P\_n) = (n/2)\ r^2 \sin(2\pi/n)$$

In the ideal centered model, the volume of the solid polygonal torus is the area of the section transported along a circle of length 2πR:

$$V(TPN(n)) = 2\pi R\ A(P\_n) = \pi\ n\ R\ r^2 \sin(2\pi/n)$$

TPN(n) contains no monodromy. Each lateral side of the polygon generates its own untwisted lateral band. It is geometrically meaningful, but it is not yet the TTC object.

6. TTT(n): topological twist toroid

TTT(n) is the topological transition from the non-twisted polygonal torus to the cyclic twist toroid. It introduces the rule by which the lateral faces or internal labels are cyclically advanced after one full revolution.

$$\mathrm{TTT}(n) = \mathrm{TPN}(n) + \mathrm{Twist}(360°/n)$$

$$\tau_n = 2\pi/n = 360°/n$$

The progressive twist function is:

$$\psi(u) = u/n$$

so that $\psi(2\pi) = 2\pi/n$ and $\psi(2\pi n) = 2\pi$. If L_i denotes a lateral band or sector label, then the topological transition is:

$$L_i \rightarrow L_{i+1 \bmod n}$$

After n revolutions all labels return to their initial state. TTT(n) is therefore the cyclic gluing grammar, not yet necessarily a physical device.

7. TTC(n): cyclic twist toroid

TTC(n) is the complete cyclic twist toroid: a toroidal structure whose section has internal cyclic symmetry and whose closure condition is not simple periodicity but discrete monodromy. Formally:

$$T_n = (S^1 \times \Sigma) / \sim$$

$$(s + 2\pi, x) \sim (s, R(2\pi/n)x)$$

If $\Sigma = P_n$, the section is a regular polygon. If the model is generalized, Σ may be another section admitting a rotational symmetry of order n. The defining property remains the same: one turn advances the internal orientation by one discrete step.

$$R(2\pi/n)^n = R(2\pi) = I$$

This is the formal cyclic closure condition. The body may appear geometrically closed after one visible revolution because the polygon as an unlabelled shape is invariant under $2\pi/n$, but the labelled internal identity recovers only after n revolutions.

8. Two levels of closure

A frequent source of confusion is the difference between geometric closure and label/phase closure. TTC(n) must keep these two levels separate.

Level	Meaning	Typical period
Geometric body closure	The unlabelled section may match after one revolution because P_n is invariant under R(2π/n).	360°
Internal phase closure	A labelled sector or material phase returns to its initial identity only after n advances.	n × 360°

For TTC(6), the visible body closes after one toroidal turn, but the full labelled cyclic phase closes after six turns if the fundamental step is s = 1. For derived steps s, the label period must be computed by the order of the permutation generated by s modulo n.

$$\text{period in steps} = n / \gcd(n, s)$$

For n = 6: s = 1 gives a cycle of length 6; s = 2 gives two interlaced C3 cycles; s = 3 gives three opposed C2 pairs.

9. Main cases: n = 3 and n = 6

The model is defined for $n \geq 3$, but two cases are structurally important.

TTC(3)

For n = 3, the fundamental twist is 120°. The section may be triangular, and the cyclic rule is triadic:

$$\tau\_3 = 2\pi/3 = 120°$$

$$R(120°)\^3 = I$$

TTC(3) is the minimal nontrivial cyclic case. It is useful for conceptual comparison and for understanding three-phase or triadic rotation patterns. It should not be overclaimed as entirely isolated from known triangular-torus constructions; in this document it functions as part of the broader TTC(n) grammar.

TTC(6)

For n = 6, the fundamental twist is 60°. This is the central case of the document because it aligns naturally with hexagonal partitioning, sixfold phase structures, and subdivisions by 6, 12, 24, and 36.

$$\tau\_6 = 2\pi/6 = \pi/3 = 60°$$

$$X(s + 2\pi) = R(60°)\ X(s), \qquad X(s + 12\pi) = X(s)$$

The TTC(6) identity can be stated compactly:

$$\text{TTC(6) = global C1 toroidal path + internal C6 section + R60 monodromy}$$

10. CTTC(n): central twist toroid core

When a central or inner module is needed, the notation CTTC(n) is preferred over TTc(n), because it avoids visual confusion with TTC(n). CTTC(n) means Central Twist Toroid Core. It is not automatically identical to any magnetic coil or solenoid; it is a central subsystem that may receive, guide, or interact with the fields organized by the external TTC(n) architecture.

In related spheroidal models, a central solenoidal component may be denoted STSD(n). The safe bridge is: CTTC(n) is the toroidal-core terminology, while STSD(n) is the spheroidal/solenoidal terminology. When both models are compared, the document should explicitly state the correspondence rather than merging the acronyms.

$$\mathrm{CTTC}(n) = \text{central core notation within the TTC/MTTC grammar}$$

This prevents a typographic or conceptual collapse between TTC(n), TTc(n), and STSD(n).

11. MTTC(n) and PMTTC(n)

MTTC(n) is the ideal magnetic extension of TTC(n). It adds a magnetization distribution M or a field distribution B compatible with the same monodromy rule.

$$\mathrm{MTTC}(n) = \mathrm{TTC}(n) + \text{magnetic distribution compatible with } R(2\pi/n)$$

$$M(s + 2\pi, x) = R(2\pi/n)\, M(s, x)$$

$$B(s + 2\pi, x) = R(2\pi/n)\, B(s, x)$$

This compatibility defines discrete spatial helicity. It does not by itself imply temporal rotation, induction, torque, or production of energy. A static compatible field remains static unless motion, time-varying current, changing magnetization, or another physical interaction is introduced.

PMTTC(n) is the possible physical or prototypical implementation of MTTC(n). It introduces material choices, magnet shapes, coil windings, tolerances, gaps, heating, hysteresis, saturation, friction, and measurement constraints.

$$\mathrm{PMTTC}(n) = \text{physical/prototypical materialization of } \mathrm{MTTC}(n)$$

12. Magnetic compatibility and imposed magnetization

A critical point must be stated explicitly: the rotation of the magnetization vector is not a passive consequence of drawing a twisted geometry. If permanent magnets are used, their magnetization is fixed by material processing and assembly. Therefore the relation

$$M_{k+1} = R(2\pi/n)\, M_k$$

must be read as a design and assembly condition, not as spontaneous behavior. Each discrete magnetic segment must be physically oriented according to the prescribed phase before being fixed into the structure. If coils are used, the phase relation can instead be imposed by winding geometry and current drive.

The ideal surface magnetic charge density remains governed by:

$$\sigma_m = M \cdot n$$

where M is the real magnetization and n is the local surface normal. Twist changes geometry and normals; it does not automatically determine the real domain structure of the material. That requires electromagnetic modeling and measurement.

13. Metric area asymmetry

The topological twist cyclically connects lateral bands, but it does not automatically equalize their metric areas. A band that moves from an inner radial region to an outer radial region experiences a different metric stretch than a band that remains closer to the inner side of the torus.

For a twisted lateral surface parametrized as $X_i(u,t)$, the correct local area is obtained from the metric integral:

$$S_i = \iint \| \partial X_i/\partial u \times \partial X_i/\partial t \| \, du \, dt$$

In general:

$$S_i^{TTT} \neq S_i^{TPN}, \qquad \text{and} \qquad S_i^{TTT} \neq S_j^{TTT}$$

This local asymmetry introduces a periodic variation of the metric tensor along the toroidal direction. For practical applications such as wall thickness, magnetic loading, fluid channels, or flux-density distribution, a numerical correction may be required. One possible strategy is controlled local deformation or spheroidization of the section to compensate for toroidal curvature and radial metric dilation.

14. The C1-Cn tangent ideal ratio

A useful geometric support model considers one central circle C1 and n equal peripheral circles Cn distributed around it, tangent to the central circle and to their neighboring peripheral circles. Under the circular tangent-complete idealization, the required ratio is:

$$r\_Cn / R\_C1 = \sin(\pi/n) / [1 - \sin(\pi/n)]$$

Case	Ratio	Interpretation
$n = 3$	$r\_C3 / R\_C1 = 3 + 2\sqrt{3} \approx 6.464$	peripheral circles larger than central C1
$n = 6$	$r\_C6 / R\_C1 = 1$	peripheral and central radii equal
$n > 6$	$r\_Cn / R\_C1 < 1$	peripheral circles smaller than central C1

This result gives TTC/MTTC(6) a special geometric balance in the tangent circular support model: the C6 peripheral elements and the C1 center have equal radii. This does not prove physical optimality, but it strengthens n = 6 as a central geometric case.

15. Validation protocol V1-V5

The model should be validated in ordered layers. This prevents a formal geometric statement from being mistaken for a working physical device.

Stage	Name	Criterion
V1	Geometric validation	Check $X(s + 2\pi) = R(2\pi/n)X(s)$.
V2	Topological validation	Check $X(s + 2\pi n) = X(s)$ and finite monodromy.
V3	Vector compatibility	Check $B(s + 2\pi,x) = R(2\pi/n)B(s,x)$.
V4	Numerical simulation	FEM or discrete model for field, flux, gradients, losses.
V5	Prototype and measurement	Build only after V1-V4 are specified and testable.

Only V1 and V2 belong to formal geometry/topology. V3 belongs to field-model consistency. V4 and V5 are required before any physical claim can be considered validated.

16. Measurable C6 signature

For MTTC(6), a simplified angular signature may be proposed as a measurement hypothesis:

$$B(\theta) \approx B0 + B6 \cos(6\theta + \varphi6) + B36 \cos(36\theta + \varphi36)$$

This is not an experimental result. It is a proposed diagnostic expression for detecting whether a C6 lobar component, or a finer 36-step microstructure, appears in a measured field. The interpretation is:

- B0: mean field component.
- B6: principal C6 lobar component.
- B36: possible higher microstructure if a 36-step implementation is used.
- $\varphi6$ and $\varphi36$: phase offsets determined by orientation and construction.

The signature can be evaluated along circular sampling paths inside the torus hole, near the surface, and outside the torus.

17. Simulation and experimental program

A practical research program should proceed in a conservative order:

1. Generate deterministic geometry for TTC(6), not generative artwork.
2. Export clean CAD or mesh data with known section, twist, and scale.
3. Run magnetostatic simulation for idealized M or coil-current distributions.
4. Measure B along angular sampling rings and compare with the C6 signature.
5. Vary the phase rule, e.g. $s = 1$, $s = 2$, $s = 3$, and compare subcycle behavior.
6. Only then define a PMTTC(6) prototype with tolerances and materials.

Suggested simulation outputs include B-field maps in the torus hole, external leakage maps, flux through central surfaces, gradient distribution, and harmonic decomposition of $B(\theta)$.

18. Limits and non-claims

The following statements are intentionally not claimed:

- No claim of energy production without an input source.
- No claim of a validated motor, generator, confinement device, or propulsion system.
- No claim that geometry alone fixes real magnetic domains.
- No claim that twist automatically creates temporal rotation.
- No claim that local metric areas are equal after twist.
- No claim that finite-element or laboratory validation has already been completed.

The strength of the model lies in its clean separation between definition, ideal compatibility, simulation, and experiment. This separation does not weaken the architecture; it makes it testable.

19. Conclusion

TTC(n) defines a family of cyclic twist toroids: global C1 toroidal structures carrying an internal Cn section with discrete monodromy $R(2\pi/n)$. The central case TTC(6) is structurally significant because the fundamental phase is 60°, the C6 symmetry is naturally compatible with hexagonal organization, and the tangent C1-C6 ideal ratio yields equal central and peripheral radii in the circular support model.

MTTC(n) extends the architecture by requiring magnetization or magnetic field compatibility with the same monodromy. PMTTC(n) is a later physical implementation layer, not the definition itself. The proposed validation chain V1-V5 provides a disciplined path from geometry to experiment.

$$\text{TTC}(6) = \text{global C1 geometry} + \text{internal C6 monodromy}$$

$$\text{MTTC}(6) = \text{TTC}(6) + \text{C6-compatible magnetic field model}$$

$$\text{PMTTC}(6) = \text{possible physical materialization to be simulated and tested}$$

Appendix A. Essential formulas

Topic	Formula
Classical torus	$X(s + 2\pi) = X(s)$
TTC rotated closure	$X(s + 2\pi) = R(2\pi/n)X(s)$
TTC full internal closure	$X(s + 2\pi n) = X(s)$
Monodromy order	$R(2\pi/n)^n = I$
Polygon side	$a_n = 2r \sin(\pi/n)$
Polygon area	$A(P_n) = (n/2)r^2 \sin(2\pi/n)$
TPN volume	$V = \pi\, n\, R\, r^2 \sin(2\pi/n)$
Magnetic compatibility	$B(s + 2\pi,x) = R(2\pi/n)B(s,x)$
Ideal surface magnetic charge	$\sigma_m = M \cdot n$
C1-Cn tangent ratio	$r_{Cn}/R_{C1} = \sin(\pi/n)/(1 - \sin(\pi/n))$
C6 measurement signature	$B(\theta) \approx B0 + B6 \cos(6\theta+\varphi6) + B36 \cos(36\theta+\varphi36)$

Appendix B. Bibliographic orientation

This public conceptual document should be read with standard mathematical background in torus geometry, fiber bundles, monodromy, polygonal sections, and elementary magnetostatics. The following categories are relevant for a complete academic bibliography:

- Classical differential geometry of curves and surfaces.
- Algebraic and point-set topology, especially fiber bundles and mapping tori.
- Computational geometry and mesh generation for toroidal solids.
- Classical electromagnetism and magnetostatics.
- Finite-element electromagnetic simulation and magnetic-material modeling.
- Experimental field mapping with Hall probes, magnetometers, and angular sampling.

For a peer-reviewed scientific submission, this bibliographic orientation should be replaced by a fully formatted bibliography with verified editions, page references, and citations to specific claims. For public posting, the purpose is to make the conceptual structure clear while avoiding unsupported physical claims.