

Mathematical Proof of the Existence of Intrinsic Spatial Mass: A Rigorous Framework Based on Discrete Groups and Complex Linear Spaces

Mingyu Zhao (zhaomingyu@alu.scu.edu.cn)
Independent Researcher, Xiangtan, Hunan, 411100, China

INTRODUCTION & AIM

Traditional Dilemma

- Mass theory has long held a **particle-centric view**, treating spacetime as a passive background
- Fails to explain quantum gravity "particle-space coupling" and the **nature of dark energy and dark matter**
- Existing studies infer intrinsic spatial mass only from physical intuition, **lacking mathematical rigor**

Breakthrough of This Work

Due to spacetime equivalence, "spatial mass" is used herein to denote "spacetime mass". We construct a strict **axiom-lemma-theorem** derivation system and prove the existence of intrinsic spatial mass from first principles for the first time.

METHOD

1. Mathematical Foundation

4D Extended Complex Mass Space $\mathcal{M} \cong \mathbb{C}^4$

Any mass state:

$$m = (m_{\text{rp}}, m_{\text{rs}}, m_{\text{ip}}, m_{\text{is}})^T$$

- m_{rp} : Real particle mass | m_{rs} : Real spatial mass
- m_{ip} : Imaginary particle mass | m_{is} : Imaginary spatial mass

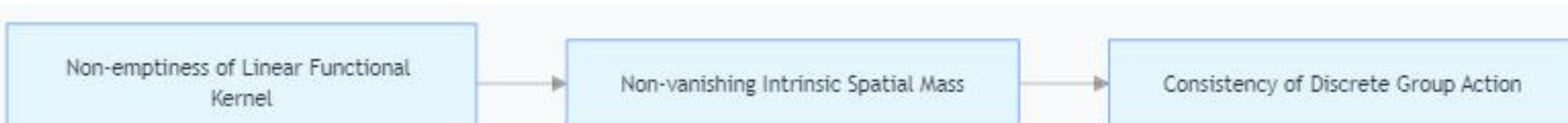
Double \mathbb{Z}_2 Discrete Symmetry Group

- Particle-Space Reciprocity: $g_1 = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix}$
- Real-Imaginary Reciprocity: $g_2 = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}$

2. Four Core Axioms

- Space Completeness:** \mathcal{M} is closed under linear operations and double \mathbb{Z}_2 actions
- Physical Observability:** Hermitian inner product $\langle m, m \rangle \geq 0$
- Lorentz Complex Extension:** Superluminal Lorentz factor $\gamma = \pm ik$ ($k \in \mathbb{R}_+$)
- Zero-Equation Constraint:** Three linear functionals define mass conservation

3. Core Derivation Chain



RESULTS & DISCUSSION

Three Forms of Intrinsic Spatial Mass

(All embedded in a \mathbb{C}^2 -isomorphic complex mass subspace)

Form	Mathematical Expression	Physical Essence
1	$m_{\text{is}} = im_{\text{rp}}$	Real Particle-Imaginary Space Conjugate Pair
2	$m_{\text{rs}} = -im_{\text{ip}}$	Imaginary Particle-Real Space Conjugate Pair
3	$m_{\text{is}} = -m_{\text{ip}}$	Superluminal Imaginary Particle-Space Dual Pair

Self-Consistency Verification

- Direct Sum:** $\ker L_1 \oplus \ker L_2 \oplus \ker L_3 \subseteq \mathcal{M}$, pairwise intersections only contain zero vector
- Group Closure:** Double \mathbb{Z}_2 actions only transform between forms, preserving physical validity
- Dimensional Match:** Any two forms form a 2D complex subspace isomorphic to \mathbb{C}^2

CONCLUSION

Core Conclusion

The essence of intrinsic spatial mass is jointly determined by **discrete symmetry (double \mathbb{Z}_2 group)** and **wave-particle duality (zero equation)**, independent of any specific physical field assumptions.

Scientific Significance

- Provides core support for the axiomatic construction of mass mathematics
- Establishes rigorous foundation for dark energy (imaginary negative mass), dark matter (imaginary positive mass) and earthquake mechanisms
- Breaks "particle-spacetime" dualism and promotes mass theory paradigm shift
- Opens new mathematical interpretation path for quantum wave-particle duality

FUTURE WORK / REFERENCES

Future Work

- As a novel mathematical tool to solve mathematical conjectures (e.g., Millennium Prize Problems)
- As a new mathematical-physical method to establish novel physical theories

References

- Zhao Mingyu. UV= Z^2 , Zero-Equations and New Physics(PPT version)[M]. United Science Press, 2025.
- Zhao Mingyu. Discrete Symmetry, Zero Equations, and Mass Mathematics[M]. United Science Press, 2025.
- Strang, G. Linear Algebra and Its Applications (5th ed.) [M]. Boston: Cengage Learning, 2016.
- Rudin, W. Functional Analysis (2nd ed.) [M]. New York: McGraw-Hill, 1991.
- Serre, J. P. Linear Representations of Finite Groups [M]. New York: Springer-Verlag, 1977.
- Nielsen, M. A., & Chuang, I. L. Quantum Computation and Quantum Information [M]. Cambridge: Cambridge University Press, 2010.