Self-Introduction & Research Overview

From Scattering Amplitudes to Celestial Holography

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About Me

Personal Information

- **Name:** Aphiwat Yuenyong (Tee)
- **Position:** Ph.D. Student
- **Affiliation:** Department of Physics, Faculty of Science, King Mongkut's University of Technology Thonburi (KMUTT), Bangkok, Thailand

Main Research Interests

- Scattering Amplitudes
- Celestial Amplitudes
- Celestial Holography

Scattering Amplitudes: What and Why?

What are Scattering Amplitudes?

- Complex functions $\mathcal{A}(p_i, h_i)$ that determine scattering probabilities and cross sections: $P \propto |\mathcal{A}|^2$.[1]
- Directly connect quantum field theory (QFT) predictions to experimental observables at particle accelerators (CERN LHC).

Why Are They Important?

1. **Rich Mathematical Structure:** They bypass the factorial growth of Feynman diagrams, revealing hidden geometric structures and dualities.
2. **Bridge to Gravity:** The double-copy relation connects gauge theories (Yang-Mills) to Gravity theory [2, 3, 4, 5, 6]:

$$\text{Gravity} \approx (\text{Gauge Theory})^2$$

From Flat Space to Celestial Holography

The Holographic Principle

- Encodes a $(d+1)$-dimensional gravitational bulk theory into a d-dimensional boundary quantum theory.
- **AdS/CFT** [7, 8] works for anti-de Sitter space, but our universe is asymptotically flat!

Celestial Holography Idea

- Establishes holography in 4D asymptotically flat spacetimes.
- The boundary is the 2D **Celestial Sphere** $\mathbb{S}^2$ at null infinity ($\mathcal{I}$).

Correspondence [9]

4D asymptotically flat spacetimes $\iff$ 2D Celestial CFT (CCFT)

Core Idea: Celestial Amplitudes

Flat Space Holography via Mellin Transform

Maps a 4D flat-space S-matrix to 2D primary fields on the **Celestial Sphere ($\mathbb{S}^2$)** using a Mellin transform over energy [10]:

$$\mathcal{A}_{\text{celestial}}(\Delta_i, z_i, \bar{z}_i) = \int_0^\infty \prod_{i=1}^{n} d\omega_i \, \omega_i^{\Delta_i - 1} \mathcal{A}_{\text{flat}}(p_i)$$

Core Duality

4D S-Matrix in Flat Space $\iff$ 2D Celestial CFT (CCFT)

Current Work

Current Work

- Constructing integral transformations that render celestial amplitudes explicitly conformally invariant.[arXiv: 2602.14422]
- Applying standard scattering amplitude techniques to conformally invariant celestial amplitudes.
- Investigating the underlying structural properties and relations of celestial amplitudes.

Key References

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Thank You!