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Deepak Vaid <dvaid79@gmail.com>

Fwd: AOP 81029
1 message

Luigi Teixeira de Sousa <luigi.tiraque@gmail.com>   6 May 2025 at 16:19
To: Deepak Vaid <dvaid79@gmail.com>

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De: **Annals of Physics** <em@editorialmanager.com>
Date: ter, 6 de mai de 2025 03:39
Subject: AOP 81029
To: Luigi Teixeira de Sousa <luigi.tiraque@gmail.com>

Ms. AOP **81029**
Title: A Loop Quantum Gravity Inspired Action for the Bosonic String and Emergent Dimensions at Large Scales
Corresponding Author: Mx. Luigi Teixeira de Sousa
Annals of Physics

Dear Dr. Teixeira de Sousa:

The reviewer sent comments on your paper, referenced above. Please note, your paper is not acceptable for publication in its present form.

If you feel that you can suitably address the reviewer's comments included below, I invite you to revise and resubmit your manuscript. Please submit your revision online (within 21 days) by logging onto the Editorial Manager for the journal Annals of Physics.

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   AND/OR

b) provide a suitable rebuttal to each reviewer comment
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I look forward to receiving your revised manuscript.

Yours sincerely,

prof Robert de Mello Koch
Co-Editor
Annals of Physics

Reviewer's comments:

Reviewer #1: The manuscript presents a novel modification of the Nambu-Goto action for the bosonic string, incorporating insights from Loop Quantum Gravity (LQG), particularly the existence of a minimal area at the Planck scale. The work bridges concepts from string theory and LQG, proposing a "bimetric string" action and exploring its implications, including emergent dimensions and holography. The paper is ambitious, but requires careful scrutiny.

Introduction. The introduction contrasts string theory and LQG, highlighting their respective strengths and limitations. The discussion of background independence in string theory could benefit from references to more recent critiques or developments such as recent advances in non-perturbative string theory. The "central dogma" (minimal area Δ) is well-motivated from LQG but could be better contextualized within existing string theory literature, where minimal length scales are discussed. The paper's goals are clearly stated, but the transition to the modified Nambu-Goto action feels abrupt, a smoother connection between LQG's area quantization and the string action would improve this.

Section 2. a) The proposed action $S\_MNG = -T\int dx^2\sqrt{-(h+k\,\Delta)}$ needs a clearer justification: the author states in a footnote that Δ is as a scalar density later identified with the Kalb-Ramond field should be, at least, physically justified because the remaining of this section is based in this argument, otherwise it should be rigorously derived. b) The expansion in $k=l\_pl/l\_s$ seems sound, but the assumption $k\ll1$ (Planck scale much smaller than string scale) should be discussed further—does this hold in all regimes? c) The duality between h_{ab} and h^{ab} (Eq. 2.6a-2.6c) is intriguing but lacks a deeper physical interpretation. How does this duality manifest in observable string dynamics?

Section 3. a) The author introduces the connection to bimetric gravity, but the analogy should be strengthened by discussing how the bimetric string avoids issues like the Boulware-Deser ghost. b) The link between Δ_{ab} and the Kalb-Ramond field $B\_{\mu\nu}$ (Sec. 3.2) is a highlight, but the derivation of Eq. (3.21) should be detailed for clarity. c) The section assumes familiarity with bimetric gravity, a brief review of key concepts would aid readers outside this niche.

Section 4. a) In equations (4.7-4.10) the physical meaning of the coupling between $\phi(x)$, Δ and X^μ (akin to a dilaton) needs a more thorough explanation. b) The Born-Infeld analogy (Sec. 4.2) should address why the Kalb-Ramond field must be exact.

Section 5. a) The covariant quantization procedure seems correct, but the absence of anomalies (Sec. 5.12) is a significant claim that deserves more discussion. How does this compare to standard string theory? b) The truncation of modes $\alpha\_\mu^\nu =0$ for $\abs{n}>d$ due to discreteness needs validation—does this align with other approaches to quantum gravity? c) Table 1 (values of a for different D and μ) lacks context. A brief explanation of how these values affect the string spectrum would help.

Section 6. a) The link to Afshordi's model is interesting, but the constraints on m_μ (Eq. 6.3) feel ad hoc, a better and deeper connection to LQG's discreteness would strengthen this section. b) The suggestion of (2+1)-dimensional fundamental spacetime (Sec. 6) is speculative and should be better addressed, more evidence or references to support this claim are needed.

Section 7. a) The physical interpretation of the emergent holographic dimension X^r as a "scaling dimension" needs clarification. b) The connection to AdS/CFT (Sec. 7.2) lacks concrete evidence, how does this classical construction relate to the original Maldacena's duality?

Discussion. a) The discussion synthesizes the paper's key results but could better highlight open questions (e.g., experimental signatures, relation to black hole physics), considering the ideas established in the manuscript. b) The claim that the model is anomaly-free and ghost-free (Sec. 5) should be tempered with caveats (e.g., limitations of the truncation scheme).

In my consideration these issues should be addressed and fully explained in order to her consider for publication. Also a full review should be done to the writing to correct typos.

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