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Investigation of higher spin theory through holography and mathematical methods in free conformal field theory

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List of examiner corrections and changes made with respect to these corrections

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Note: Equation numbers (or page numbers) in the corrected dissertation might slightly differ from the examiners comments.

Examiner 1

• For Chapter 3 (Holography), it would be helpful to have a paragraph at the beginning outlining what the chapter will cover since the chapter does not count as a full chapter on holography, but rather useful results taken from holography.

Correction: Added a longer paragraph to the introduction of Chapter 3 explaining that the chapter describes useful results from holography.

• For Chapter 4 (Spectrum of Primaries), it would be helpful to to have an outline of what will be done at the beginning of each subsection.

Correction: Added an introductory paragraph to each subsection to outline what will be done in the subsection.

• Subsection 5.9 (Constructing Polynomials Using Complex Coordinates) of Chapter 5 (Constructing Higher Spin Currents/Primaries) ends a bit abruptly and more discussion could be included here about its utility.

Correction: Added more text to the introductory paragraph of subsection 5.9 and added a concluding paragraph at the end of subsection 5.9 to outline its utility.

• In Chapter 5 (Constructing Higher Spin Currents/Primaries), it claims the final section is written in terms of a many-body wavefunction problem. However, this isn't spelled out explicitly anywhere in the chapter.

Correction: On page 98 after equation (467), I have added the statement that the construction of primaries has been framed as a many-body wavefunction problem.

• On page 7, $h(\phi)$ is not defined or discussed in any way.

Correction: After equation (2) on page 7, I have defined $h(\phi)$.

• On page 8 three lines below equation (4), the parameter λ has been introduced without defining it.

Correction: After equation (4) on page 8, I have defined λ.

• One page 12, the sentences: "As a consequence of this, the representation includes null states. The conservation law corresponds these to null states. ", is somewhat unmotivated, and the second part of it is not grammatically correct.

Correction: I refer the reader to the discussion after equation (200) and fixed the grammar error.

• On page 18 in the first sentence, μ_2 should be μ_3.

Correction: Changed μ_2 to μ_3.

• On page 19, equation (45) is missing a bracket.

Correction: Added the missing bracket.

• On page 21 in equation (57), it is not clear why the $-i$ appears.

Correction: There was a $-i$ missing in the previous lines of equation (57) (and a missing $-i$ in the definition of the one-form W), which has been added.

• On page 50, it is stated that equation (203) is of order s^3, whereas in fact it is order s^4.

Correction: Changed the statement to order s^4.

• On page 98, polonomials should be changed to polynomials and its should be changed to it's.

Correction: Fixed the spelling mistakes.

• On page 101, it states that "This ireep is reducible", which seems to be a misspelling as well as being an oxymoron.

Correction: Changed ireep to rep.

• On page 101 below equation (488), a notation for the Young diagrams with numbers written in is used for the first time, without comment.

Correction: I refer the reader to Appendix A.3.

• On page 104, Wilson-Fischer should be spelled Wilson-Fisher.

Correction: Fixed the spelling error.

Examiner 2

• It would be better to have the references in order.

Correction: References now numbered in order of appearance.

• At the beginning of paragraph 3 on page 6, it would be nice to mention the duality between type IIB string theory and $\mathcal{N} = 4$ SYM theory.

Correction: I added remark (2) in Section 3 (Holography) and referred the reader to remark (2) in paragraph 3 on page 6.

• In figure 1, the vertical axis should be $\lambda/(4\pi N)$.

Correction: Changed the vertical axis to $g_s \propto 1/N$.

• After equation (5) on page 8, explain why the results is always 0,+1, or -1.

Correction: Added a paragraph explaining the above results.

• Explain that repetition of indices (e.g. in equations (6)-(9)) means summation over indices.

Correction: Added the statement after equation (6) that repeated indices imply summation over the indices.

• After equation (6), single box representation of $U(N)$ should be introduced.

Correction: I refer the reader to Appendix A.3.

• In equation (19), page 15, the spacetime dimension is considered to be $3 + 1$. It should be mentioned or changed to a general dimension form. This should be fixed in other equations and places too.

Correction: Changed the dimension in equation (19) from 3 to $d - 1$ and changed the dimension of the corresponding action S in equation (23) from 4 to d. Also, the commutator in equation (20) has been written in a general dimension.

• Explain what the dots mean in equation (34).

Correction: Added a sentence after equation (34) explaining the meaning of the dots.

• After equation (47), one example (like a massive scalar field) could be given and explain the relation between the conformal weight and the mass.

Correction: Added an example in terms of a massive scalar field (equation (48)) and gave the relation between the conformal weight and the mass (equation (49)). Also referred the reader to Chapter (3) where there is more discussion given.

• Equation (50) means the flat metric is invariant (not the metric).

Correction: Changed the sentence leading up to equation (52) to read "...leaves the flat metric invariant...".

• In equation (50), the symbol Λ should be defined in general dimension, not in $3+1$ dimension.

Correction: Changed $\Lambda^a_c \in SO(1,3)$ to $\Lambda^a_c \in SO(1,d)$.

• After equation (51), generalize $SO(1,3)$ to any dimension.

Correction: Changed $SO(1,3)$ to $SO(1,d)$.

• After equation (51), define the spin connection.

Correction: Defined the spin connection in equation (54), which is written in terms of the vielbein.

• In the last paragraph on page 20, counting the number of independent components should be fixed.

Correction: Fixed the counting (changed the $+$ sign on the second term to a $-$ sign).

• In the first line on page 21, generalize $SO(1,3)$.

Correction: Changed $SO(1,3)$ to $SO(1,d)$.

• After equation (53), explain why the commutator of two momentum operators is antisymmetric.

Correction: Stated that $[P_a, P_b] = -[P_b, P_a]$.

• At the end of remark (1) on page 21, the relation between dS and AdS spaces is by changing the sign of the cosmological constant and not their radius.

Correction: Added a sentence to remark (1) explaining this.

• In the first paragraph on page 30, explain what are the numbers in $\mathfrak{hu}(1,0|4)$.

Correction: Decided to remove this sentence as it does not really add anything to the dissertation. Also, the closest explanation to the numbers above I could find seemed somewhat outside of the scope of this dissertation.

• By comparing equations (108) and (113), it is not clear what is the difference between the W and B fields.

Correction: Added a paragraph after equation (116) explaining the difference between the W and B field.

• After equation (122), illustrate why these constraints lead to integer spins.

Correction: Added a paragraph after equation (125) explaining why the constraints leads to integer spins.

• There is a missing master field W in the first equation of (126).

Correction: Added the missing master field.

• Add some comments on Vasiliev equations after equation (126).

Correction: Added a concluding paragraph to provide further comment on Vasiliev equations.

• After equation (129), introduce the abbreviation GKPW.

Correction: Added the abbreviation for GKPW.

• After equation (131), string coupling goes like $1/N$.

Correction: Changed $1/\sqrt{N}$ to $1/N$.

• In equation (134), it would be better to use different symbol than "=".

Correction: Changed = to $\equiv$.

- What is the parameter μ_0 in equation (137).

  Correction: Stated after equation (142) that μ_0^2 is a mass parameter.

- Define $f[x]$ in equation (141).

  Correction: Defined $f[x]$ after equation (146).

- The symbol ln does not appear properly in some equations like (144) and (153).

  Correction: Fixed the appearance of ln in equations.

- Add some comments on how one can derive equation (155) from equation (154).

  Correction: Added some further comments after equation (160).

- In Chapter 4 (Spectrum of Primaries), fix the notation for the group $SO(4,2)/SO(2,4)$.

  Correction: Fixed the notation to $SO(4,2)$.

- In equation (246), the vector space is 5 dimensional, not 4 dimensional.

  Correction: Fixed the typo.

- On top of page 61, the parameters are j and k.

  Correction: Fixed the statement about the parameters.

- In line 6 after equation (325), the stress-energy tensor is not given in equation (7).

  Correction: Fixed the citation mistake.

- Choose one notation for the indices in equations (397), (398),...

  Correction: Fixed the notation.

- The main reference for gauge/gravity duality is the original paper by Maldacena, not the reference [1] on page 146.

Correction: Fixed the reference to the main reference.