

Boundary S -matrix in a $(2, 0)$ theory of AdS_3 Supergravity

Payal Kaura

IIT-Roorkee

Indian Strings Meeting'08

Reference:

arxiv:0809.4603 (JHEP12(2008)002)

With Bindusar Sahoo

Introduction

- AdS_3 Supergravity has been playing an interesting role in String Theory after the discovery of BTZ black holes, since these arise as a factor in the near horizon geometry of certain class of black holes in string theory.

Introduction

- AdS_3 Supergravity has been playing an interesting role in String Theory after the discovery of BTZ black holes, since these arise as a factor in the near horizon geometry of certain class of black holes in string theory.
- The statistical and gravity analysis of entropy for such black holes, in the presence of higher derivative terms, matches with the Cardy formula for the degeneracy of states in 2 dimensional CFT.

Introduction

- AdS_3 Supergravity has been playing an interesting role in String Theory after the discovery of BTZ black holes, since these arise as a factor in the near horizon geometry of certain class of black holes in string theory.
- The statistical and gravity analysis of entropy for such black holes, in the presence of higher derivative terms, matches with the Cardy formula for the degeneracy of states in 2 dimensional CFT.
- Kraus and Larsen (hep-th/0506176,0508218) argued using ADS/CFT correspondence that if the three dimensional theory has extended Supersymmetry, then the entropy is completely determined in terms of the coefficients of gauge as well as gravitational Chern Simons terms and does not receive any higher derivative corrections.

- Later, David, Sahoo and Sen (arxiv:0705.0735) gave the bulk interpretation of the above result and looked for the non-renormalizability of the entropy of a BTZ black hole in a theory with $(0, 4)$ supersymmetry and higher.

- Later, David, Sahoo and Sen (arxiv:0705.0735) gave the bulk interpretation of the above result and looked for the non-renormalizability of the entropy of a BTZ black hole in a theory with $(0, 4)$ supersymmetry and higher.
- They showed that the boundary S -Matrix does not get renormalized and therefore the bulk action does not get renormalized except for the terms which can be removed by field redefinition.

- Later, David, Sahoo and Sen (arxiv:0705.0735) gave the bulk interpretation of the above result and looked for the non-renormalizability of the entropy of a BTZ black hole in a theory with $(0, 4)$ supersymmetry and higher.
- They showed that the boundary S -Matrix does not get renormalized and therefore the bulk action does not get renormalized except for the terms which can be removed by field redefinition.
- Gupta and Sen (arxiv:0710.4177) came up with a result that one can obtain a direct field redefinition in the bulk to absorb the higher derivative pieces to see the non-renormalizability of action.

- This induces the redefinition of currents in the boundary and hence the S-matrices calculated from two actions related by field redefinition in the bulk are the same upto unitary transformation.

- One expects the result of Kraus and Larsen to hold for theories with lesser extended supersymmetry, for example theories with $(2, 0)$ supersymmetry.

- One expects the result of Kraus and Larsen to hold for theories with lesser extended supersymmetry, for example theories with $(2, 0)$ supersymmetry.
- From above arguments, all $(2, 0)$ actions are related by field redefinitions,

- One expects the result of Kraus and Larsen to hold for theories with lesser extended supersymmetry, for example theories with $(2, 0)$ supersymmetry.
- From above arguments, all $(2, 0)$ actions are related by field redefinitions, implies the S-matrix with and without higher derivative terms are related by unitary transformation,

- One expects the result of Kraus and Larsen to hold for theories with lesser extended supersymmetry, for example theories with $(2, 0)$ superymmetry.
- From above arguments, all $(2, 0)$ actions are related by field redefinitions, implies the S-matrix with and without higher derivative terms are related by unitary transformation, in turn implies Kraus and Larsen's non-renormalization of black hole entropy, even for $(2, 0)$ theories.

- One expects the result of Kraus and Larsen to hold for theories with lesser extended supersymmetry, for example theories with $(2, 0)$ superymmetry.
- From above arguments, all $(2, 0)$ actions are related by field redefinitions, implies the S-matrix with and without higher derivative terms are related by unitary transformation, in turn implies Kraus and Larsen's non-renormalization of black hole entropy, even for $(2, 0)$ theories.
- We were, however, interested in distinguishing the set of higher derivative terms that alter the boundary S-matrix, computed using the standard supergravity action, upto trivial/non-trivial unitary transformation.

- Two sets of higher derivative terms for $(2, 0)$ theories:

- Two sets of higher derivative terms for $(2, 0)$ theories:
- Terms constructed out of the field strengths covariant with respect to supersymmetry transformations under which the standard action remains invariant,

- Two sets of higher derivative terms for $(2, 0)$ theories:
- Terms constructed out of the field strengths covariant with respect to supersymmetry transformations under which the standard action remains invariant, do not alter the boundary S-matrix and thus the unitary transformation will be exactly identity.

- Two sets of higher derivative terms for $(2, 0)$ theories:
- Terms constructed out of the field strengths covariant with respect to supersymmetry transformations under which the standard action remains invariant, do not alter the boundary S-matrix and thus the unitary transformation will be exactly identity.
- Terms which can render the full action to be invariant under a set of supersymmetry transformation laws different from the original ones.

- Two sets of higher derivative terms for $(2, 0)$ theories:
- Terms constructed out of the field strengths covariant with respect to supersymmetry transformations under which the standard action remains invariant, do not alter the boundary S -matrix and thus the unitary transformation will be exactly identity.
- Terms which can render the full action to be invariant under a set of supersymmetry transformation laws different from the original ones. Such terms can be removed by field redefinition and hence the change in S -Matrix will be a non-trivial unitary transformation.

Plan of the Talk

- Standard $\mathcal{N} = (2, 0)$ supergravity action

Plan of the Talk

- Standard $\mathcal{N} = (2, 0)$ supergravity action
 - First Order and Second Order formulation

Plan of the Talk

- Standard $\mathcal{N} = (2, 0)$ supergravity action
 - First Order and Second Order formulation
 - Equations of motion

Plan of the Talk

- Standard $\mathcal{N} = (2, 0)$ supergravity action
 - First Order and Second Order formulation
 - Equations of motion
- Effect of Higher derivative terms on the boundary S-matrix

Plan of the Talk

- Standard $\mathcal{N} = (2, 0)$ supergravity action
 - First Order and Second Order formulation
 - Equations of motion
- Effect of Higher derivative terms on the boundary S-matrix
- Boundary S-matrix involving correlators of $U(1)$ current and supersymmetry current

$N = (2, 0)$ Supergravity action

- The $N = (2, 0)$ sugra action including gravitational Chern Simons term is written as:

$$\begin{aligned} \mathcal{S}_0 = & \int d^3x \left[eR + 2m^2 e - \frac{a_L}{2} \epsilon^{MNP} A_M \partial_N A_P \right. \\ & + \frac{i}{4} a_L \epsilon^{MNP} (\bar{\psi}_M (\mathcal{D}_N \psi_P) - (\mathcal{D}_N \bar{\psi}_M) \psi_P) \\ & - K \int d^3x \epsilon^{MNP} \left[\left(\frac{1}{2} \omega_{Mcd} \partial_N \omega_P^{dc} + \frac{1}{3} \omega_{Mbc} \omega_N^{cd} \omega_P^b \right) \right. \\ & \left. \left. - \frac{im}{8} e_M^a \bar{\psi}_N \gamma_a \psi_P \right], \right. \end{aligned}$$

with $a_L = K + \frac{1}{m},$

and $\mathcal{D}_M \psi_N = \partial_M \psi_N - \frac{1}{2} B_M^a \gamma_a \psi_N + \frac{i}{2} A_M \psi_N,$

First and Second order Formulation

- In first order formulation of a theory, one treats ω_M^{ab} as an independent gauge field.

First and Second order Formulation

- In first order formulation of a theory, one treats ω_M^{ab} as an independent gauge field.
- In second order, ω_M^{ab} is treated as a dependent gauge field.

First and Second order Formulation

- In first order formulation of a theory, one treats ω_M^{ab} as an independent gauge field.
- In second order, ω_M^{ab} is treated as a dependent gauge field.
- The $(2, 0)$ supergravity theory, without the gravitational Chern-Simons terms, is supersymmetric in both the formulations under the same supersymmetric transformation laws.

First and Second order Formulation

- In first order formulation of a theory, one treats ω_M^{ab} as an independent gauge field.
- In second order, ω_M^{ab} is treated as a dependent gauge field.
- The $(2, 0)$ supergravity theory, without the gravitational Chern-Simons terms, is supersymmetric in both the formulations under the same supersymmetric transformation laws.
- Both the formulations also give rise to the same equations of motion.

- But the story drastically changes, for "Second Order formulation", after including the gravitational Chern-Simons term in the action.

- But the story drastically changes, for "Second Order formulation", after including the gravitational Chern-Simons term in the action.
- In the first order formulation of the theory, the action is supersymmetric, under the previously defined supersymmetric transformation laws, even after including the gravitational Chern Simons term.

- But the story drastically changes, for "Second Order formulation", after including the gravitational Chern-Simons term in the action.
- In the first order formulation of the theory, the action is supersymmetric, under the previously defined supersymmetric transformation laws, even after including the gravitational Chern Simons term.
- Also, one gets the same equations of motion as derived for the theory without the gravitational Chern Simons term.

- In the Second Order formulation, however, the action with gravitational Chern Simons term is not invariant under the previously defined supersymmetry transformations,

- In the Second Order formulation, however, the action with gravitational Chern Simons term is not invariant under the previously defined supersymmetry transformations, but one can add terms made out of field strengths, in the action to make it supersymmetric.

- In the Second Order formulation, however, the action with gravitational Chern Simons term is not invariant under the previously defined supersymmetry transformations, but one can add terms made out of field strengths, in the action to make it supersymmetric.
- The equations of motion also gets modified, and the first order spectrum belongs to a subset of the second order.

- In the Second order formulation, however, the action with gravitational Chern Simons term is not invariant under the previously defined supersymmetry transformations, but one can add terms made out of field strengths, in the action to make it supersymmetric.
- The equations of motion also gets modified, and the first order spectrum belongs to a subset of the second order.
- We are interested in the correlation functions of CFT operators dual to this common sector,

- In the Second order formulation, however, the action with gravitational Chern Simons term is not invariant under the previously defined supersymmetry transformations, but one can add terms made out of field strengths, in the action to make it supersymmetric.
- The equations of motion also gets modified, and the first order spectrum belongs to a subset of the second order.
- We are interested in the correlation functions of CFT operators dual to this common sector, and hence will use the corresponding equations of motion in our analysis of boundary S-matrix.

Super-Covariant field strengths

- Definition- Those field strengths which, under standard susy transformations DO NOT give rise to the terms proportional to the partial derivatives of the susy transformation parameter.

Super-Covariant field strengths

- Definition- Those field strengths which, under standard susy transformations DO NOT give rise to the terms proportional to the partial derivatives of the susy transformation parameter.
- Example-
Riemann tensor $R_{MN}{}^{ab}$ (which is the field strength associated with $\omega_M{}^{ab}$) is not covariant with respect to the supersymmetry transformations and we need to covariantize it,

Super-Covariant field strengths

- Definition- Those field strengths which, under standard susy transformations DO NOT give rise to the terms proportional to the partial derivatives of the susy transformation parameter.
- Example-
Riemann tensor $R_{MN}{}^{ab}$ (which is the field strength associated with $\omega_M{}^{ab}$) is not covariant with respect to the supersymmetry transformations and we need to covariantize it, as

$$\tilde{\mathcal{R}}_{MN}{}^{ab} = R_{MN}{}^{ab} - 2\delta_{\frac{1}{2}\psi_{[M}}^{(Q)} \omega_{N]}{}^{ab},$$

Equations of motion

- The equations of motion derived from the action :

$$\mathcal{R}_a{}^M - \frac{1}{2}\mathcal{R}e_a{}^M - m^2 e_a{}^M = 0,$$

$$\widehat{F}_{MN} \equiv 2\partial_{[M}A_{N]} - \frac{1}{2}\bar{\psi}_{[M}\psi_{N]} = 0,$$

$$G_{MN} \equiv 2\mathcal{D}_{[M}\psi_{N]} = 0 \quad \bar{G}_{MN} \equiv 2\mathcal{D}_{[M}\bar{\psi}_{N]} = 0,$$

where

$$\mathcal{R}_{MN}{}^{ab} = R_{MN}{}^{ab} + \frac{i}{4}\varepsilon^{abc}{}^d\bar{\psi}_{[M}\gamma_c\psi_{N]},$$

$$\mathcal{R}_M{}^a = e_b{}^N \mathcal{R}_{MN}{}^{ab},$$

$$\mathcal{R} = e_a{}^M \mathcal{R}_M{}^a,$$

- \hat{F}_{MN} and G_{MN} are supersymmetric covariant field strengths for the gauge field A_M and Rarita-Schwinger field ψ_M respectively and $\mathcal{R}_{MN}{}^{ab}$ is the supersymmetric covariant Riemann tensor modulo some terms proportional to G_{MN} .

- \widehat{F}_{MN} and G_{MN} are supersymmetric covariant field strengths for the gauge field A_M and Rarita-Scwinger field ψ_M respectively and $\mathcal{R}_{MN}{}^{ab}$ is the supersymmetric covariant Riemann tensor modulo some terms proportional to G_{MN} .
- Also,

$$D_M \mathcal{R}_{NP} = 0,$$

Where D_M is the usual covariant derivative defined using the torsion free connections.

- \widehat{F}_{MN} and G_{MN} are supersymmetric covariant field strengths for the gauge field A_M and Rarita-Scwinger field ψ_M respectively and $\mathcal{R}_{MN}{}^{ab}$ is the supersymmetric covariant Riemann tensor modulo some terms proportional to G_{MN} .
- Also,

$$D_M \mathcal{R}_{NP} = 0,$$

Where D_M is the usual covariant derivative defined using the torsion free connections.

- Thus, from the equations of motion, we see that the terms containing supersymmetric covariant field strengths and/ or their covariant derivatives vanish onshell.

Effect of Higher derivative terms

- We shall look at the higher derivative terms in the action on the boundary S-Matrix computed from the standard supergravity action.

Effect of Higher derivative terms

- We shall look at the higher derivative terms in the action on the boundary S-Matrix computed from the standard supergravity action.
- By AdS/CFT correspondence, the evaluated onshell action, with specified boundary conditions, act as a partition function, for evaluating correlators in the boundary,

Effect of Higher derivative terms

- We shall look at the higher derivative terms in the action on the boundary S-Matrix computed from the standard supergravity action.
- By AdS/CFT correspondence, the evaluated onshell action, with specified boundary conditions, act as a partition function, for evaluating correlators in the boundary, and the boundary values act as sources for relevant correlators.

Effect of Higher derivative terms

- We shall look at the higher derivative terms in the action on the boundary S-Matrix computed from the standard supergravity action.
- By AdS/CFT correspondence, the evaluated onshell action, with specified boundary conditions, act as a partition function, for evaluating correlators in the boundary, and the boundary values act as sources for relevant correlators.
- Therefore, if some terms vanish as a result of using equations of motion, then those terms will not contribute to the boundary S-Matrix.

Effect of Higher derivative terms

- We shall look at the higher derivative terms in the action on the boundary S-Matrix computed from the standard supergravity action.
- By AdS/CFT correspondence, the evaluated onshell action, with specified boundary conditions, act as a partition function, for evaluating correlators in the boundary, and the boundary values act as sources for relevant correlators.
- Therefore, if some terms vanish as a result of using equations of motion, then those terms will not contribute to the boundary S-Matrix.
- We will now look at the different sort of higher derivative terms that could affect the onshell action.

- Terms which are needed for the supersymmetrization of the gravitational Chern Simons term, are constructed out of the supersymmetric covariant field strengths.

- Terms which are needed for the supersymmetrization of the gravitational Chern Simons term, are constructed out of the supersymmetric covariant field strengths.
- The contribution of these terms to the equations of motion will be terms containing supersymmetric covariant field strengths and /or their super-covariant derivatives.

- Terms which are needed for the supersymmetrization of the gravitational Chern Simons term, are constructed out of the supersymmetric covariant field strengths.
- The contribution of these terms to the equations of motion will be terms containing supersymmetric covariant field strengths and /or their super-covariant derivatives.
- Such terms will necessarily vanish when the original equations of motion are satisfied,

- Terms which are needed for the supersymmetrization of the gravitational Chern Simons term, are constructed out of the supersymmetric covariant field strengths.
- The contribution of these terms to the equations of motion will be terms containing supersymmetric covariant field strengths and /or their super-covariant derivatives.
- Such terms will necessarily vanish when the original equations of motion are satisfied, and therefore will not affect the boundary correlators.

- Next, Terms that can be added to the action that are supersymmetric on their own under the standard supersymmetry transformations.

- Next, Terms that can be added to the action that are supersymmetric on their own under the standard supersymmetry transformations.
- Such terms are constructed out of the supersymmetric covariant field strengths and/ or their supercovariant derivatives.

- Next, Terms that can be added to the action that are supersymmetric on their own under the standard supersymmetry transformations.
- Such terms are constructed out of the supersymmetric covariant field strengths and/ or their supercovariant derivatives.

- The equations of motion, that these additional terms will contribute, will contain terms involving \hat{F}_{MN} , G_{MN} , $D_M \mathcal{R}_{NP}$ and/or their supercovariant derivatives in it.

- The equations of motion, that these additional terms will contribute, will contain terms involving \hat{F}_{MN} , G_{MN} , $D_M \mathcal{R}_{NP}$ and/or their supercovariant derivatives in it. And these additional contributions will vanish, when the original equations of motion are satisfied.

- The equations of motion, that these additional terms will contribute, will contain terms involving \hat{F}_{MN} , G_{MN} , $D_M \mathcal{R}_{NP}$ and/or their supercovariant derivatives in it. And these additional contributions will vanish, when the original equations of motion are satisfied.
- Therefore, the solutions obtained for the original equations of motion will still solve the equations of motion in the presence of these higher derivative terms.

- The equations of motion, that these additional terms will contribute, will contain terms involving \hat{F}_{MN} , G_{MN} , $D_M \mathcal{R}_{NP}$ and/or their supercovariant derivatives in it. And these additional contributions will vanish, when the original equations of motion are satisfied.
- Therefore, the solutions obtained for the original equations of motion will still solve the equations of motion in the presence of these higher derivative terms.
- Hence, the correlators in the gauge+fermionic sector will not be affected by these terms.

- For stress tensor correlators, the same argument works as given by David, Sahoo, Sen (arxiv:0705.0735),

- For stress tensor correlators, the same argument works as given by David, Sahoo, Sen (arxiv:0705.0735), which says that the stress tensor correlators are related to the current correlators by supersymmetry.

- For stress tensor correlators, the same argument works as given by David, Sahoo, Sen (arxiv:0705.0735), which says that the stress tensor correlators are related to the current correlators by supersymmetry.
- And since, by our argument the current correlators do not get renormalized,

- For stress tensor correlators, the same argument works as given by David, Sahoo, Sen (arxiv:0705.0735), which says that the stress tensor correlators are related to the current correlators by supersymmetry.
- And since, by our argument the current correlators do not get renormalized, this implies that the stress tensor correlators also do not get renormalized.

- There can be a general higher derivative term in the action that can keep the full action invariant under a modified set of supersymmetry transformation laws.

- There can be a general higher derivative term in the action that can keep the full action invariant under a modified set of supersymmetry transformation laws.
- Such terms can modify the equations of motion and will not vanish onshell, changing the boundary S-matrix.

- There can be a general higher derivative term in the action that can keep the full action invariant under a modified set of supersymmetry transformation laws.
- Such terms can modify the equations of motion and will not vanish onshell, changing the boundary S-matrix.
- But, since such terms can be removed by field redefinition,

- There can be a general higher derivative term in the action that can keep the full action invariant under a modified set of supersymmetry transformation laws.
- Such terms can modify the equations of motion and will not vanish onshell, changing the boundary S -matrix.
- But, since such terms can be removed by field redefinition, therefore the boundary S -matrix can be related to the boundary S -matrix calculated from the standard sugra action, by a unitary transformation.

Boundary S -Matrix

- Now we will look at the boundary S -matrix involving two and three point correlation function of the operators dual in the gauge+fermionic sector of the theory.

Boundary S -Matrix

- Now we will look at the boundary S -matrix involving two and three point correlation function of the operators dual in the gauge+fermionic sector of the theory.
- We begin by writing the Chern Simons form of the sugra action in Euclidean space

$$\begin{aligned} \mathcal{S} = & ia_L \int d^3x \epsilon^{MNP} \left[\frac{1}{2} B_M^a \partial_N B_P^b \delta_{ab} + \frac{i}{6} \epsilon_{abc} B_M^a B_N^b B_P^c \right. \\ & - ia_R \int d^3x \epsilon^{MNP} \left[\frac{1}{2} B'_M{}^a \partial_N B'_P{}^b \delta_{ab} + \frac{i}{6} \epsilon_{abc} B'_M{}^a B'_N{}^b B'_P{}^c \right. \\ & + i \frac{a_L}{2} \int d^3x \epsilon^{MNP} A_M \partial_N A_P \\ & \left. + \frac{a_L}{4} \int d^3x \epsilon^{MNP} (\bar{\psi}_M (\mathcal{D}_N \psi_P) - (\mathcal{D}_N \bar{\psi}_M) \psi_P), \right. \end{aligned}$$

• Where

$$B_M^a = \frac{i}{2} \varepsilon^{abc} \omega_{Mbc} - m e_M^a,$$

$$B'_M{}^a = \frac{i}{2} \varepsilon^{abc} \omega_{Mbc} + m e_M^a,$$

$$\mathcal{D}_M \psi_N = \partial_M \psi_N - \frac{1}{2} B_M^a \gamma_a \psi_N + \frac{i}{2} A_M \psi_N,$$

$$\mathcal{D}_M \bar{\psi}_N = \partial_M \bar{\psi}_N + \frac{1}{2} B_M^a \bar{\psi}_N \gamma_a - \frac{i}{2} A_M \bar{\psi}_N,$$

- Now the idea behind calculating the correlation function is to:

- Now the idea behind calculating the correlation function is to:
 - To solve the equations of motion arising out of the theory under a specified set of boundary condition for the fields

- Now the idea behind calculating the correlation function is to:
 - To solve the equations of motion arising out of the theory under a specified set of boundary condition for the fields
 - Put the above solution in the action and express the on-shell action as a functional of the boundary values of the fields

- Now the idea behind calculating the correlation function is to:
 - To solve the equations of motion arising out of the theory under a specified set of boundary condition for the fields
 - Put the above solution in the action and express the on-shell action as a functional of the boundary values of the fields
 - The above on-shell action then acts like a partition function for calculating CFT correlation function of relevant currents for which the boundary values of the dual fields acts like a source. This prescription is given by AdS/CFT correspondence.

- Now the idea behind calculating the correlation function is to:
 - To solve the equations of motion arising out of the theory under a specified set of boundary condition for the fields
 - Put the above solution in the action and express the on-shell action as a functional of the boundary values of the fields
 - The above on-shell action then acts like a partition function for calculating CFT correlation function of relevant currents for which the boundary values of the dual fields acts like a source. This prescription is given by AdS/CFT correspondence.
 - We will quantify all the above as we proceed

- The equations of motion, in the form notation, are obtained as:

$$dA = \frac{1}{4} \bar{\psi} \wedge \psi,$$

$$d\psi - \frac{1}{2} B^a \gamma_a \wedge \psi = -\frac{i}{2} A \wedge \psi,$$

$$d\bar{\psi} + \frac{1}{2} B^a \wedge \bar{\psi} \gamma_a = \frac{i}{2} A \wedge \bar{\psi},$$

- We solve these equations till first order, by imposing the following gauge conditions on ψ and $\bar{\psi}$:

$$\gamma^M \psi_M = 0 \quad \bar{\psi}_M \gamma^M = 0,$$

- The full solution till first order iteration is:

$$A = d\rho + \frac{1}{4}\bar{\phi}d\eta + \frac{1}{4}\bar{\eta}d\phi + \frac{1}{4}\bar{\phi}\phi dz,$$

$$\psi^{(1)} = (x^0)^{-\frac{1}{2}} \left(1 - \frac{i}{2}\rho \right) (d\eta + \phi dz),$$

$$\psi^{(2)} = (x^0)^{\frac{1}{2}} \left(1 - \frac{i}{2}\rho \right) d\phi,$$

$$\bar{\psi}^{(1)} = (x^0)^{\frac{1}{2}} \left(1 + \frac{i}{2}\rho \right) d\bar{\phi},$$

$$\bar{\psi}^{(2)} = (x^0)^{-\frac{1}{2}} \left(1 + \frac{i}{2}\rho \right) (d\bar{\eta} - \bar{\phi} dz),$$

- Where η , ϕ , $\bar{\eta}$ and $\bar{\phi}$ are function of modified Bessel's functions as:

$$\eta = \frac{1}{2\pi} \int d^2\vec{p} (x^0 p)^2 K_2(x^0 p) e^{i\vec{p}\cdot\vec{z}} \mathcal{A}_\eta(\vec{p}),$$

$$\phi = \frac{1}{2\pi} \int d^2\vec{p} (x^0 p) K_1(x^0 p) e^{i\vec{p}\cdot\vec{z}} (-2ip_z) \mathcal{A}_\eta(\vec{p}),$$

$$\bar{\eta} = \frac{1}{2\pi} \int d^2\vec{p} (x^0 p)^2 K_2(x^0 p) e^{i\vec{p}\cdot\vec{z}} \mathcal{A}_{\bar{\eta}}(\vec{p}),$$

$$\bar{\phi} = \frac{1}{2\pi} \int d^2\vec{p} (x^0 p) K_1(x^0 p) e^{i\vec{p}\cdot\vec{z}} (2ip_z) \mathcal{A}_{\bar{\eta}}(\vec{p}),$$

- Now we shall impose boundary conditions on the \bar{z} components of fields, since we are working in $(2, 0)$ theory.

- Now we shall impose boundary conditions on the \bar{z} components of fields, since we are working in $(2, 0)$ theory.
- The boundary conditions on the gauge field and Rarita-Schwinger fields are

$$\lim_{x^0 \rightarrow 0} A_{\bar{z}}(x^0, \vec{z}) = A_{\bar{z}}^{(0)}(\vec{z}),$$

$$\lim_{x^0 \rightarrow 0} (x^0)^{\frac{1}{2}} \psi_{\bar{z}}^{(1)} = \Theta_{\bar{z}}^{(-)}(\vec{z}),$$

$$\lim_{x^0 \rightarrow 0} (x^0)^{\frac{1}{2}} \bar{\psi}_{\bar{z}}^{(2)} = \Theta_{\bar{z}}^{(+)}(\vec{z}),$$

- We need to add the following boundary action for consistency requirements

$$\mathcal{S}_{\text{bdy}} = \mathcal{S}_{\text{bdy}}[\psi, \bar{\psi}] + \mathcal{S}_{\text{bdy}}[A]$$

$$\mathcal{S}_{\text{bdy}}[\psi, \bar{\psi}] =$$

$$-\frac{ia_L}{2} \int d^2 \vec{z} \bar{\psi}_z^{(1)}(x^0, \vec{z}) \psi_{\bar{z}}^{(1)}(x^0, \vec{z}) \Big|_{x^0=0}$$

$$-\frac{ia_L}{2} \int d^2 \vec{z} \bar{\psi}_{\bar{z}}^{(2)}(x^0, \vec{z}) \psi_z^{(2)}(x^0, \vec{z}) \Big|_{x^0=0}$$

$$\mathcal{S}_{\text{bdy}}[A] = a_L \int d^2 \vec{z} A_z(\vec{z}, x^0) A_{\bar{z}}(\vec{z}, x^0) \Big|_{x^0=0},$$

- After obtaining the solution to the equations of motion subject to the boundary conditions upto terms quadratic in the boundary values, we evaluate the action along with the boundary action, for these on-shell configuration of fields. We get

$$\begin{aligned}
& \mathcal{S}[A_{\bar{z}}^{(0)}, \Theta_{\bar{z}}^{(+)}, \Theta_{\bar{z}}^{(-)}] \\
&= -\frac{a_L}{\pi} \int d^2 \vec{z} d^2 \vec{w} \frac{1}{(z-w)^2} A_{\bar{z}}^{(0)}(\vec{w}) A_{\bar{z}}^{(0)}(\vec{z}) \\
&\quad -\frac{2ia_L}{\pi} \int d^2 \vec{z} d^2 \vec{w} \frac{1}{(z-w)^3} \Theta_{\bar{z}}^{(+)}(\vec{w}) \Theta_{\bar{z}}^{(-)}(\vec{z}) \\
&\quad -\frac{a_L}{\pi^2} \int d^2 \vec{z} d^2 \vec{w} d^2 \vec{v} \frac{1}{(z-w)(z-v)(w-v)^2} H
\end{aligned}$$

Where $H = A_{\bar{z}}^{(0)}(\vec{z}) \Theta_{\bar{z}}^{(+)}(\vec{v}) \Theta_{\bar{z}}^{(-)}(\vec{w})$

- Then according to *AdS/CFT* conjecture, we have

$$\exp(-\mathcal{S}(A, \psi, \bar{\psi})) = \left\langle \exp \left(\frac{1}{2\pi} \int_{\partial} A \right) \right\rangle$$

$$\text{Where } A = J(\vec{z}) A_{\vec{z}}^{(0)}(\vec{z}) + G^{(+)}(\vec{z}) \Theta_{\vec{z}}^{(-)}(\vec{z}) \\ + G^{(-)}(\vec{z}) \Theta_{\vec{z}}^{(+)}(\vec{z}),$$

- This implies the following two and three point correlation functions

$$\begin{aligned}
 & \langle J(\vec{z}_1) J(\vec{z}_2) \rangle \\
 = & (2\pi)^2 \frac{\delta}{\delta A_{\vec{z}}^{(0)}(\vec{z}_1)} \frac{\delta}{\delta A_{\vec{z}}^{(0)}(\vec{z}_2)} e^{-\mathcal{S}} \Big|_{(A_{\vec{z}}^{(0)}(\vec{z}), \Theta_{\vec{z}}^{(+)}(\vec{z}), \Theta_{\vec{z}}^{(-)}(\vec{z}))=0} \\
 & \langle G^{(+)}(\vec{z}_1) G^{(-)}(\vec{z}_2) \rangle \\
 = & (2\pi)^2 \frac{\delta}{\delta \Theta_{\vec{z}}^{(-)}(\vec{z}_1)} \frac{\delta}{\delta \Theta_{\vec{z}}^{(+)}(\vec{z}_2)} e^{-\mathcal{S}} \Big|_{(A_{\vec{z}}^{(0)}(\vec{z}), \Theta_{\vec{z}}^{(+)}(\vec{z}), \Theta_{\vec{z}}^{(-)}(\vec{z}))=0}
 \end{aligned}$$

$$\begin{aligned}
& \left\langle J(\vec{z}_1) G^{(+)}(\vec{z}_2) G^{(-)}(\vec{z}_3) \right\rangle \\
= & (2\pi)^3 \frac{\delta}{\delta A_{\vec{z}}^{(0)}(\vec{z}_1)} \frac{\delta}{\delta \Theta_{\vec{z}}^{(-)}(\vec{z}_2)} \frac{\delta}{\delta \Theta_{\vec{z}}^{(+)}(\vec{z}_3)} e^{-S} \Big|_{(A_{\vec{z}}^{(0)}(\vec{z}), \Theta_{\vec{z}}^{(+)}(\vec{z}), \Theta_{\vec{z}}^{(-)}(\vec{z})) =}
\end{aligned}$$

- Using the evaluated onshell action, we get

$$\langle J(\vec{z}_1)J(\vec{z}_2) \rangle = 8a_L\pi \frac{1}{(z_1 - z_2)^2}$$

$$\langle G^{(+)}(\vec{z}_1)G^{(-)}(\vec{z}_2) \rangle = 8ia_L\pi \frac{1}{(z_1 - z_2)^3}$$

$$\begin{aligned} & \langle J(\vec{z}_1)G^{(+)}(\vec{z}_2)G^{(-)}(\vec{z}_3) \rangle \\ &= 8a_L\pi \frac{1}{(z_1 - z_2)(z_1 - z_3)(z_2 - z_3)^2}, \end{aligned}$$

- Using the evaluated onshell action, we get

$$\langle J(\vec{z}_1)J(\vec{z}_2) \rangle = 8a_L\pi \frac{1}{(z_1 - z_2)^2}$$

$$\langle G^{(+)}(\vec{z}_1)G^{(-)}(\vec{z}_2) \rangle = 8ia_L\pi \frac{1}{(z_1 - z_2)^3}$$

$$\begin{aligned} & \langle J(\vec{z}_1)G^{(+)}(\vec{z}_2)G^{(-)}(\vec{z}_3) \rangle \\ &= 8a_L\pi \frac{1}{(z_1 - z_2)(z_1 - z_3)(z_2 - z_3)^2}, \end{aligned}$$

- These are the expected conformal field theory results.

Conclusions

- We looked at the standard $\mathcal{N} = (2, 0)$ supergravity action and outlined the basic differences of its two avatars i.e first order and second order formulation

Conclusions

- We looked at the standard $\mathcal{N} = (2, 0)$ supergravity action and outlined the basic differences of its two avatars i.e first order and second order formulation
- We also looked at two sets of higher derivative terms that affects the standard boundary S-matrix by trivial/non-trivial unitary transformations

Conclusions

- We looked at the standard $\mathcal{N} = (2, 0)$ supergravity action and outlined the basic differences of its two avatars i.e first order and second order formulation
- We also looked at two sets of higher derivative terms that affects the standard boundary S-matrix by trivial/non-trivial unitary transformations
- We also computed the standard boundary S-matrix involving two and three point correlators of $U(1)$ and supersymmetry currents and see that this result matches with the conformal field theory result.

Conclusions

- We looked at the standard $\mathcal{N} = (2, 0)$ supergravity action and outlined the basic differences of its two avatars i.e first order and second order formulation
- We also looked at two sets of higher derivative terms that affects the standard boundary S-matrix by trivial/non-trivial unitary transformations
- We also computed the standard boundary S-matrix involving two and three point correlators of $U(1)$ and supersymmetry currents and see that this result matches with the conformal field theory result.

THANK YOU