Gauged (super)conformal models

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Outline

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- Why (super)conformal invariant mechanics?

Motivation

- Superconformal sigma models and multicentre black holes

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Background

- Conformal mechanics describes motion of a charged particle in the near horizon of an extreme Reissner-Nordström black hole [*hep-th/9804177*]. The near horizon geometry is $AdS_2 \times S^2$ with an $SO(1,2)\times SO(3)$ symmetry group where the $SO(1,2)$ factor can be realized as the symmetry group of a 1d conformal invariant mechanics.
- In the *non-relativistic* limit (large black holes), the radial motion of an extreme particle $(m = q)$ is governed by the same Hamiltonian as the Alfaro-Fubini-Furlan (AFF) model [*Nuovo Cimento A 34, 569 (1976)*]. In particular, the radial coordinate of the near horizon geometry is identified with the the conformal mechanics degree of freedom.
- A supersymmetric generalization of such non-relativistic conformal model exhabits $SU(1,1|1)\cong OSp(2|2)$ superconformal symmetry [*Theor. Math. Phys. 56 (1983) 862 & Nucl. Phys. B245 (1984) 17*]. It was then shown that a truncation of such model can describe an *extreme* superparticle moving radialy in the near horizon geometry of an extreme RN black hole solution of $\mathcal{N} = 2$ supergravity in 4d [*hep-th/9804177*]. The main clue is that these black holes have $AdS_2 \times S^2$ geometry near their horizon where AdS_2 isometries serves as the conformal symmetry group.

Background

- Taking into account the angular motion of the test particle in the near horizon geometry, it was realized that the same correspondence exists for *any finite value* of the black hole mass [*hep-th/0210196*].
- Studying this correspondence in Hamiltonian formalism revealed a deeper connection between the two theories. Requiring same symmetries, one can determine the desired canonical transformations between the two sets of conserved charges. The same transformation can be applied to more advanced cases [*hep-th/0212204*].

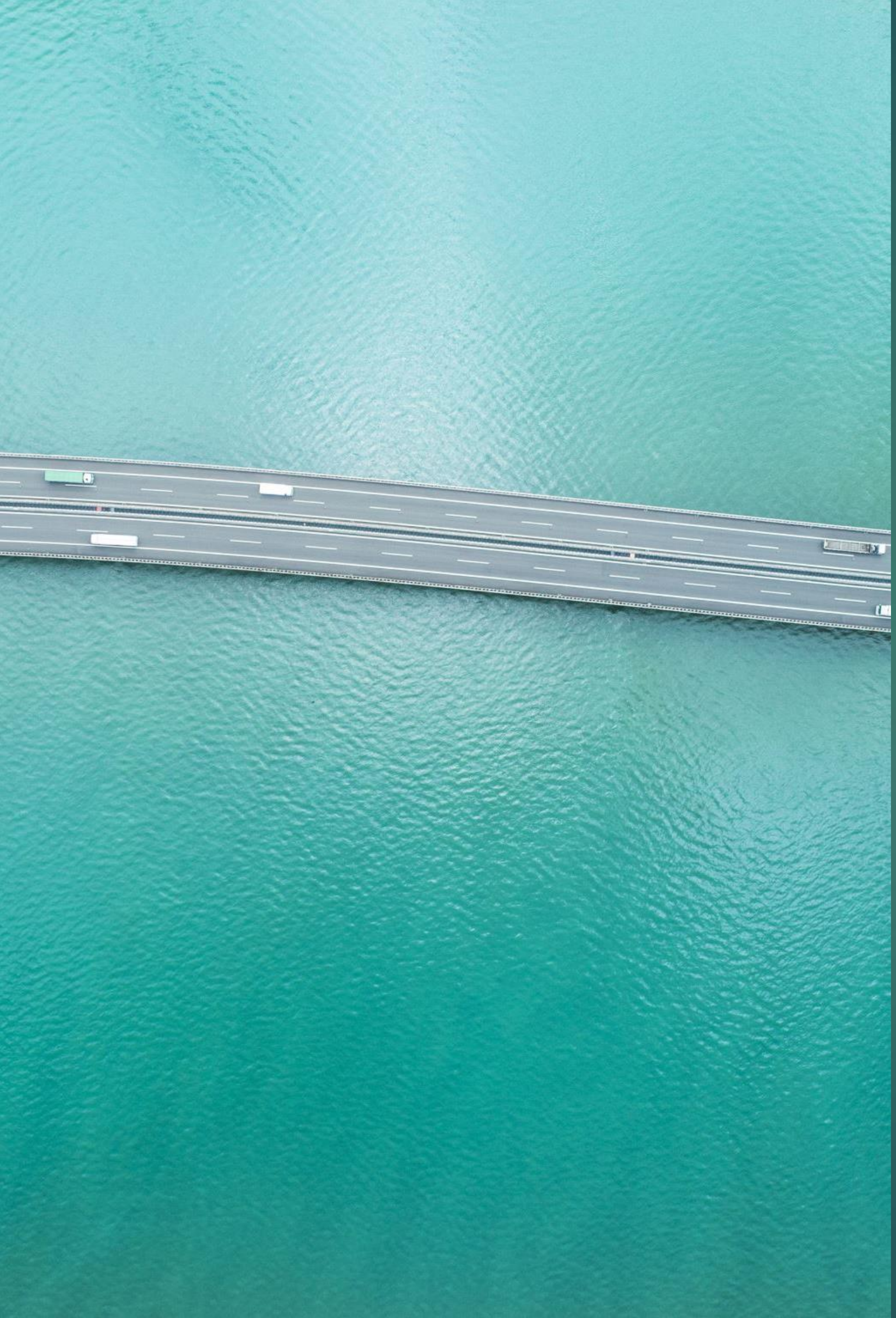
In the first step, one can take the correspondence between the particle moving on $AdS_2 \times S^2$ and AFF model to determine the appropriate canonical transformation. Then, considering the angular dof of the test particle, the symmetry algebra becomes $so(1,2) \oplus su(2)$ and the same transformation can be applied to the group generators. Doing so exposes the proper extension to the AFF conformal model that classically corresponds to the full dynamics of the particle in AdS_2 background. Following the same logic but in a reverse direction, one can first supersymmetrize the extended AFF model. Then, taking advantage of the conical transformation, the Hamiltonian governing the motion of a superparticle on $AdS_2 \times S^2$ background can be constructed.

Motivation

- Multicentred black hole solutions of $\mathcal{N} = 2$ supergravity in 4d can be considered as the bound state of dyonic black holes. They are known to have $AdS_2 \times S^2$ near horizon geometry [*hep-th/9508072*].
- In a specific set of values for the charged centres, the solution reduces to the so-called scaling solutions with zero angular momentum. In this family of solutions, centres can approach each other arbitrarily closely. The asymptotic geometry of such solutions is also studied. As discussed in [*1807.01879*], the asymptotic geometry is not simply $AdS_2 \times S^2$, but the two-sphere rotates by AdS_2 time. In other words, the S^2 factor appears as a bundle on AdS_2.
- The supersymmetric (quantum) mechanics of a number of dyonic particles, including some stringy interactions takes the form of a 1d, $\mathcal{N} = 4$ supersymmetric quiver gauge theory [*hep-th/0206072*]. Integrating out the stringy modes when the gauge theory is in its Coulomb phase reduces it to the mechanics of N dyons, whose essential features can be identified with those of N dyonic BPS black holes in $\mathcal{N} = 2$ 4d supergravity.
- In the scaling limit and after gauging the shift symmetry of the theory, the Coulomb quiver mechanics becomes superconformally invariant [*2009.07107 & 1310.7929*] admitting $D(2,1;0)$ superconformal group.

Results & Conclusion

- To understand the near horizon physics of supersymmetric black holes, studying superconformal sigma models seems to be crucial. The question is what are the set of structural and geometric conditions for a supersymmetric sigma model to become superconformally invariant?
- As we showed in [*2203.10167*], there are sigma models that admit full superconformal symmetry **only after gauging some of their isometries**. From the canonical point of view, the gauging procedure can be analysed as symplectic reduction of the phase space.
- We started with a bosonic sigma model coupled to a background gauge field. After gauging the isometries, we found the set of conditions required for conformal invariance of the theory.
- We also studied the supersymmetric extensions of the gauged bosonic model with various amount of supersymmetries. The complete set of conditions are obtained for each case and turned out to be deformed versions of their ungauged counterparts. These deformations have nice geometric interpretations [*2203.10167*].
- $\mathcal{N} = 4B$ supersymmetric gauged sigma model is of particular interest. It admits the exceptional one-parameter supergroup $D(2,1;\alpha)$ as its symmetry group. Hence, the Coulomb branch quiver mechanics describing the dynamics of D-brane systems in an AdS_2 scaling limit is a special case with $\alpha = 0$.
- Also, as a step towards quantization, quantum ordering ambiguities of the symmetry generators were solved.



Thank you!