



Higher spins in hyper-superspace

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Abstract

We extend the results of arXiv:1401.1645 on the generalized conformal $Sp(2n)$ -structure of infinite multiplets of higher-spin fields, formulated in spaces with extra tensorial directions (hyperspaces), to the description of $OSp(1|2n)$ -invariant infinite-dimensional higher-spin supermultiplets formulated in terms of scalar superfields on flat hyper-superspaces and on $OSp(1|n)$ supergroup manifolds. We find generalized superconformal transformations relating the superfields and their equations of motion in flat hyper-superspace with those on the $OSp(1|n)$ supermanifold. We then use these transformations to relate the two-, three- and four-point correlation functions of the scalar superfields on flat hyperspace, derived by requiring the $OSp(1|2n)$ invariance of the correlators, to correlation functions on the $OSp(1|n)$ group manifold. As a byproduct, for the simplest particular case of a conventional $\mathcal{N} = 1$, $D = 3$ superconformal theory of scalar superfields, we also derive correlation functions of component fields of the scalar supermultiplet including those of auxiliary fields.

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1. Introduction

In [1] we have studied some aspects of the description of infinite sets of integer and half-integer massless higher-spin fields in flat and anti-de-Sitter (AdS) spaces in terms of scalar and spinor ‘hyperfields’ propagating in hyperspaces. In addition to a conventional space–time as a subspace, hyperspaces are endowed with extra tensorial coordinates encoding the spin degrees of freedom of conventional space–time fields. This formulation, which was originally put forward by Fronsdal as an alternative to the Kaluza–Klein theory [2], has been extensively developed by several authors [3–22].

The theories on tensorially extended (super)spaces, which we will henceforth refer to as hyper-(super)spaces, offer many interesting and challenging problems regarding higher-spin fields, one of them being the further development and study of generalized (super)conformal theories on these spaces. This motivated our recent work [1] in which, using generalized conformal transformations, we established an explicit relation between the equations of motion of hyperfields on flat hyperspace and on $Sp(n)$ group-manifolds, the latter being tensorial generalizations¹ of AdS spaces. This relation was then employed in order to explicitly derive the $Sp(2n)$ -invariant two-, three- and four-point correlation functions for fields on $Sp(n)$ group manifolds, from the known $Sp(2n)$ -invariant correlation functions on flat hyperspaces, thus generalizing the results obtained in [5,10,23].

In this paper we further extend the results of [1] to the description of supersymmetric systems of higher-spin fields in hyper-superspaces, which were previously studied, e.g. in [3,4,6–8,11,14,20,24]. In particular, by means of a generalized superconformal transformation, we establish an explicit relation between the superfield equations of motion [11] on flat hyper-superspace and on an $OSp(1|n)$ supergroup manifold. Furthermore, the explicit solution of the generalized superconformal Ward identities allows us to derive the $OSp(1|2n)$ -invariant two-, three- and four-point superfield correlation functions on flat hyper-superspace and, consequently, using the generalized superconformal transformations, we obtain the corresponding correlation functions on the $OSp(1|n)$ group manifolds. Our results, therefore, generalize the superfield description and computation of superfield correlators in conventional superconformal field theories, considered, e.g. in [25–28], to superconformal higher-spin theories. A byproduct of our analysis is the derivation of correlation functions involving the component fields of the scalar supermultiplet, including the auxiliary fields, for the simple special case of a three-dimensional $\mathcal{N} = 1$ superconformal theory of scalar superfields.

As in the case of the $\mathcal{N} = 1$, $D = 3$ superconformal theory, the fact that 3- and 4-point correlation functions are non-zero for hyperfields of an anomalous conformal weight may indicate the existence of interacting conformal higher-spin fields which involve higher orders of their field strengths.

It should be noted that in the literature [29–49] various supersymmetric higher-spin systems have been considered in either irreducible or reducible representations of the Poincaré and AdS groups (see, e.g. [50,51] for a discussion of reducible higher-spin multiplets in the “metric-like” approach). As we will see, the systems of integer and half-integer higher-spin fields considered in [3,4,6–8,11,14,20] and in this paper form *irreducible* infinite-dimensional supermultiplets of space–time supersymmetry. These supersymmetric higher-spin systems are therefore different

¹ Here $Sp(n)$ stands for the real non-compact form $Sp(n, \mathbb{R})$ of $Sp(n, \mathbb{C})$, where $\mathbb{R}$ will be omitted for brevity.

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