Introduction to supergravity 2015: Exercise 3.

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Here we work with the linearized new-minimal supergravity [1]. Our superspace conventions are found in [2]. The component field definitions for the gravitational superfield in the linearized new-minimal formulation are (in the Wess-Zumino gauge)

$$
\begin{aligned}
-\frac{i}{4}\bar{D}^2 D_\alpha \phi_m| &= \psi_{m\alpha}, \\
-\frac{1}{2}[D_\alpha, \bar{D}_{\dot\alpha}]\phi_m| &= h_{\alpha\dot\alpha m} + B_{\alpha\dot\alpha m}, \\
-\frac{1}{8}D^\alpha \bar{D}^2 D_\alpha \phi_m| &= A_m,
\end{aligned}
\tag{1}
$$

where $h_{mn} = h_{nm}$ and $B_{mn} = -B_{nm}$.

The definition of the global supersymmetry transformations is

$$\delta\mathcal{O}| = \xi^\alpha D_\alpha \mathcal{O}| + \bar\xi_{\dot\alpha}\bar{D}^{\dot\alpha}\mathcal{O}|. \tag{2}$$

For example for the gravitino

$$\delta\psi_{m\alpha} = \delta\left(-\frac{i}{4}\bar{D}^2 D_\alpha\phi_m|\right) = \xi^\beta D_\beta\left(-\frac{i}{4}\bar{D}^2 D_\alpha\phi_m\right)| + \bar\xi_{\dot\alpha}\bar{D}^{\dot\alpha}\left(-\frac{i}{4}\bar{D}^2 D_\alpha\phi_m\right)|. \tag{3}$$

Similarly one finds the transformations for all the component fields in (1).

Do the following

1. Find the transformations for all the component fields in (1). Calculate in the WZ gauge.

2. Does the algebra of these supersymmetry transformations close off-shell (up to Poincaré and gauge transformations)? Calculate the commutator $[\delta_\xi, \delta_\eta]\psi_{m\alpha}$ for example. What is the difference here compared to the on-shell linearized supergravity?

References

[1] S. Cecotti, S. Ferrara, M. Porrati and S. Sabharwal, "New Minimal Higher Derivative Supergravity Coupled To Matter," Nucl. Phys. B **306**, 160 (1988).

[2] J. Wess and J. Bagger, "Supersymmetry and supergravity," Princeton, USA: Univ. Pr. (1992) 259 p