Introduction to supergravity 2015: Exercise 5.

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Here we work with the linearized new-minimal supergravity [1]. Our superspace conventions are found in [2]. A Bianchi identity for this supergravity reads

$$W_\alpha = -\frac{1}{2}\bar{D}^{\dot{\alpha}} E_{\alpha\dot{\alpha}}, \tag{1}$$

which can be used as a definition for W_α. Here W_α is a superfield of the new-minimal supergravity which also has the property

$$W_\alpha \sim \theta_\alpha R, \tag{2}$$

where R is the linearized Ricci scalar.

The Lagrangian for linearized new-minimal $R + R^2$ supergravity reads

$$\mathcal{L}_{R+R^2} = \int d^4\theta\, \phi_m E^m + \left\{ \alpha \int d^2\theta\, W^\alpha W_\alpha + c.c. \right\}. \tag{3}$$

Do the following

1. Explain why (3) gives $R + R^2$.
2. Write (3) in the linearized superconformal supergravity framework with the help of a real linear compensator L.
3. Make the compensator unconstrained by introducing the term
$$\Phi L + \bar{\Phi} L, \tag{4}$$
where Φ is a chiral superfield.
4. Show that we can not integrate out L. Verify that we could integrate it out for $\alpha = 0$. What does this mean?
5. Find the dual theory to (3). You will find standard linearized supergravity and a massive vector multiplet [1, 3].

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

[3] S. Cecotti, S. Ferrara and L. Girardello, "Massive Vector Multiplets From Superstrings," Nucl. Phys. B **294**, 537 (1987).