Supergravity gaugings and BRST cohomology

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- "A note on gaugings in four spacetime dimensions and electric-magnetic duality", with M. Henneaux, B. Julia and A. Ranjbar (1709.06014)
- "Deformations of vector-scalar models", with G. Barnich, N. Boulanger, M. Henneaux, B. Julia and A. Ranjbar (1712.08126)

Dualities and Generalized Geometries

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Gaugings of extended supergravities

Promote a subgroup of the global symmetries to a local symmetry, using the available vector fields of the theory,

$$G_{\text{gauge}} \subseteq G_{\text{electric}} \subseteq G_{\text{duality}} \subseteq Sp(2n_v, \mathbb{R})\,.$$

$\rightarrow$ Possibilities strongly depend on the choice of electric frame

[Review: Trigiante 1609.09745]

Particular case of deformation problem [Review: Henneaux 971226]

- Action $S = S^{(0)} + gS^{(1)} + g^2 S^{(2)} + \dots$
- Gauge symmetries $\delta\Phi = \delta_{(0)}\Phi + g\delta_{(1)}\Phi + g^2\delta_{(2)}\Phi + \dots$

so that

$$\frac{\delta S}{\delta \Phi}\delta\Phi = 0\,.$$

BRST cohomology

Questions:

- Are there other types of deformations besides gaugings?
- Do alternative formulations bring new possibilities?

Method: cohomology of the BRST operator s,

- $s^2 = 0$
- allowed deformations are given by solutions of $sX = 0$
- trivial deformations are of the form $X = sY$ for some Y

$\rightarrow$ non-trivial deformations are controlled by the cohomology of s at ghost number zero.

Assumptions:

- Lagrangian starting point
- Smooth deformation
- Locality

BRST cohomology

Questions:

- Are there other types of deformations besides gaugings?
  $\rightarrow$ None that deform the gauge transformations.
- Do alternative Lagrangian formulations bring new possibilities?
  $\rightarrow$ Not the know ones.

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Lagrangian starting point (1709.06014)

Focus on scalars + abelian vectors, with the usual Lagrangian

$$\mathcal{L} = \mathcal{L}_S(\phi^i, \partial_\mu \phi^i) - \frac{1}{4}\mathcal{I}_{IJ}(\phi) F^I_{\mu\nu} F^{J\mu\nu} + \frac{1}{8}\mathcal{R}_{IJ}(\phi)\, \varepsilon^{\mu\nu\rho\sigma} F^I_{\mu\nu} F^J_{\rho\sigma}$$

Other starting points?

- Embedding tensor Lagrangian [de Wit, Samtleben, Trigiante 0507289]: Auxiliary/pure gauge fields do not change the cohomology
- First-order Lagrangian [Bunster, Henneaux 1011.5889, 1101.6064]: Non-abelian deformations are obstructed

All deformations fall into two classes:

- Add gauge-invariant terms to the Lagrangian (I-type)
- Gauging of the underlying global symmetries, e.g.

$$\delta_{\text{global}} A^I_\mu = \eta^\Gamma (f_\Gamma)^I{}_J A^J_\mu \;\rightarrow\; \delta_{\text{gauge}} A^I_\mu = \partial_\mu \epsilon^I + g\,\epsilon^K\, k^\Gamma{}_K (f_\Gamma)^I{}_J A^J_\mu$$

$\rightarrow$ Structure constants $f^I{}_{JK} = (f_\Gamma)^I{}_J k^\Gamma{}_K$

$\rightarrow$ The matrix $k^\Gamma{}_K$ satisfies all the constraints of the embedding tensor

Useful by-product: classification of global symmetries according to their gauge invariance properties

type	gauge-inv. transformation	gauge-inv. current
U	no	no
W	yes	no
V	yes	yes

Summary and perspectives

- We computed all deformations of abelian vector-scalar models with the BRST method
- Assumptions: Lagrangian, continuous and local
- Link between deformations and global symmetries (+ embedding tensor constraints) appears naturally from cohomology
- Other known formulations with extra fields do not bring new possibilities

How to go further?

- Symmetries not in the usual duality group
  Example: $\delta A_\mu = \alpha\, x^\nu F_{\mu\nu}$ for free e.-m. [Brandt 0105010]
- New formulations (lagrangian or not), non-continuous
- Non-local?
  Duality symmetry $\delta \vec{A} = \alpha \Delta^{-1}(\vec{\nabla} \times \vec{E})$, $\delta A_0 = 0$
  [Deser, Teitelboim 1976; Bunster, Henneaux 1101.6064]