

Extending GR: from Supergravity to Higher Spins

QFT and Gravity II - part II

DARIO FRANCIA

Scuola Normale Superiore - A.Y. 2014-2015

dario.francia@sns.it

We shall illustrate the basic features of possible extensions of GR, implemented by assuming broader and deeper underlying symmetry structures.

Number of hours: 20

Exam: problems and discussion.

References:

- Freedman D Z and Van Proyen A, *Supergravity* (Cambridge University Press, 2012).
- Notes.

Part I

□ Basics of higher-spin theory

Motivations: relativistic point particles; higher spins in String Theory; holography. Irreps of the Poincaré Group in any D. The Fierz system. Construction of kinetic tensors and free Lagrangians: Fronsdal's theory. Reducible systems and Maxwell-like formulation.

□ Free higher spins on (A)dS

Maximally symmetric spaces. Irreps of Anti-de Sitter group. Unitarity bounds. Massive and massless particles on AdS. Singletons in D=4. Fronsdal's theory on (A)dS. Partly massless irreps: the example of spin 2.

□ No-go results

Generalities. Weinberg 1964. Aragone-Deser. Porrati's no-go theorem for massless higher spins interacting with gravity.

□ Building up interactions

Cubic vertices in Minkowski background. The Noether method. Abelian and non-Abelian vertices. Born-Infeld theory. Metsaev's classification. Frame formulation of GR. Gravity as a Poincaré gauge theory. Metric-like higher-spin connections and curvatures. Frame-like formulation of free higher spins: first off-shell and on-shell

theorems. Higher-spin algebra: symmetries of the Laplacian, oscillator realization and \star -product, general features. Master fields. Auxiliary twistor space: master one-forms and zero-forms. Vasiliev's equations.

Part II

□ Spinors

Clifford algebra and gamma matrices in even and odd dimensions. Recursive construction in the Weyl basis for $D = 2, \dots, 11$. The matrix γ_{2n+1} . Discrete symmetries. Weyl, Majorana, pseudo-Majorana and Majorana-Weyl spinors.

□ $\mathcal{N} = 1, D = 4$ Supergravity

Table of $\mathcal{N} \leq 8$ supergravity multiplets in $D = 4$. Rarita-Schwinger fields: massive and massless free Lagrangians. Coupling massless spin-3/2 particles to gravity. Action for $\mathcal{N} = 1, D = 4$ Supergravity. 1.5 formulation. Invariance under local supersymmetry. The case of spin $s = 5/2$: Fradkin-Vasiliev observation and role of AdS background.