A decade of Polynomial Affine model of Gravity

José Perdiguero Gárate

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2.1 Building the model

$$\begin{aligned} \hat{\Gamma}_{\alpha}{}^{\beta}{}_{\gamma} &= \hat{\Gamma}_{(\alpha}{}^{\beta}{}_{\gamma)} + \hat{\Gamma}_{[\alpha}{}^{\beta}{}_{\gamma]}, \\ &= \Gamma_{\alpha}{}^{\beta}{}_{\gamma} + \mathcal{B}_{\alpha}{}^{\beta}{}_{\gamma} + \delta^{\beta}_{[\gamma}\mathcal{A}_{\alpha]}, \end{aligned} \tag{1}$$

$$
\begin{aligned}
S = \int \mathrm{d}V^{\alpha\beta\gamma\delta}\Big[& B_1 \mathcal{R}_{\mu\nu}{}^{\mu}{}_{\rho}\mathcal{B}_{\alpha}{}^{\nu}{}_{\beta}\mathcal{B}_{\gamma}{}^{\rho}{}_{\delta} + B_2 \mathcal{R}_{\alpha\beta}{}^{\mu}{}_{\rho}\mathcal{B}_{\gamma}{}^{\nu}{}_{\delta}\mathcal{B}_{\mu}{}^{\rho}{}_{\nu} + B_3 \mathcal{R}_{\mu\nu}{}^{\mu}{}_{\alpha}\mathcal{B}_{\beta}{}^{\nu}{}_{\gamma}\mathcal{A}_{\delta} \\
& + B_4 \mathcal{R}_{\alpha\beta}{}^{\sigma}{}_{\rho}\mathcal{B}_{\gamma}{}^{\rho}{}_{\delta}\mathcal{A}_{\sigma} + B_5 \mathcal{R}_{\alpha\beta}{}^{\rho}{}_{\rho}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta}\mathcal{A}_{\sigma} + C_1 \mathcal{R}_{\mu\alpha}{}^{\mu}{}_{\nu}\nabla_{\beta}\mathcal{B}_{\gamma}{}^{\nu}{}_{\delta} \\
& + C_2 \mathcal{R}_{\alpha\beta}{}^{\rho}{}_{\rho}\nabla_{\sigma}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta} + D_1 \mathcal{B}_{\nu}{}^{\mu}{}_{\lambda}\mathcal{B}_{\mu}{}^{\nu}{}_{\alpha}\nabla_{\beta}\mathcal{R}_{\gamma}{}^{\lambda}{}_{\delta} + D_2 \mathcal{B}_{\alpha}{}^{\mu}{}_{\beta}\mathcal{B}_{\mu}{}^{\lambda}{}_{\nu}\nabla_{\lambda}\mathcal{B}_{\gamma}{}^{\nu}{}_{\delta} \\
& + D_3 \mathcal{B}_{\alpha}{}^{\mu}{}_{\nu}\mathcal{B}_{\beta}{}^{\lambda}{}_{\gamma}\nabla_{\lambda}\mathcal{B}_{\mu}{}^{\nu}{}_{\delta} + D_4 \mathcal{B}_{\alpha}{}^{\lambda}{}_{\beta}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta}\nabla_{\lambda}\mathcal{A}_{\sigma} + D_5 \mathcal{B}_{\alpha}{}^{\lambda}{}_{\beta}\mathcal{A}_{\sigma}\nabla_{\lambda}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta} \\
& + D_6 \mathcal{B}_{\alpha}{}^{\lambda}{}_{\beta}\mathcal{A}_{\gamma}\nabla_{\lambda}A_{\delta} + D_7 \mathcal{B}_{\alpha}{}^{\lambda}{}_{\beta}\mathcal{A}_{\lambda}\nabla_{\gamma}A_{\delta} + E_1 \nabla_{\rho}\mathcal{B}_{\alpha}{}^{\rho}{}_{\beta}\nabla_{\sigma}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta} \\
& + E_2 \nabla_{\rho}\mathcal{B}_{\alpha}{}^{\rho}{}_{\beta}\nabla_{\gamma}\mathcal{A}_{\delta} + F_1 \mathcal{B}_{\alpha}{}^{\mu}{}_{\beta}\mathcal{B}_{\gamma}{}^{\sigma}{}_{\delta}\mathcal{B}_{\mu}{}^{\lambda}{}_{\rho}\mathcal{B}_{\sigma}{}^{\rho}{}_{\lambda} + F_2 \mathcal{B}_{\alpha}{}^{\mu}{}_{\beta}\mathcal{B}_{\gamma}{}^{\nu}{}_{\lambda}\mathcal{B}_{\delta}{}^{\lambda}{}_{\rho}\mathcal{B}_{\mu}{}^{\rho}{}_{\nu} \\
& + F_3 \mathcal{B}_{\nu}{}^{\mu}{}_{\lambda}\mathcal{B}_{\mu}{}^{\nu}{}_{\alpha}\mathcal{B}_{\beta}{}^{\lambda}{}_{\gamma}\mathcal{A}_{\delta} + F_4 \mathcal{B}_{\alpha}{}^{\mu}{}_{\beta}\mathcal{B}_{\gamma}{}^{\nu}{}_{\delta}\mathcal{A}_{\mu}\mathcal{A}_{\nu}\Big].
\end{aligned}
\tag{2}
$$

$$
\begin{aligned}
S = \int \mathrm{d}V^{\alpha\beta\gamma}\Big[& B_1 \mathcal{A}_{\alpha}\mathcal{A}_{\beta}\mathcal{B}_{\beta}{}^{\mu}{}_{\gamma} + B_2 \mathcal{A}_{\alpha}\mathcal{F}_{\beta\gamma} + B_3 \mathcal{A}_{\alpha}\nabla_{\mu}\mathcal{B}_{\beta}{}^{\mu}{}_{\gamma} \\
& + B_4 \mathcal{B}_{\alpha}{}^{\mu}{}_{\nu}\mathcal{B}_{\beta}{}^{\nu}{}_{\lambda}\mathcal{B}_{\gamma}{}^{\lambda}{}_{\mu} + B_5 \mathcal{R}_{\alpha\beta}{}^{\mu}{}_{\mu}\mathcal{A}_{\gamma} + B_6 \mathcal{R}_{\mu\alpha}{}^{\mu}{}_{\nu}\mathcal{B}_{\beta}{}^{\nu}{}_{\gamma} \\
& + B_7 \Gamma_{\alpha}{}^{\mu}{}_{\mu}\partial_{\beta}\Gamma_{\alpha}{}^{\nu}{}_{\nu} + B_8 \left(\Gamma_{\alpha}{}^{\mu}{}_{\nu}\partial_{\beta}\Gamma_{\gamma}{}^{\nu}{}_{\mu} + \frac{2}{3}\Gamma_{\alpha}{}^{\mu}{}_{\nu}\Gamma_{\beta}{}^{\nu}{}_{\lambda}\Gamma_{\gamma}{}^{\lambda}{}_{\mu}\right)\Big].
\end{aligned}
\tag{3}
$$

$$
S = \int \mathrm{d}V^{\alpha\beta}\Big[\alpha_1 \mathcal{R}_{\sigma\alpha}{}^{\sigma}{}_{\beta} + \alpha_2 \mathcal{A}_{\sigma}\mathcal{B}_{\alpha}{}^{\sigma}{}_{\beta} + \alpha_3 \mathcal{F}_{\alpha\beta} + \alpha_4 \nabla_{\sigma}\mathcal{B}_{\alpha}{}^{\sigma}{}_{\beta}\Big]. \tag{4}
$$

2.2 Coupling a scalar field

$$
\mathcal{K}^{\mu\nu} = \alpha\nabla_{\lambda}\mathcal{B}_{\rho}{}^{(\mu}{}_{\sigma}\mathrm{d}V^{\nu)\lambda\rho\sigma} + \beta\mathcal{A}_{\lambda}\mathcal{B}_{\rho}{}^{(\mu}{}_{\sigma}\mathrm{d}V^{\nu)\lambda\rho\sigma} + \gamma\mathcal{B}_{\kappa}{}^{(\mu}{}_{\lambda}\mathcal{B}_{\rho}{}^{(\nu}{}_{\sigma}\mathrm{d}V^{\kappa\lambda\rho\sigma}, \tag{5}
$$

$$
S_{\phi} = -\int \mathcal{K}^{\mu\nu}\partial_{\mu}\phi\partial_{\nu}\phi \tag{6}
$$

2.3 Building ansatz

3 Affine perturbation theory

4 Analysis of the solutions

5 Final remarks

References