

# A decade of Polynomial Affine model of Gravity

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## 1 Introduction

## 2 The Polynomial Affine model of Gravity

### 2.1 Building the model

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

$$\begin{aligned}
S = \int dV^{\alpha\beta\gamma\delta} & \left[ 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 \right. \\
& + 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 \mathcal{A}_\delta + D_7 \mathcal{B}_\alpha{}^\lambda{}_\beta \mathcal{A}_\lambda \nabla_\gamma \mathcal{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 \\
& \left. + 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 \right]. \tag{2}
\end{aligned}$$

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

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

## 2.2 Coupling a scalar field

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

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

$$\mathcal{K}^{\mu\nu} = \int \alpha dV^{\alpha\beta\mu} \mathcal{B}_\alpha{}^\nu{}_\beta, \tag{7}$$

$$S_\phi = - \int \mathcal{K}^{\mu\nu} \partial_\mu \phi \partial_\nu \phi \tag{8}$$

**2.3 Building ansatz**

**3 Affine perturbation theory**

**4 Analysis of the solutions**

**5 Final remarks**

**References**