Numerical solutions for boson stars in $f(\mathcal{R})$ gravity using PINNs

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1 Introduction

2 Dynamics in $f(\mathcal{R})$

In Palatini's formalisms, the manifold is endowed with two fundamental and independent fields: the metric tensor $g_{\mu\nu}$ and the affine connection $\Gamma^{\alpha}{}_{\beta\gamma}$, the former allow us to define the notion of distance, whereas the latter define the notion of parallelism. The action is written as follow

$$S[g,\Gamma] = \frac{1}{2k}\int \mathrm{d}^4x\sqrt{-g}f(\mathcal{R}) - \frac{1}{2}\int \mathrm{d}^4x\sqrt{-g}\mathcal{P}(X,\Phi), \tag{1}$$

where the first term correspond to a generalization of the Einstein-Hilbert action, by replacing the functional with an arbitrary function of the Ricci scalar, and the second term stands for the matter sector defined as

$$\mathcal{P} = X - 2V(\Phi), \tag{2}$$

where $X = g^{\alpha\beta}\partial_\alpha\Phi\partial_\beta\Phi$ and $V(\Phi) = -\frac{1}{2}\mu^2\Phi\Phi$, with μ as the mass of the complex scalar field. The field equations are obtained through varying the action with respect to the inverse metric tensor $g^{\mu\nu}$ and the affine connection $\Gamma^{\alpha}{}_{\beta\gamma}$ respectively

3 Numerical analysis

4 Final remarks