

A GEOMETRIC STUDY OF $f(r)$ -GRAVITY SPACETIMES THROUGH PROJECTIVE CURVATURE TENSOR

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(Received: Apr. 07, 2025 Accepted: Mar. 27, 2026 Published: Apr. 30, 2026)

Abstract: This research investigates spacetime with projective curvature tensor in $f(r)$ gravity. It explores projectively flat and projectively flat perfect fluid spacetime, determining isotropic pressure (p) and energy density (σ). The study extends to energy conditions and reveals that spacetimes with divergence-free projective curvature tensor may represent a dark energy dominated era or have constant isotropic pressure and energy density, especially when the energy-momentum tensor is recurrent or bi-recurrent.

Keywords and Phrases: Spacetime, Perfect Fluid Spacetime, $f(r)$ -Gravity, Projective Curvature Tensor, Energy-momentum tensor.

2020 Mathematics Subject Classification: 53A20, 53C25, 53C50, 83C05, 83C15.

1. Introduction

Projective geometry and projective transformations have deep roots in mathematics, particularly in the field of geometry. Projective geometry originated in the early 19th century, with influential contributions from mathematicians like Jean-Victor Poncelet and August Ferdinand Möbius.

In the context of differential geometry, projective transformations play a significant role in understanding the geometry of curves and surfaces. Differential