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Advancements in Computer Algebra for General Relativity Simulations

Ramesh Kumar Dontukurthi[1] and Dr. Gautam Kr Rajput[2]
Research Scholar, Department of Mathematics[1]
Associate Professor, Department of Mathematics[2]
Sunrise University, Alwar, Rajasthan, India

Abstract: *Computer algebra in general relativity plays a crucial role in solving complex mathematical problems associated with Einstein's field equations and other geometrical formulations. General relativity, which describes the gravitational interaction as the curvature of spacetime, often involves highly non-linear differential equations that are difficult to solve analytically. Computer algebra systems (CAS) such as Mathematica, Maple, and GRtensor, are employed to perform symbolic computations like tensor manipulations, solving geodesic equations, and evaluating curvature invariants. These systems enable efficient exploration of exact solutions, automated derivations of spacetime properties, and the study of gravitational waves and black hole dynamics. By automating algebraic processes, computer algebra significantly advances research in theoretical and applied aspects of general relativity, facilitating deeper understanding and exploration of relativistic phenomena*

Keywords: computer algebra; gravitation; relativity