

Effects of the Cosmological Constant on Energy and Angular Momentum of a Particle Moving in a Circle with Respect to the Schwarzschild - de Sitter Metric in Comparison with the Schwarzschild Metric

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Considering the Schwarzschild - de Sitter space-time, many authors have explored a range of cosmological events and effects. But, the effects of the cosmological constant (Λ) on energy and angular momentum in the Schwarzschild – de Sitter space-time are not studied in depth in comparison to the Schwarzschild space-time.

In this study, we obtain the expressions for total energy per unit rest mass (E') and for angular momentum per unit rest mass (h') not only in the Schwarzschild - de Sitter space-time but also in the Schwarzschild space-time considering a particle moving in a circular path. Then, we discuss the conditions for the possibility of circular orbits. Finally, we plot the graphs for E' and for h' against the coordinate radius of the circle for different low and high values of the central mass (M) for positive and negative cosmological constants for the Schwarzschild - de Sitter space-time in comparison with the Schwarzschild space-time. Also, we plot the graphs for $M = 0$ when Λ is negative.

Considering the plotted graphs, we conclude that the effects introduced by the cosmological constant on E' and h' are negligible with the present value of the cosmological constant. But, for higher cosmological constant values, the effects on E' and h' are known to be significant. However, Λ affects E' and h' indeed when a particle moves in a circle.

According to this study, positive Λ creates a repulsive field and when it is negative it creates an attractive field. Accordingly, in the nonappearance of a central mass there is no possibility of circular motion when Λ is positive as a repulsive field would not give rise to circular motion. In the case of the Schwarzschild - de Sitter space-time E' and h' for a particle moving in a circle are less (greater) than that in the case of the Schwarzschild space-time when Λ is positive (negative).

Key words: Schwarzschild - de Sitter space-time, Schwarzschild space-time, Cosmological constant

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