Abstract

The infinities or singularities (points of spacetime where the curvature blows up) are considered as serious problems in physics. Classical general relativity predicts spacetime singularities. This theory does not give an enough description of the behavior of the spacetime in the high curvature regions. On the other hand, in quantum field theory there are other kinds of singularities coming from the non-renormalizability of this theory. Moreover, there are several problems in cosmology such as the horizon and flatness problem.

All these considerations point in the direction of the Limiting Curvature Hypothesis (LCH). This hypothesis provides natural solutions to gravitational singularities and introduces a more realistic cosmological model. According to this hypothesis, the curvature of spacetime at any point can never be larger that certain limiting value.

In order to implement this hypothesis, we must modify the general relativity by introducing a limiting value for the curvature; this can be done by modifying Einstein's field equations:

$$R^{\mu\nu} - \frac{1}{2} R g^{\mu\nu} = -8\pi G T^{\mu\nu}$$

By inserting a cosmological constant Λ, which is the limiting value of curvature, the modified field equations are:

$$R^{\mu\nu} - \frac{1}{2}Rg^{\mu\nu} - \frac{1}{4}\Lambda(1 - \sqrt{1 - \frac{R^2}{\Lambda^2}})g^{\mu\nu} = -8\pi GT^{\mu\nu}$$

At low curvatures, when *R* is very small, the new equations are reduced to Einstein's field equations.

In chapter 2, we introduced the modified field equations which satisfy LCH and found first and second order differential equations from the time-time and space-space components of the field equations for both matter and radiation universes and for different kinds of geometries of spacetime, we also obtained nonsingular spherically symmetric solution that represent a giant star when it collapses to form a black hole. In chapter 3, we solved the differential equations numerically and found nonsingular solutions and we plotted these solutions.