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New Paradigms in the Study of Cosmic Singularity

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***Abstract*: Cosmic Singularity was that the point in spacetime where density, temperature, matter and curvature were concentrated down to one infinitely tiny point. All the known laws of physics and spacetime break down at this point since the quantities become infinite at singularity. This paper focuses on the new paradigms in the study of Cosmic Singularity and gives an overview of the topic as a whole.**

***Keywords*: Astrophysics, Cosmic science, Cosmic singularity, Singularity.**

1. Introduction

Since the theory of relativity proved the theoretical existence of black holes in our universe, cosmologists have wondered as to what could exist at the center of the black holes. An even older question has been what existed before the universe itself i.e. whether the big bang was the true beginning of the universe or was there something before it.

Both of these questions lead to the same answer, the theoretical existence of cosmic singularity.

Gravitational Singularity or cosmic singularity is that point in spacetime where the mass and gravitational field of a celestial body become infinite by general relativity. All the quantities such as temperature, density, matter and curvature can be concentrated at this infinitely small point. Since these quantities become infinite at singularity, the laws of normal physics and spacetime break down.

2. Origin of the Theory of Singularity

The discovery of the Theory of Relativity led to the theoretical existence of black holes which in turn led to the prediction of singularity for the first time.

It speculated that once a certain point in mass is reached by a star, such an intense gravitational force would be exerted that the star would collapse to form a black hole since nothing would be able to escape its surface. According to general relativity, any object would form a black hole once it reaches a certain point and at the center of that black hole, singularity would be formed.

Another notable mention is the Penrose-Hawking singularity theorem. It defines a singularity to have geodesics that cannot be extended in a smooth manner. The termination of such a geodesic is considered to be the singularity. Through this theorem, they aimed to explain how gravitation could produce singularity. Stephen Hawking traced the same back to Big Bang to explain what existed before the existence of the universe itself.

3. The Big Bang Theory and Singularity

It is a general opinion that the universe came from nothing at all and that there was nothing before the Big Bang but what exactly is nothing at all?

The answer depends on how we understand the Big Bang. If we reverse the direction of our vision and look back in time, we discover that the universe reaches a state of compression where gravitational force and density are infinite. This unique singularity is the beginning of the universe- matter, energy, space, time and all physical laws. Modern theories predict that the initial state of the universe, even before the Big Bang, was singularity.

Now the question that arises is that: when the mass reaches beyond a certain point, it would collapse and form a black hole, so why didn't the universe collapse to form a black hole at the time of the Big Bang when all the mass, temperature, density, curvature and other quantities were concentrated at an infinitely small point? The answer can be divided into two parts. Firstly, the density limits for gravitational collapse currently apply only to objects with relatively fixed mass and thus they do not necessarily apply to rapidly expanding space such as the Big Bang. Secondly, quantum mechanics does not permit particles to inhabit a space smaller than their wavelengths.

4. Interpretation and Contradictions

Numerous hypotheses in material science have numerical singularities of one kind or another. Equations for these physical hypotheses anticipate that the ball of mass of some quantity gets to be infinite or increments without constraint. This is generally a sign for a missing piece within the hypothesis, as seen in the ultraviolet catastrophe, renormalization, and instability of a hydrogen atom anticipated by the Larmor Formula. Some theories, such as the loop quantum gravity, propose that singularities may not exist. This can be also true for classical unified theories as the Einstein-Maxwell-Dirac equations. The thought can be stated as: due to quantum gravity effects, there's a least distance beyond which

the force of gravity no longer proceeds to increase as the distance between the masses gets shorter, or alternatively that interpenetrating particle waves cover gravitational effects that would be felt at a distance.

5. Existence of Singularities

Solutions to the equations of general relativity or another hypothesis of gravity frequently result in encountering points where the metric increases to infinity. Be that as it may, numerous points are totally normal, and the infinities are simply a result of utilizing an inappropriate coordinate system. In order to test whether there's a singularity at a certain point, one must check whether at this point diffeomorphism quantities become infinite. Such quantities are the same in each coordinate system, so these amounts will not "go away" by altering the coordinates. In coordinate systems, helpful for working in regions distant from the black hole, a portion of the metric gets to be infinite at the event horizon. In any case, spacetime at the event horizon is standard. The consistency gets to be apparent when changing to another coordinate system, where the metric is smooth. On the other hand, within the center of the black hole, where the metric gets to be infinite as well, the solutions propose a singularity exists.

6. Conclusion

In this paper, we covered various aspects of the theory of cosmic singularity such as its origin, the relation between the Big Bang and cosmic singularity, its interpretations and contradictions, and the hypothesis of the existence of spacetime singularity. The study of the said topic has been progressing rapidly for the past decade. Overall this paper discusses the new paradigms in the study of cosmic singularity.

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