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Commentary

Mechanism of Relativity Theory of Black Holes in Thermodynamics

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DESCRIPTION

The relativity's theory of black holes was discussed over the past 30 years has showed significant cues that gravitation, thermodynamics, and quantum theory have a very deep and fundamental connection. Black hole thermodynamics is the basis of this connection because it appears that some laws of black hole mechanics are actually just the regular laws of thermodynamics applied to a system containing a black hole. Indeed, the majority of our current physical insights into the nature of quantum phenomena occurring in strong gravitational fields have about their roots in the finding of the thermodynamic behaviour of black holes, which was primarily accomplished by classical and semi classical analyses. The physical temperature of black holes is zero, making them ideal absorbers with no emissions. In contrary, black holes in quantum theory produce Hawking radiation with a flawless thermal range. As a result, it is possible to understand the laws of black hole mechanics as physically correlating to the standard laws of thermodynamics. Black holes emit a thermal radiation known as Hawking radiation, which may be demonstrated using quantum field theory in curved space-time. The surface gravity of Hawking radiation is inversely proportional to its temperature. The entropy of black holes generally scales with the size of the horizon. The holographic principle was developed as a result of the entropy's scaling feature.

This analysis is a semi-classical representation since it is based on quantum field theory in curved space-time. Thus, it is expected that quantum gravitational corrections would rectify the black hole thermodynamics. Moreover, it has been clearly proven that quantum gravitational corrections will alter the relationship between entropy and the area of a black hole. As a result, these quantum modifications to the structure of space-time can cause thermal fluctuations in black hole thermodynamics. However, because these correction factors are functions of area rather than volume, they may still be analyzed using the holographic principle. Indeed, because AdS/CFT is a physical manifestation of the holographic principle, it has been utilized to generate quantum gravitational corrections to a black hole's entropy. To acquire adjustments to the black hole thermodynamics, multiple techniques to quantum gravity can be used. One could identify a quantity associated with black holes, namely A/4 in general relativity, as acting as the mathematical representation of entropy using the classical laws of black hole mechanics and the formula for the temperature of Hawking radiation. Strong proof that this quantity actually represents the physical entropy of a black hole can be found in the GSL's apparent validity.

Finding an explanation for and direct derivation of the equation for the entropy of a black hole is a key objective of quantum gravity study. Although we have learned a lot about black hole thermodynamics, there are still a lot of crucial questions that need to be answered. The "Black Hole Information Conundrum" and problems with the degrees of freedom responsible for a black hole's entropy are foremost among these.

Applications of thermodynamics in black hole

- In AdS spacetime, a quantum corrected Schwarzschild black hole is introduced.
- There is a divergence term in the Euclidean action due to quantum fluctuation, which contributes to the energy of spacetime.
- When we reduce the influence of quantum fluctuations, we get a lower free energy and thermodynamic quantity.
- Using quantum fluctuation, we discover that the area entropy theorem is a result of both quantum fluctuations and black holes.
- The Generalized Second Law (GSL) establishes a clear connection between the fundamental laws of thermodynamics and the laws governing black holes the GSL's proponents' reasoning.
- This part also includes a discussion of entropy bounds.

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