



[original idea]

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The tipping point of temperature during black hole formation

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Abstract

We explore the tipping point in the temperature during black hole formation of an ideal gas in a *gedankenexperiment*.

keywords: black hole temperature, quantum thermodynamics, quantum gravity

Burning spacetime

1. Suppose a *gedankenexperiment* in which an ideal gas star has sufficient mass to turn into a black hole.
2. The ideal gas follows the equation of state $PV = NkT$.
3. P = pressure; V = volume; N = number of particles in the gas; k = Boltzmann's constant; T = absolute temperature.
4. Let's consider two stages, A and B .

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5. A is the collapsing stage.
6. B is the stage where the “hole” (void of spacetime) is expanding in the context of [1–3].

Stage A

7. The volume of the star *decreases*.
8. The pressure *increases*.
9. Consider that the pressure increase surpasses the volume decrease such that $PV > 0$.
10. Since $PV > 0$, $T > 0$, i.e., T *increases*.

The tipping point

11. In (10), T reaches the Planck temperature.
12. Suppose that the Planck temperature is the *maximum temperature allowed in spacetime*.
13. Suppose that at this *extreme situation*, **spacetime tears apart** [1–3].

Stage B

14. The volume of the “star” (*hollow sphere*) *increases*.
15. At this stage, *volume* means the portion of the “star” embedded in space; in other words, the hole (void of spacetime) does not account for the volume.
16. The pressure *decreases*.
17. Consider that (14) and (16) are such that $PV < 0$.

18. From (17), $T < 0$, i.e., T decreases.

Notes

19. The temperature of a black hole is proportional to the inverse of its mass [4].

20. Energy and mass are related by $E = Mc^2$.

21. Energy and temperature, in an ideal gas, are related by $E \propto kT$.

22. *In summary, during contraction of the star, the temperature raises; during the expansion of the “hollow sphere”, the temperature diminishes.*

Final Remarks

23. The Planck temperature tears spacetime apart, and as a result, during the black hole formation, its temperature decreases.

Open Invitation

*Review, add content, and **co-author** this paper [5, 6]. Join the **Open Physics Collaboration**. Send your contribution to mplobo@uft.edu.br.*

Ethical conduct of research

This original work was pre-registered under the OSF Preprints [7], please cite it accordingly [8]. This will ensure that researches are conducted with integrity and intellectual honesty at all times and by all means.

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