[original insight]

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Pauli's exclusion principle during gravitational collapse

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Abstract

We propose a discussion of Pauli's Principle of Exclusion during the gravitational collapse of a star in terms of its temperature.

keywords: Pauli's exclusion principle, gravitation collapse and energy condition

Introduction

1. What happens to the particles that obey Pauli's principle of exclusion during the gravitational collapse of a star from an energy standpoint?

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2. Considering the gravitational collapse of a star, we conjecture a possible consequence of the increase in its volumetric density as the temperature decreases, overcoming the pressure of degeneration attributed to the fermionic particles described by Pauli's exclusion principle.

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3. Fermions (electrons, protons, and neutrons) are subject to the Pauli's exclusion principle (PEP).
4. The PEP controls the collapse of a star due to the pressure of degeneracy, where atoms are prevented from collapsing over each other [1].
5. As a result of PEP, two spin-1/2 fermions cannot simultaneously have the same quantum numbers [2, 3].
6. The occupation number of fermions determined by PEP dictates that two identical fermions cannot simultaneously occupy the same quantum state, so if a fermionic particle has spin $m_s = +1/2$, the other will have $m_s = -1/2$ [2].
7. The equation describing the occupation number for the fermions depends on the exponential of the inverse of the temperature,

$$\eta(E) = \frac{g(E)}{e^{\alpha + \frac{E}{k_B T}} + 1},$$

where $\eta(E)$ is the energy density of the particles, $g(E)$ is the number of configurations with energy E by cubic centimeter, α is the factor of degeneration, which depends on the particles density, E is the energy of the particle, k_B is the Boltzmann constant, and T is the absolute temperature [2–4].

8. For low densities, $\alpha \gg 0$, and for very high densities, $\alpha \ll 0$ [4].
9. The volumetric density of a fluid (ρ) increases as its temperature decreases.
10. Suppose that during the collapse of a star, the factor of degeneration α decreases with the increase of the density ρ due to the decrease of the temperature T [1, 2, 4].
11. In a star capable of generating a black hole, the gravitational force during the gravitational collapse makes the density of the star much

higher than the pressure of degeneracy, generating a rupture in space-time [5–7].

12. As a consequence, fermions in the black hole are brought to a “new state.”

Final Remarks

13. A “new state of matter” would probably mean a superposition of fermions and bosons.
14. More discussions about the surprising consequence of the so called *hollow black hole* can be found here [8–12].

Open Invitation

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Ethical conduct of research

This original work was pre-registered under the OSF Preprints [13], please cite it accordingly [14]. This will ensure that researches are conducted with integrity and intellectual honesty at all times and by all means.

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