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Comment on "Quantum-Mechanical Suppression of Gas Accretion by Primordial Black Holes"

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Abstract

It was recently claimed (https://arxiv.org/pdf/2409.09081) that accretion of ordinary matter on black holes of mass $(6 \times 10^{14} - 4 \times 10^{19})\,\mathrm{g}$ would be inhibited by quantum mechanical effects, namely the de Broglie wavelength of the electron being larger than the Schwarzschild radius. However the conclusion is based on considering accretion of a single atom over the age of the Universe. There is no suppression of the accretion rate per atom on such black holes.

Loeb (2024) recently argued that primordial black holes (PBHs) in the mass range $10^{14} - 10^{19}\,\mathrm{g}$ cannot accrete ordinary matter, because their Schwarzschild radius is too small to capture an electron fast enough, its wave function extending over a much larger region. The nucleus on the other hand has a much smaller wavelength and can be absorbed by a black hole in the usual classical picture.

Loeb (2024) estimates that the electron would take an additional $\tau = 10^{-11}\,\mathrm{s}$ to be captured, following the atomic nucleus, due the quantum mechanical suppression. Therefore the maximum rate of absorption of an atom by a black hole is $m_n/\tau \sim 10^{-13}\,\mathrm{g/s}$, where m_n is the mass of the nucleus (taken to be a proton). This is of course a negligible rate, since it involves only a single proton. However the author claims on this basis that conventional hydrodynamic treatments of accretion are invalid. Clearly, a time delay of $10^{-11}\,\mathrm{s}$ in the process of absorption of an atom cannot invalidate a classical description of fluid absorption, so this argument makes no sense.

REFERENCES

Loeb, A. 2024.
https://arxiv.org/abs/2409.09081

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