



Department of
Theoretical Physics

THE QUANTUM SPACETIME SEMINAR SERIES

The ghost in the radiation: Robust encodings of the black hole interior
(Zoom Seminar)

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Zoom link shall be shared separately



We reconsider the black hole firewall puzzle, emphasizing that quantum error-correction, computational complexity, and pseudorandomness are crucial concepts for understanding the black hole interior. We assume that the Hawking radiation emitted by an old black hole is pseudorandom, meaning that it cannot be distinguished from a perfectly thermal state by any efficient quantum computation acting on the radiation alone. We then infer the existence of a subspace of the radiation system which we interpret as an encoding of the black hole interior. This encoded interior is entangled with the late outgoing Hawking quanta emitted by the old black hole, and is inaccessible to computationally bounded observers who are outside the black hole. Specifically, efficient operations acting on the radiation, those with quantum computational complexity polynomial in the entropy of the remaining black hole, commute with a complete set of logical operators acting on the encoded interior, up to corrections which are exponentially small in the entropy. Thus, under our pseudorandomness assumption, the black hole interior is well protected from exterior observers as long as the remaining black hole is macroscopic. On the other hand, if the radiation is not pseudorandom, an exterior observer may be able to create a firewall by applying a polynomial-time quantum computation to the radiation.

This talk is based on [arXiv:2003.05451](https://arxiv.org/abs/2003.05451).