ID de Contribution: **119** Type: **Non spécifié**

How special are black holes? Correspondence with objects saturating unitarity bounds in generic theories

Black holes are considered exceptional due to their time evolution and information processing. However, these properties are generic for objects, the so-called saturons, that attain the maximal entropy permitted by unitarity. We discuss the correspondence between black holes and saturons within a renormalizable $SU(N)$ invariant theory.

The spectrum contains a tower of bubbles representing bound states of $SU(N)$ Goldstones. We argue that a saturated bound state exhibits a striking resemblance with a black hole despite the absence of gravity. The Bekenstein-Hawking formula gives the saturon entropy. Semiclassically, saturons possess an information horizon. They evaporate at a thermal rate with a temperature proportional to their inverse radius. The information retrieval time is equal to Page's time. Additionally, we examine the memory burden effect, which states that the quantum information contained within a system stabilizes it. We discuss the fundamental and observational implications of the black hole–saturon correspondence.

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Classification de Session: Parallel session 4

Classification de thématique: HEP-TH