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Insights on Black Hole Stability from Light Towers

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We revisit and study quantum corrections to the supersymmetric entropy of BPS black holes in 4d N=2 supergravity, which can be obtained from Type IIA string theory compactified on a Calabi–Yau threefold. Macroscopically, these corrections arise from an infinite series of higher-derivative F-terms that encode modifications to the two-derivative supergravity effective action. They result from integrating out the tower of light D0-branes in the large volume patch. We analyze the most general black hole configuration with D0–D2–D4–D6 charges and find that this setup can receive non-perturbative corrections. We interpret these corrections as arising from virtual particle pair production. We characterize the quantum effects by providing both a semi-classical description and a precise one-loop evaluation. We show that, despite the presence of non-trivial corrections, the stability of the system remains intact. As a byproduct, we uncover a correspondence among virtual pair production of the states in the lightest UV tower, classical confinement in the black hole throat and non-perturbative corrections to the Wald entropy.

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