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Quantum-corrected ultraextremal horizons

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The distinguished role of extremal horizons is beyond any doubts. It is sufficient to mention briefly such issues as black hole entropy, the scenarios of evaporation including the nature of remnants, etc. Meanwhile, although such object appear naturally on the pure classical level (the famous examples is the Reissner-Nordstrom black hole with the mass equal to charge), the question of their existence becomes non-trivial in the semiclassical case, when backreaction of quantum fields (whatever weak it be) is taken into account. This is due to the fact that the quantum-corrected metric contains some combinations of the stress-energy tensor having the meaning of the energy measured by a free-falling observer that potentially may diverge near the extremal horizon. However, numerical calculations showed that such divergencies do not occur for massless fields in the Reissner-Nordstrom background [1]. Analytical studies for massive quantized fields [2] gave the same result. Then they have been extended to so called ultraextremal horizons [3] when the metric coefficient $-g_{tt} \sim (r_+ - r)^3$ near the horizon (here r is the Schwarzschild-like coordinate, $r = r_+$ corresponds to the horizon). Such horizons are encountered, for example, in the Reissner-Nordstrom-de Sitter solution, when the cosmological constant $\Lambda > 0$ [4]. In doing so, it turns out that the horizon is of cosmological nature, so r approach r_+ from $r < r_+$.

The results for ultraextremal horizons are obtained in [3] for massive fields only. We examine backreaction of the quantized scalar field with an arbitrary mass and curvature coupling on ultraextremal horizons. We examine the behavior of the stress-energy tensor of the quantized field near r_+ and show that, under influence of the quantum backreaction, the horizon of such a kind moves to a new position near which the metric does not change its asymptotics, so the ultraextremal black holes and cosmological spacetimes do exist as self-consistent solutions of the semiclassical field equations. In the limit of the large mass our results agree with previous ones known in literature.

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