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Cosmic no-hair in spherically symmetric black hole spacetimes

We analyze in detail the geometry and dynamics of the cosmological region arising in spherically symmetric black hole solutions of the Einstein-Maxwell-scalar field system with a positive cosmological constant. More precisely, we solve, for such a system, a characteristic initial value problem with data emulating a dynamic cosmological horizon. Our assumptions are fairly weak, in that we only assume that the data approaches that of a subextremal Reissner-Nordström-de Sitter black hole, without imposing any rate of decay. We then show that the radius (of symmetry) blows up along any null ray parallel to the cosmological horizon, in such a way that $r = +\infty$ is, in an appropriate sense, a spacelike hypersurface. We also prove a version of the Cosmic No-Hair Conjecture by showing that in the past of any causal curve reaching infinity both the metric and the Riemann curvature tensor asymptote those of a de Sitter spacetime. Finally, we discuss conditions under which all the previous results can be globalized.