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Exotic (Smooth) Black Holes: Exotic Smoothness and Black Holes

Abstract

The differential or smoothness structure of a topological manifold (if it exists) is non-unique. In all dimensions except 4 there are only a finite number of different (i.e. non-diffeomorphic) smoothness structures. But dimension 4 is exceptional. Here there are an infinite number of different smoothness structures, countably infinite for most compact and uncountably many for many non-compact 4-manifolds. This may be physically important since in the Kruskal presentation of black hole solutions we only have direct physical information in our local coordinates outside the horizons. We discuss implications of going beyond the standard smooth extension globally to the topological $R^2 \cdot S^2$ Kruskal space. At the curvature singularity, two metric components vanish which can be interpreted as a dimensional reduction from 4D to 2D. We will support this result by a geometrical interpretation using hyperbolic manifolds.