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Comparison geometry and spacetime harmonic functions

Comparison theorems are the basis for our geometric understanding of Riemannian manifolds satisfying a given curvature condition. A remarkable example is the Gromov-Lawson toric band inequality, which bounds the distance between the two sides of a Riemannian torus-cross-interval with positive scalar curvature by a sharp constant inversely proportional to the scalar curvature's minimum. We will give a new qualitative version of this and similar band-type inequalities in dimension 3 using the notion of spacetime harmonic functions, which recently played the lead role in our recent proof of the positive mass theorem. Other applications include new versions of Bonnet-Meyer's diameter theorem and Llarull's theorem which do not require a completeness assumption. This is joint work with Sven Hirsch, Marcus Khuri, and Yiyue Zhang.