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The Regularity Singularity at Points of GR-Shock Wave Collision and the Question of its Physical Implication

In this talk I am going to present the results of a recent paper (M.R. and B. Temple, Proc. R. Soc. A, 2012, vol. 468 no. 2146, 2962-2980), in which it is shown that the regularity of the gravitational metric tensor cannot be lifted from Lipschitz continuity to $C^{1,1}$ by any $C^{1,1}$ coordinate transformation in a neighborhood of a point of shock wave interaction in General Relativity. This is in contrast to Israel's celebrated 1966 Theorem, which states that such coordinate transformations always exist in a neighborhood of a point on a smooth single shock surface. The results imply that points of shock wave interaction represent a new kind of singularity in spacetime, singularities that make perfectly good sense physically, that can form from the evolution of smooth initial data, but at which spacetime is not locally Minkowskian under any coordinate transformation. In particular, at such singularities, delta function sources in the second derivatives of the gravitational metric tensor exist in all coordinate systems, but due to cancellations, the Riemann curvature tensor remains uniformly bounded. (We currently work on the question whether Regularity Singularities cause detectable physical effects.)