Points of General Relativistic Shock Wave Interaction are "Regularity Singularities" where Spacetime is Not Locally Flat

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In this talk I am going to present the results of a recent paper [2], in which we show that the regularity of the gravitational metric tensor cannot be lifted from $C^{0,1}$ to $C^{1,1}$ by any $C^{1,1}$ coordinate transformation in a neighborhood of a point of shock wave interaction in General Relativity, without forcing the determinant of the metric tensor to vanish at the point of interaction. 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 [1]. 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 cancelation, the Riemann curvature tensor remains uniformly bounded.

References

[1] W. Israel, Singular hypersurfaces and thin shells in general relativity, *Il Nuovo Cimento*, **Volume XLIV B no. 1** (1966), pp. 1-14.

[2] M. Reintjes and B. Temple, Points of General Relativistic Shock Wave Interaction are "Regularity Singularities" where Spacetime is Not Locally Flat, *Proc. R. Soc. A* (accepted), arXiv:1105.0798.

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