

# Do General Relativistic Shock Wave Interactions Create Regularity Singularities in Spacetime?

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## Abstract:

It is an open question whether shock wave solutions of the Einstein Euler equations contain “regularity singularities”, i.e., points where the spacetime metric would be no smoother than Lipschitz ( $C^{0,1}$ ) in any coordinate system so that locally inertial frames fail to exist. As shown in Israel’s 1966 paper, a metric  $C^{0,1}$  across a *single* shock surface can be smoothed to the  $C^{1,1}$  regularity sufficient for locally inertial frames to exist, by a coordinate transformation, but the method of proof fails for shock wave interactions. In the first paper addressing shock wave interactions [1, 3], we construct a coordinate transformation that smooths  $C^{0,1}$  metrics to  $C^{1,1}$  in spherical symmetry. Thus regularity singularities are ruled out in these basic cases, but, whether such singularities exist in more complicated shock wave solutions of the Einstein equations generated by Glimm’s method remains an *open problem*.

## References

- [1] M. Reintjes and B. Temple, *No Regularity Singularities Exist at Points of General Relativistic Shock Wave Interaction between Shocks from Different Characteristic Families*, Proc. R. Soc. A **471**:20140834. arXiv:1610.02390
- [2] M. Reintjes and B. Temple, *Shock Wave Interactions in General Relativity: The Geometry behind Metric Smoothing and the Existence of Locally Inertial Frames*, (2016), 34 pages, arXiv:1610.02390.
- [3] M. Reintjes, *Spacetime is Locally Inertial at Points of General Relativistic Shock Wave Interaction between Shocks from Different Characteristic Families*, (2014), arXiv:1409.5060.

- [4] M. Reintjes and B. Temple, *Regularity Singularities and the Scattering of Gravity Waves in Approximate Locally Inertial Frames*, to appear: Meth. Appl. Analysis. arXiv:1506.04074.