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Unexpectedly exciting axisymmetric apparent horizons

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In numerical relativity, marginally outer trapped surfaces (MOTSs) (often referred to as apparent horizons) are the main tool to locate and characterize black holes. For five decades it has been known that during a binary merger, the initial apparent horizons of the individual holes disappear inside a new joint MOTS that forms around them once they are sufficiently close together. However the ultimate fate of those initial horizons has remained a subject of speculation. In this talk I will introduce new mathematical tools that can be used to locate and understand axisymmetric MOTS. In particular I will show that the MOTS equations can be rewritten as a pair of coupled second order equations that are closely related to geodesic equations and hence dubbed the MOTSodesic equations. Numerically, these are very easily solved and in the linked talks by KTB Chan, R Hennigar and S Muth they will be used to identify and study rich families of previously unknown MOTS in a variety of black hole spacetimes, including both exact solutions and binary merger simulations. I will also show that the MOTS stability operator bears the same relation to MOTSodesics as the Jacobi deviation operator does to geodesics and consider the implications.

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