

## **Black Hole Mergers and their Non-Smooth Event Horizons**

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*Abstract:* Stationary black hole solutions, like the Kerr metric, have smooth event horizons, in the sense that they are infinitely continuously differentiable hypersurfaces embedded in the spacetime. However, this no longer holds when stationarity is broken. We describe the different ways that event horizons can be non-smooth; these come in two broad classes: caustic and non-caustic features. Focusing on those which occur generically, we can further refine each of these classes to give a classification of non-smooth structures on event horizons in four dimensions. We also discuss how these structures evolve in time. We will then study three examples of dynamical event horizons, and examine their non-smoothness. Firstly, we will briefly introduce the merger of two Schwarzschild black holes in the infinite-mass-ratio limit, as first studied by Emparan and Martínez. Then, we will study the merger of a black hole with a cosmological horizon, and will argue that we retrieve the first example as the cosmological constant is sent to zero. Finally, we will briefly comment on the merger of two Kerr black holes.