

# Simplicity and Universality in Binary Black Hole mergers: from Caustics-Diffraction to Integrability

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The waveform of a binary black hole (BBH) coalescence appears to be both simple and universal. A natural question to ask is the following: is the BBH waveform “boring” or, rather, “elegant”? This talk is structured in two parts, a first one with a decidedly heuristic (and admittedly boldly ambitious) flavor and a second part in which ideas of the first part are cast in a more modest (but still ambitious) setting. Specifically, the first part presents a hierarchical research program aiming at probing such simplicity and universality of BBH dynamics. Adopting a (bottom-up) “asymptotic-reasoning” approach, we define different layers for the treatment of the problem, starting by modeling the BBH merger waveform in terms of the Airy function realised as the universal diffraction pattern on a fold-caustic and, passing through the Painlevé-II transcendent as a non-linear generalisation of Airy, proposing a “wave-mean flow” description of the dynamics with an effective separation of “fast and slow” degrees of freedom, the latter described by an integrable system. This scheme implements a view of the BBH waveform as ‘elegant’, potentially providing a probe into the fundamental structure of a (self-dual) sector of the gravitational theory. The second part of the talk starts exploring these ideas by casting such “fast/slow” gravitational dynamics in the setting of a hyperboloidal approach to (linear) scattering on black holes: ‘slow’ degrees of freedom are frozen and encoded into the background geometry, whereas the scattered field provides the ‘fast’ degrees of freedom. The associated non-selfadjoint infinitesimal generator of the dynamics presents a neat separation into bulk and boundary parts, providing an avenue for the exploration of the symmetries underlying, respectively, slow and fast degrees of freedom, plausibly realised as a semidirect action of bulk symmetries onto the (asymptotic/)boundary symmetries. The talk provides both an invitation to C. Vitell’s talk and an update to recent work by J. Besson on non-modal aspects of the non-selfadjoint (fast) dynamics of the scattered field.

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