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Causality Constraints on Mergers beyond General Relativity

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Gravitational waves emitted during a black-hole merger might differ from what General Relativity predicts due to the presence of yet unknown degrees of freedom coupled to gravity. A simple example is that of a scalar field that produces black hole hair, affecting both the inspiral and ringdown phases of black hole mergers. We can constrain such scenarios from the point of view of fundamental principles: can black holes be altered by a scalar field in an Effective Field Theory (EFT) consistent with causality, unitarity and locality? I will consider the requirement that the EFT produces no measurable time-advances in the propagation of scalar and graviton probes. This forces the scalar-graviton interaction to be much weaker than what would be allowed by perturbative control, sharply narrowing the space of theories that describe testable deviations from General Relativity.

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