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Causality cuts off black hole hair

Gravitational wave detection has motivated the study of effective field theories (EFTs) that describe deviations from General Relativity in the strong-field regime. One example is given by EFTs describing a shift-symmetric scalar field coupled to the graviton, which can lead to black hole hair if specific interactions are considered. We can constrain such interactions from the point of view of fundamental principles: can black holes have sizeable scalar hair in an EFT consistent with causality and unitarity?
I will consider the requirement that the EFT produces no measurable time-advances in the propagation of scalar and graviton probes. This forces the UV cutoff to be very small, to a point that if black hole hair were close to the observational threshold, then new physics would alter the scalar-tensor description already at scales of order km.
Further constraints may arise from unitarity and causality in the form of dispersion relations for S-matrix elements. I will discuss the interplay between these constraints and the requirement of macroscopic causality.

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