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Causality bounds on scalar-tensor EFTs

We compute the causality/positivity bounds on the Wilson coefficients of scalar-tensor effective field theories. Two-sided bounds are obtained by extracting IR information from UV physics via dispersion relations of scattering amplitudes, making use of the full crossing symmetry. The graviton t-channel pole is carefully treated in the numerical optimization, taking into account the constraints with fixed impact parameters. It is shown that the typical sizes of the Wilson coefficients can be estimated by simply inspecting the dispersion relations. We carve out sharp bounds on the leading coefficients, particularly, the scalar-Gauss-Bonnet couplings, and discuss how some bounds vary with the leading $(\partial\phi)^4$ coefficient and as well as phenomenological implications of the causality bounds. Causality bounds on the scalar-tensor effective field theories that include parity-violating operators are also calculated. Some parity-violating coefficients are found to be upper bounded by the parity-conserving counterparts, or the higher order parity-conserving coefficients. While the observational constraints on parity-violating coefficients are weaker than the parity-conserving counterparts, the causality bounds are of comparable strength and thus may play a more prominent role in constraining strong gravity effects in upcoming observations.

Secondary track

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