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Shockwaves and Time Delays in Einstein-Maxwell Effective Field Theory

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We derive the shockwave metric in four-dimensional Einstein–Maxwell effective field theory (EFT) by performing an ultra-relativistic boost of the charged black hole solution accompanied by a rescaling of its mass and charge, including leading order EFT corrections. In contrast to the neutral (Schwarzschild) case, where higher derivative operators leave the shockwave geometry unchanged, we show that electrically charged shockwaves receive non-trivial EFT corrections. We then compute the time delay experienced by a probe photon traversing the resulting charged shockwave. We find that two EFT contributions, the correction to the shockwave geometry and the backreaction induced by the probe photon, are both essential for obtaining a physical time delay that is invariant under field redefinitions of the metric.

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