Classical Resummation and Breakdown of Strong-Field QED

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QED perturbation theory has been conjectured to break down in sufficiently strong backgrounds, obstructing the analysis of strong-field physics. The regime associated with this Ritus-Narozhny ('RN') conjecture includes that of high field strength and low energy, in which we can approximate QED by its classical limit.

We show that the breakdown occurs even in classical electrodynamics. This does not trivialise the RN conjecture – in fact, our results are the first to show that the conjecture applies to non-constant fields without invoking the locally-constant-field approximation. More progress in exploring the RN conjecture is possible in the classical theory than in QED, as we can effectively resume the classical perturbative series to all orders, using LAD or LL equations of motion. We will show that this resummation cures the unphysical behaviour associated with the breakdown of perturbation theory in the considered regime.

Implications for the quantum theory are discussed. We show for a range of observables that unitarity removes diagrams previously believed to be responsible for the breakdown of QED perturbation theory and that what remains after this cancellation requires classical resummation.