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Scalar field theory regularization scheme using weak values

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We propose a theoretical scheme in which a regularized scalar field theory emerges naturally from entangling an otherwise standard scalar field with an ancillary, non-dynamic field. Using suitable initial and final Gaussian states of the two-field system, it is possible to retain the Feynman-diagrammatic expansion of the standard theory with a modified "weak"propagator having a regularized Hadamard function, the ultraviolet behavior of which can be freely tuned through the choice of states. In particular, we discuss a sequence of states whose limiting Hadamard function vanishes, leading to the so-called Wheeler propagator—a quantum realization of the half-advanced/half-retarded potential of Wheeler-Feynman absorber theory. Te Wheeler propagator example provides a simple illustration of how finite self-energies in ϕ^3 and ϕ^4 theories arise from this scheme.

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