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Haag's Theorem and Parameterized Quantum Field Theory EDWIN SEIDEWITZ, Researcher — "Haag's theorem is very inconvenient; it means that the interaction picture exists only if there is no interaction" (Streater and Wightman, 1964). In traditional quantum field theory (QFT), Haag's theorem states that any field unitarily equivalent to a free field must itself be a free field. But the derivation of the Dyson series perturbation expansion relies on the use of the interaction picture, in which the interacting field is unitarily equivalent to the free field, but which must still account for interactions. So, the usual derivation of the scattering matrix in QFT is mathematically ill defined. Nevertheless, perturbative QFT is currently the only practical approach for addressing realistic scattering, and it has been very successful in making empirical predictions. This success can be understood through an alternative derivation of the Dyson series in a covariant formulation of QFT using an invariant, fifth *path parameter* in addition to the usual four position parameters. The parameterization provides an additional degree of freedom that allows Haag's Theorem to be avoided, permitting the consistent use of a form of interaction picture in deriving the Dyson expansion. The extra symmetry so introduced is then broken by the choice of an interacting vacuum.

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