Colosi, Daniele; **Dohse, Max**

The S-matrix in Schrödinger representation for curved spacetimes in general boundary quantum field theory. (English) Zbl 1360.83022

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Summary: We use the General Boundary Formulation (GBF) of Quantum Field Theory to compute the S-matrix for a general interacting scalar field in a wide class of curved spacetimes. As a by-product we obtain the general expression of the Feynman propagator for the scalar field, defined in the following three types of spacetime regions. First, there are the familiar interval regions (e.g. a time interval times all of space). Second, we consider the rod hypercylinder regions (all of time times a solid ball in space). Third, the tube hypercylinders (all of time times a solid shell in space) are related to interval regions, and result from removing a smaller rod from a concentric larger one. Using the Schrödinger representation for the quantum states combined with Feynman's path integral quantization, we obtain the S-matrix as the asymptotic limit of the GBF amplitude associated with finite interval, and rod regions. For interval regions, whose boundary consists of two Cauchy surfaces, the asymptotic GBF-amplitude becomes the standard S-matrix. Our work generalizes previous results (obtained in Minkowski, Rindler, de Sitter, and Anti de Sitter spacetimes) to a wide class of curved spacetimes.

MSC:

83C47 Methods of quantum field theory in general relativity and gravitational theory
83C05 Einstein's equations (general structure, canonical formalism, Cauchy problems)
81T20 Quantum field theory on curved space or space-time backgrounds
81S40 Path integrals in quantum mechanics

Keywords:

S-matrix; curved spacetime; Schrödinger representation; general boundary formulation; Feynman propagator; Feynman's path integral quantization; Cauchy surfaces

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