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Relation between the Resonance and the Scattering Matrix in the massless Spin-Boson Model

We establish the precise relation between the integral kernel of the scattering matrix and the resonance in the massless Spin-Boson model which describes the interaction of a two-level quantum system with a second-quantized scalar field. For this purpose, we derive an explicit formula for the two-body scattering matrix. We impose an ultraviolet cut-off and assume a slightly less singular behavior of the boson form factor of the relativistic scalar field but no infrared cut-off. The purpose of this work is to bring together scattering and resonance theory and it is inspired by a similar result as provided by B. Simon (published in the Annals of Mathematics, 1973), where it was shown that the singularities of the meromorphic continuation of the integral kernel of the scattering matrix are located precisely at the resonance energies. The corresponding problem has been open in quantum field theory ever since. To the best of our knowledge, the presented formula provides the first rigorous connection between resonance and scattering theory in the sense of Simon's result in a model of quantum field theory.