The 38th International Symposium on Lattice Field Theory

LATTICE 21

JULY 26-30 2021, ZOOM/GATHER@MIT

Contribution ID: **20** Type: **Oral presentation**

On the three-particle analog of the Lellouch-Lüscher formula

Friday, 30 July 2021 06:30 (15 minutes)

Back in 2000, Lellouch and Lüscher derived a formula, relating the matrix element of the weak $K \to 2\pi$ decay in a finite volume to its infinite-volume counterpart. In contrast, albeit latest theoretical developments enable the extraction of three-body scattering amplitudes on the lattice, a three-particle analog of the Lellouch-Lüscher equation has not been available until very recently. In this talk, we report on the first attempt to close this gap.

The interest in the study of three-body decays on the lattice is large. While the most obvious candidates for such a study are provided by the three-pion decays of low-mass light-flavored mesons, like the weak process $K \to 3\pi$, also the candidates for exotica, $X(3872)$ and $X(4260)$, decay largely into three-particle final states as well. Moreover, the proper treatment of the three-particle decay channel of the Roper resonance might improve the extraction of its parameters. Last but not least, the study of the electromagnetic process $\gamma^* \to 3\pi$, contributing to the anomalous magnetic moment of the muon, is certainly very interesting.

In order to avoid unnecessary technical complications in the derivation of the three-particle analog of the Lellouch-Lüscher formula, we consider the simplest case of a decay into three identical spinless particles, which interact only in the S-wave. The derivation is carried out within the explicitly covariant version of the non-relativistic effective field theory, where relativistic corrections in the internal lines are summed up to all orders. The non-relativistic formalism provides a very transparent and simple framework – especially, the use of the particle-dimer picture drastically reduces the number of relevant diagrams needed to describe the final-state interactions in the three-particle decay. Further developments concerning particles with spin, partial wave mixing, moving frames and an so on are already in progress. These modifications will not affect our result at the leading order which, as expected, will be sufficient for the first generation of lattice calculations.

We demonstrate that, similar to the two-particle sector, the relation between the finite- and infinite-volume decay matrix elements is described by an overall multiplicative factor, depending on the size of the cubic box and the parameters of the final-state interactions only. In contrast, at higher orders, the factor will become a matrix with the dimension equal to the number of independent couplings, describing the three-particle decay at this order.

Primary authors: MÜLLER, Fabian (University of Bonn); Dr RUSETSKY, Akaki (Univerity of Bonn)

Presenter: MÜLLER, Fabian (University of Bonn)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions