



Contribution ID: 4

Type: **Talk**

A framework for the calculation of the $\Delta N \gamma^*$ transition form factor on the lattice

Friday, 27 June 2014 17:50 (20 minutes)

Using the non-relativistic effective field theory framework in a finite volume, we discuss the extraction of the $\Delta N \gamma^*$ transition form factors from lattice data. A counterpart of the Lüscher approach for the matrix elements of unstable states is formulated. In particular, we thoroughly discuss various kinematic settings, which are used in the calculation of the above matrix element on the lattice. The emerging Lüscher-Lellouch factor and the analytic continuation of the matrix elements into the complex plane are also considered in detail. A full group-theoretical analysis of the problem is made, including the partial-wave mixing and projecting out the invariant form factors from data.

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Session Classification: Hadron Structure

Track Classification: Hadron Structure