

The Dressing Field Method of Gauge Symmetries Reduction: Presentation and Examples

Authors : Jeremy Attard, Jordan François, Serge Lazzarini, Thierry Masson

Abstract : Gauge theories are the natural background for describing geometrically fundamental interactions using principal and associated fiber bundles as dynamical entities. The central notion of these theories is their local gauge symmetry implemented by the local action of a Lie group H . There exist several methods used to reduce the symmetry of a gauge theory, like gauge fixing, bundle reduction theorem or spontaneous symmetry breaking mechanism (SSBM). This paper is a presentation of another method of gauge symmetry reduction, distinct from those three. Given a symmetry group H acting on a fiber bundle and its naturally associated fields (Ehresmann (or Cartan) connection, curvature, matter fields, etc.) there sometimes exists a way to erase (in whole or in part) the H -action by just reconfiguring these fields, i.e. by making a mere change of field variables in order to get new ('composite') fields on which H (in whole or in part) does not act anymore. Two examples: the re-interpretation of the BEHGHK (Higgs) mechanism, on the one hand, and the top-down construction of Tractor and Penrose's Twistor spaces and connections in the framework of conformal Cartan geometry, on the other, will be discussed. They have, of course, nothing to do with each other but the dressing field method can be applied on both to get a new insight. In the first example, it turns out, indeed, that generation of masses in the Standard Model can be separated from the symmetry breaking, the latter being a mere change of field variables, i.e. a dressing. This offers an interpretation in opposition with the one usually found in textbooks. In the second case, the dressing field method applied to the conformal Cartan geometry offer a way of understanding the deep geometric nature of the so-called Tractors and Twistors. The dressing field method, distinct from a gauge transformation (even if it can have apparently the same form), is a systematic way of finding and erasing artificial symmetries of a theory, by a mere change of field variables which redistributes the degrees of freedom of the theories.

Keywords : BEHGHK (Higgs) mechanism, conformal gravity, gauge theory, spontaneous symmetry breaking, symmetry reduction, twistors and tractors

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