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W boson polarization in vector boson scattering at the LHC

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Measuring the scattering of longitudinally-polarized vector bosons will represent a fundamental test of Electroweak Symmetry Breaking.

In addition to the challenges provided by low rates and large backgrounds,
there are conceptual issues which remain unresolved for the definition of a suitable signal.
Since vector bosons are unstable and can only be observed through their decay products,
the polarization states interfere among themselves.
Moreover, already at tree level, there are diagrams which cannot be interpreted as production
times decay of EW bosons but are necessary for gauge invariance.

We discuss two possible ways to define a cross section for polarized W's. In both cases all non resonant diagram are dropped.
In the first one, the mass of the $\ell\nu$ pair is required to be close to M_W.
In the second one, an On–Shell Projection is performed.
The two methods give comparable outcomes.
We show that generating events with a specified W polarization and exact decription of its decay leads to a coherent definition of the polarization fractions.
In most cases, the sum of polarized distributions reproduces accurately the exact results.
In the absence of cuts this procedure reproduces the results of a
standard projection on Legendre polynomials. While the latter cannot be employed in the presence of selection cuts on the charged leptons, a comparison of the data with singly polarized templates allows the extraction of the polarization fractions in a realistic environment.

We have compared the decay distribution of the charged leptons, after acceptance cuts,
in the SM, its Singlet extension and a Higgsless model.
The normalized shapes are sufficiently similar to allow an almost model
independent definition of the signal and measurement of the polarized components.

The possibility of generating VBS events with a single W polarization has been
introduced into PHANTOM.

Experimental Collaboration

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