

Decoding the Georgi-Machacek Scenario: Insights from the LHC and Future Possibilities

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The Georgi-Machacek scenario, introducing a complex and a real scalar triplet as additional components of the electroweak symmetry breaking sector, enables substantial triplet contributions to the weak gauge boson masses, subject to the equality of the complex and the real triplet vacuum expectation values (vev) via a custodial SU(2) symmetry. The magnitude of this triplet vev strongly depends on the mass hierarchy in the scalar particle spectrum of the model. It is found that some constraints get relaxed, and the phenomenological potential of the scenario is more diverse, if the doubly charged scalar in the spectrum can decay not only into two like-sign W 's but also into one or two singly charged scalars. Moreover it has been noticed that, besides the charged scalars, the neutral scalars can also provide a spectacular signal at the LHC via the $\gamma\gamma$ mode. This $\gamma\gamma$ channel has been explored in detail taking into account the irreducible backgrounds as well as fakes. It has been pointed out that substantial regions of the GM parameter space is accessible to LHC studies, both at the high-luminosity run with $\int \text{cal}Ldt = 3000fb^{-1}$, and also in Run-3 with $\int \text{cal}Ldt = 300fb^{-1}$, even after folding in systematic errors. especially when analysis based on neural network is performed.

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