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Custodial symmetry violation in the Georgi-Machacek model

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We study the effects of custodial symmetry violation in the most general scalar potential of the Georgi-Machacek model (GM). The GM model, which adds isospin triplet scalars to the Standard Model, preserves $SU(2)$ custodial symmetry at tree level by imposing a global $SU(2)_L \times SU(2)_R$ symmetry and produces a degenerate fiveplet, a degenerate triplet and two singlet states. Custodial symmetry violation is induced by hypercharge gauge interactions when the model is run down to the weak scale from a higher scale at which the exact $SU(2)_L \times SU(2)_R$ global symmetry is imposed on the scalar potential. The magnitude of the running is heavily constrained by the ρ parameter. The effect of this small custodial violating running is quantified using a linearized approximation to solve the renormalization group equations (RGE) of the custodial violating parameters while the RGE of the custodial preserving parameters is solved numerically. We compute the resulting custodial-violating mass splittings and mixings among the original states and study the consequences for the Higgs couplings to fermions and gauge bosons. Numerical scans over the allowable parameter space are also performed.

Primary author: KEESHAN, Ben (Carleton University)

Co-authors: LOGAN, Heather (Carleton University); PILKINGTON, Terry (Carleton University)

Presenter: KEESHAN, Ben (Carleton University)

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