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Triboson Excesses in light of a Real Higgs Triplet Model

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In recent years, the "multilepton anomalies" have emerged, consisting of several persistent tensions in channels with multiple electrons and/or muons in the final states, with missing transverse energy and (b-) jets. These anomalies have prompted growing interest in the possibility of a new scalar particle beyond the Standard Model (SM).
In this context, excesses have been observed in the diphoton, $Z\gamma$ and WW spectra, pointing toward the presence of a Higgs-like scalar S with mass $m_S \approx 152 \pm 1$ GeV.

While these excesses suggest the existence of a new resonance, the ZZ final state remains consistent with Standard Model predictions, showing no significant deviation. This consistency can be naturally explained if the scalar S belongs to a Real Higgs Triplet (RHT) with hypercharge $Y = 0$, which does not couple to a pair of Z bosons at tree level. In such a scenario, charged and neutral triplet scalars can be produced via Drell-Yan processes and decay into electroweak gauge bosons, leading to enhancements in triboson final states such as WWW, WWZ, and WZZ.

Recent ATLAS and CMS measurements of triboson processes report observed (expected) significances of $6.4\sigma(4.7\sigma)$ in the VVZ channel and $4.4\sigma(3.6\sigma)$ in WWZ. These can be interpreted as a possible link to the extended Higgs sector. In this study, we investigate whether the RHT Model with hypercharge $Y = 0$ can accommodate these triboson excesses through Drell-Yan production of triplet scalars, which subsequently decay into electroweak bosons, leading to an enhancement in triboson final states. We explore the parameter space where S is identified as a component of the extended Higgs sector, with a small but nonzero diphoton branching ratio. Using Monte Carlo simulations, we analyze the predicted cross-sections for WWZ, WZZ, and WWW production and compare them with current experimental data.

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