Electroweak spin-1 resonances in composite Higgs models

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Composite Higgs theories incorporating partial compositeness are gauge theories, wherein the Higgs boson emerges as a pseudo-Nambu-Goldstone boson (pNGB), such as the Pions in QCD, and top-partners manifest as bound states of three hyperfermions coming from a UV completion.

These models offer a promising solution to the Higgs sector's Naturalness problem, explaining both the unexpectedly low Higgs mass and the mass hierarchy of Standard Model fermions. Additionally, they predict extra pNGBs and spin-1 resonances that could potentially be observable at the LHC.

Our focus is on the electroweak symmetry-breaking (EWSB) sector, specifically on the $SU(4)^2/SU(4)$ coset. We construct the effective Lagrangian for both spin-0 and spin-1 resonances using the Callan-Coleman-Wess-Zumino (CCWZ) formalism and the Hidden Symmetry approach. We investigate the vector and axial-vector spin-1 resonances, finding that two neutral states mix with the Z boson and one charged state mixes with the W boson, making them candidates for single production in Drell-Yan processes at the LHC.

We explore their rich LHC phenomenology and show that there are viable scenarios where their masses could be as low as about 1 TeV, consistent with current LHC data. In such scenarios, other states that mix weakly or not at all would also have masses around 1 TeV.

The combination of single vector state production with their decay channels leads to multiple signatures that have been searched for at the LHC, particularly in ATLAS searches for heavy gauge bosons W' and Z'. We use these searches to constrain the parameter space of our models.