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Light and Heavy Scalar Resonances in the NMSSM with Correct Dark Matter Relic Abundance

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Recent CMS analyses report an excess in the diphoton-plus-b¯b channel, indicative of a heavy resonance around 650GeV decaying into a Standard Model (SM)-like Higgs boson and a lighter scalar near 95GeV. The case for a 95GeV state is further supported by diphoton excesses observed by both CMS and ATLAS, as well as a b¯b excess previously observed at the Large Electron-Position collider. This study presents a unified interpretation of these anomalies within the framework of the General Next-to-Minimal Supersymmetric Standard Model that naturally accommodates a light singlet-dominated CP-even scalar boson hs near 95 GeV and a heavier doublet-like scalar boson AH near 650 GeV. Through a comprehensive scan of the parameter space, we demonstrate that the model can explain these excesses at 2 σ level while satisfying constraints from the dark matter relic density, direct detection experiments, the properties of the 125GeV Higgs boson, B-physics observables, and searches for electroweakinos at the Large Hadron Collider (LHC). The interpretation features a Bino-dominated lightest neutralino as the dark matter candidate, whose relic abundance is achieved primarily via As funnel annihilation or coannihilation with S˜-like χ˜02s into hsAH final states. Our findings provide clear predictions for testing this scenario at the high-luminosity LHC and future colliders.

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