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Indications of a (pseudo)scalar partner state of the Z boson at 57 GeV

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In 1995 the L3 collaboration observed an enhancement at 28 GeV in three-photon decays of the Z boson. Very recently, the CMS collaboration tentatively found an enhancement at the same energy in the invariant-mass distribution of muon pairs associated with a b -quark jet plus at least another jet. We interpret these signals not as the observation of an unknown resonance at 28 GeV, but rather as a possible new boson at about 57 GeV, resulting from an electromagnetic decay of the Z , with the accompanying photon consequently having an energy of 28 GeV. In the CMS case, the observed muon pairs are then thought to be produced by such 28 GeV photons.

Direct indications of this 57 GeV boson might be seen in small enhancements visible in diphoton invariant-mass distributions measured by CMS in 2013 and even in the above CMS dimuon data from 2018. Further evidence supporting a boson with a mass of about 57 GeV stems from a clear dip at about 115 GeV visible in diphoton data by CMS and ATLAS (both 2013), four-lepton signals by CMS and ATLAS (both 2013), and $\tau\tau$ as well as $\mu\mu$ invariant-mass distributions in $\ell^+\ell^-\gamma$ decays observed by L3 (2000). Such a dip is the inevitable manifestation of the onset of a threshold enhancement for the production of a pair of bosons, in any composite model of the vector gauge bosons and their (pseudo)scalar partners.

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