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Dimuon resonance near 28 GeV and muon anomaly

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The CMS collaboration has recently reported a peak at invariant mass

$$m_X = 28.3 \pm 0.4\,\text{GeV} \tag{1}$$

of $\mu^+\mu^-$ pairs produced in association with b jet in pp-collisions at the LHC (Large Hadron Collider) [1]. The peak appeared in the 8 TeV data with $19.7\,\text{fb}^{-1}$ of integrated luminosity, while no significant excess was found in the 13 TeV data with $35.9\,\text{fb}^{-1}$ of integrated luminosity.[2)] The observation was made for two event categories with different cuts on jets directions with the local significancies of 4.2 and 2.9 standard deviations (see the paper [1] for the details). The fiducial cross section for both categories is at the level of 4 fb. Signal selection efficiency can strongly depend on the production process, so to evaluate the total $\sigma \times \text{Br}(X \to \mu^+\mu^-)$ a particular model is required. The CMS paper does not study any specific model, so only the fiducial cross sections were provided.

The reported width of the peak is

$$\Gamma_X^{(\text{exp})} = 1.8 \pm 0.8\,\text{GeV} \tag{2}$$

which is several times larger than the expected mass resolution for a dimuon system $\sigma_{\mu\mu} = 0.45\,\text{GeV}$.

We study whether the resonance X (if its existence will be confirmed in the future) can explain the deviation of the measured value of the muon anomalous magnetic moment $a_\mu \equiv (g-2)_\mu/2$ from the Standard Model value

$$\delta a_\mu \equiv a_\mu^{\text{exp}} - a_\mu^{\text{SM}} = \begin{cases} (31.3 \pm 7.7)\cdot 10^{-10}, & \text{see [2]}, \\ (26.8 \pm 7.6)\cdot 10^{-10}, & \text{see [3]}. \end{cases} \tag{3}$$

An extra scalar or vector can describe the resonance discovered in [1], and simultaneously resolve the disagreement between the Standard Model result for the muon anomalous magnetic moment and its measured value. The total width of the resonance observed in the experiment can be explained by $X \to \tau\tau$ and $X \to \nu\nu$ decays. These are the main results of the present paper.

Though X was found in association with at least one b jet, the simplest model of its production via radiating from b quark line contradicts the previous CMS paper [4]: while the cuts in the new paper are much stronger (mostly cuts on muons) the fiducial cross section is at the level of the upper limit on fiducial cross section from previous paper. To resolve this contradiction, stronger cuts on muons transverse momentum should not significantly diminish the number of events, i.e., X should be produced with high transverse momentum. This can be achieved if X is produced in decays of a heavy particle, for example, vector-like B quark via $\bar{B}_L b_R X$ interaction term. The construction of such a model is the subject of the future work.

If the existence of X will be confirmed by future experimental data, it will be a strong additional argument in favor of muon collider construction.

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2) At 13 TeV the excess can be hidden by the rapid growth of the background mainly provided by $t\bar{t}$ events (V. B. Gavrilov, private communication).

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