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Heavy Fermion Bound States for Diphoton Excess at 750GeV

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A colored heavy particle with sufficiently small width may form non-relativistic bound states when they are produced at the large hadron collider (LHC), and they can annihilate into a diphoton final state. The invariant mass of the diphoton would be around twice of the colored particle mass. In this paper, we study if such bound state can be responsible for the 750 GeV diphoton excess reported by ATLAS and CMS. We found that the best-fit signal cross section is obtained for the SU(2)_L singlet colored fermion X with $Y_X=4/3$. Having such an exotic hypercharge, the particle is expected to decay through some higher dimensional operators, consistent with the small width assumption. The decay of X may involve a stable particle χ , if both X and χ are odd under some conserved Z₂ symmetry. In that case, the particle X suffers from the constraints of jets + missing ET searches by ATLAS and CMS at 8 TeV and 13 TeV. We found that such a scenario still survives if the mass difference between X and χ is above ~ 30 GeV for $m_X \sim 375$ GeV. Even assuming pair annihilation of χ is small, the relic density of χ is small enough if the mass difference between X and χ is smaller than ~ 40 GeV.

Primary author: Prof. NOJIRI, Mihoko (KEK)

Presenter: Prof. NOJIRI, Mihoko (KEK)

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