Resonance search for new physics in the photon and jet final state at $\sqrt{s} = 13$ TeV

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The poster presents a search for excited quarks ($q^*$) decaying into a $\gamma + \text{jet}$ final state in pp collisions at $\sqrt{s} = 13$ TeV. The search is done with the data taken by the CMS experiment at the CERN LHC in 2015 corresponding to an integrated luminosity of 2.7 fb$^{-1}$. Results are presented in terms of 95% CL upper limits on cross section times branching fraction as a function of excited quark mass ($M_{q^*}$). Limits on excited quarks are presented as a function of their mass and coupling strength; masses below 4.37 TeV are excluded at 95% CL for coupling multipliers $f=1.0$.

**Introduction**
- Compositeness models: Possible explanation to mass hierarchy in quarks and leptons.
- Excited states $\rightarrow$ Signal of composite structure.
- The interaction of excited states with SM partners is given by the Lagrangian
  $$ L_{\text{int}} = \frac{1}{2\Lambda} q^*_R \sigma^{\mu\nu} \sum g_i f_T q_L a_i\gamma_{\mu\nu} + h.c. $$
- $\Lambda$ - Compositeness scale.
- $f_{\gamma}, f, f'$ - Coupling multipliers to SU(3), SU(2) and U(1) gauge field-strength tensors.

**Events we select**
- $P_T^{\gamma} > 190$ GeV and $|\eta^\gamma| < 1.44$
- Photon identification & isolation:
  - H/E < 0.05
  - Energy weighted width, $\sigma_{\text{inj}} < 0.011$
  - Requirement on $\Sigma p_T$ of photons, charged and neutral hadrons around photon candidate.
- Anti-$k_T$ (R = 0.4) Particle flow jets
- $\Delta R(\gamma, \text{jet}) > 0.5$
- $P_T^{\text{jet}} > 190$ GeV and $|\eta^{\text{jet}}| < 2.4$
- $M_{\gamma+\text{jet}} > 695$ GeV
- $\Delta\phi(\gamma, \text{jet}) > 1.5$ & $\Delta\eta(\gamma, \text{jet}) < 1.8$

**What we observe?**
- Invariant mass distribution of the $\gamma + \text{jet}$ events in data and comparison to MC simulations after final selection.

**Summary**
- A search for $q^*$ decaying to a $\gamma$ and jet is presented.
- Set 95% CL upper limits on $\sigma \times \text{BR}$ for $q^* \rightarrow \gamma + \text{jet}$.
- We exclude $1.0 < M_{q^*} < 4.37$ TeV for $f = 1.0$ and $1.0 < M_{q^*} < 1.36$ TeV for $f = 0.1$ at $\sqrt{s} = 13$ TeV with $\mathcal{L}_{\text{int}} = 2.7$ fb$^{-1}$.
- Present exclusion at 95% CL as function of coupling strength and $q^*$ mass.