Light Resonances and the Low-q^2 Bin of R_{K^*}

Wolfgang Altmannshofer
altmanwg@ucmail.uc.edu

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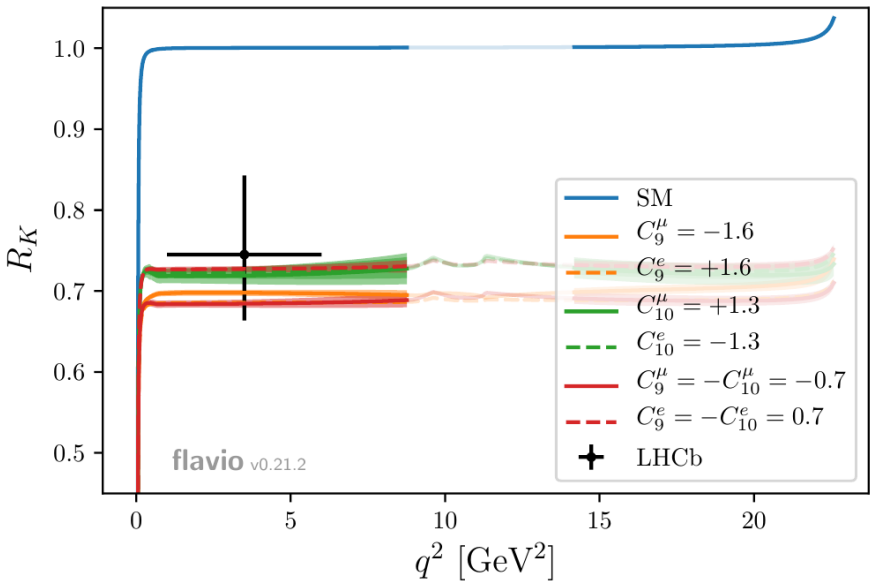
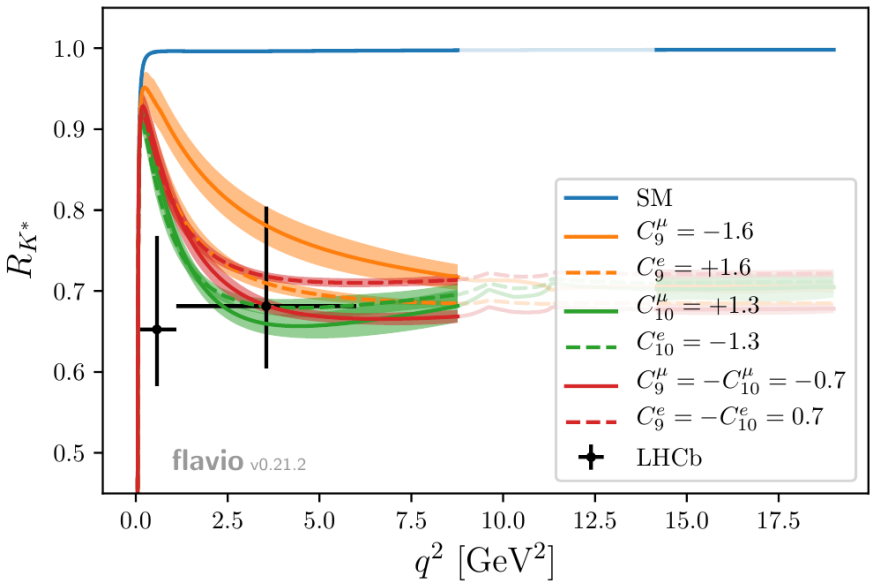
The low q^2 Bin in R_{K^*}

WA, Stangl, Straub 1704.05435



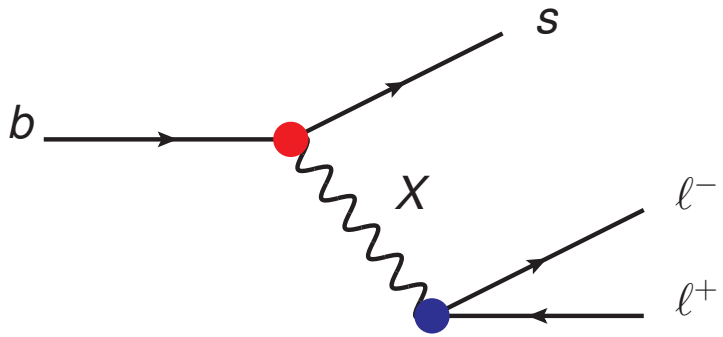


Effect of (heavy) new physics in R_{K^*} gets diluted at low q^2.
(because of the photon pole in the SM)

This behavior is not seen in the data.
Hint for new light degrees of freedom?

Very Light New Resonance ?

Lets assume there is new resonance X with mass far below the di-muon threshold that couples to bs and $\mu\mu$. Contribution to the amplitude enhanced by $1/q^2$



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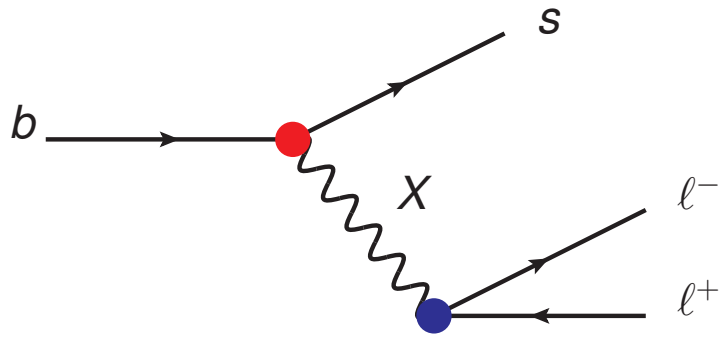
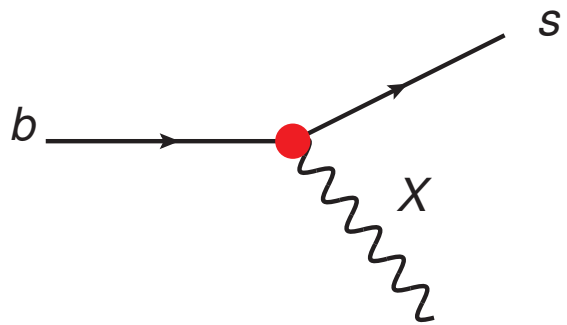


Problem: enormous $B \to X_s X$ rate, that saturates the total B width!



$$\text{BR}(B \to X_s X) \sim 800\% \times \left(\frac{0.3 \cdot 10^{-3}}{g_\ell}\right)^2 \left(\frac{\Delta R_{K^*}}{0.3}\right)^2$$

WA, Baker, Gori, Harnik, Pospelov, Stamou, Thamm 1711.07494

New Resonance Above the Di-Muon Threshold ?

LHCb 1508.04094

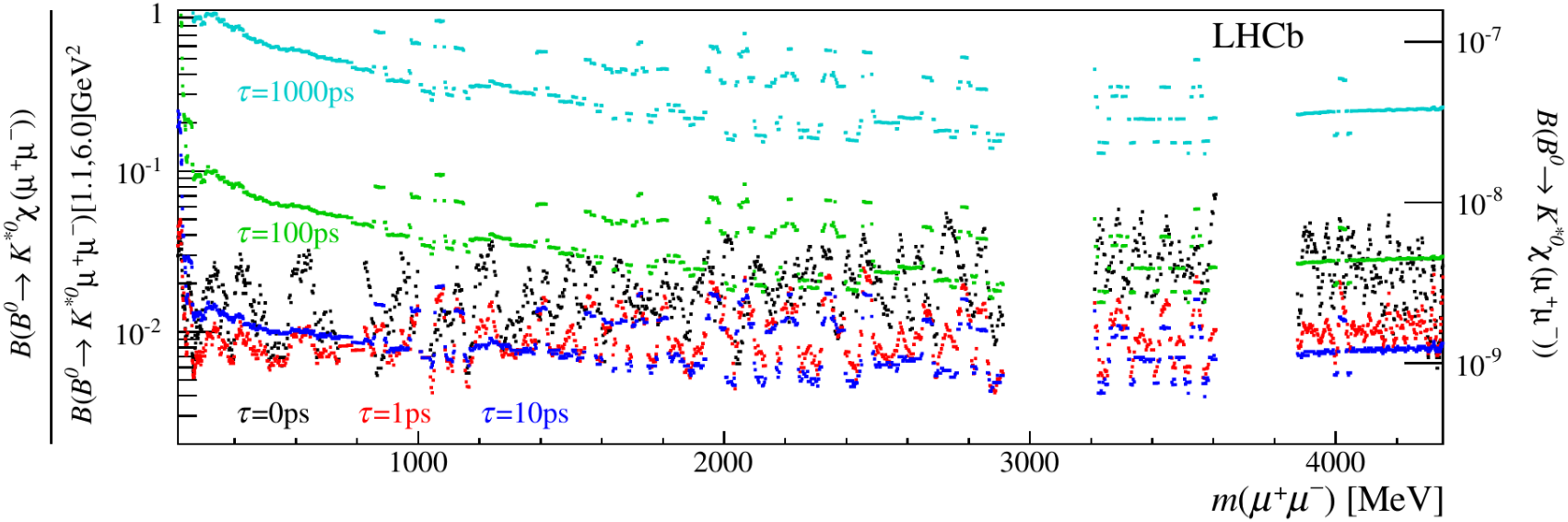
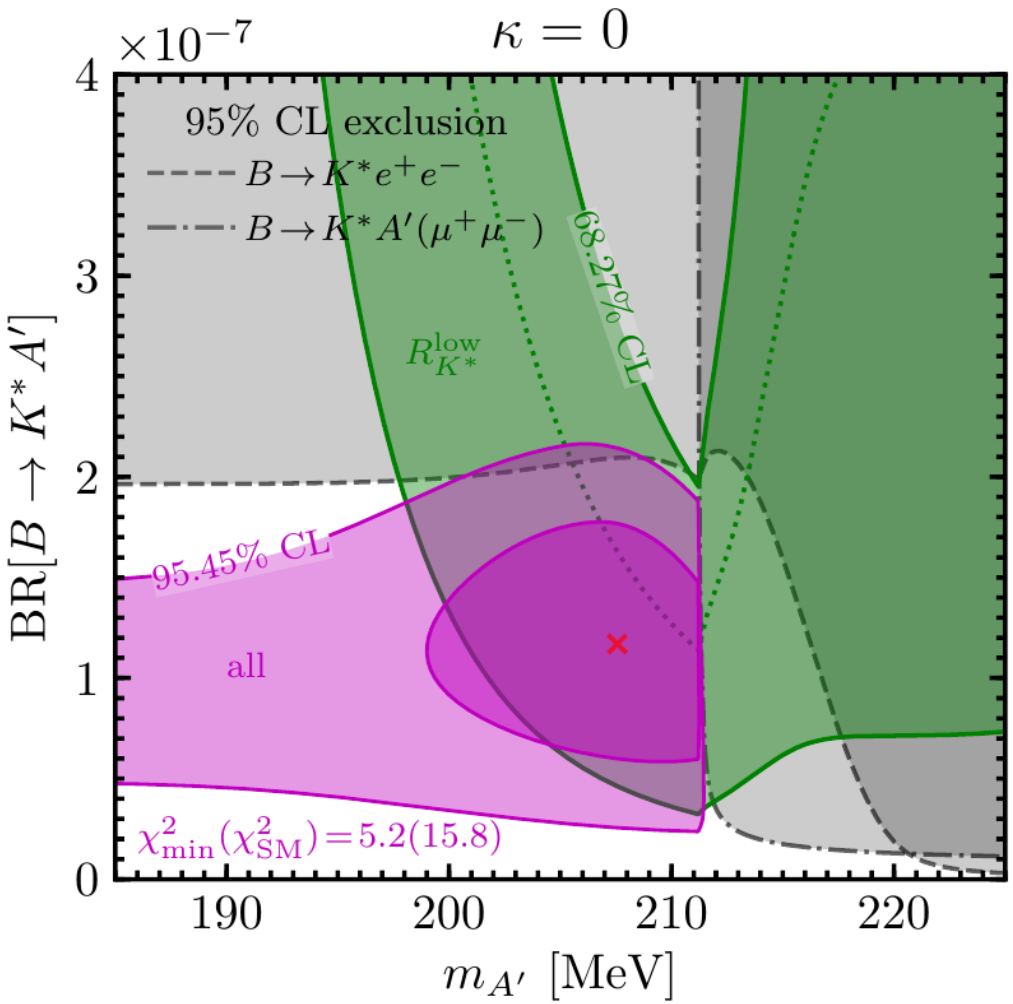


Figure 7: Upper limits at 95% CL for (left axis) $\mathcal{B}(B^0 \to K^{*0}\chi(\mu^+\mu^-))/\mathcal{B}(B^0 \to K^{*0}\mu^+\mu^-)$, with $B^0 \to K^{*0}\mu^+\mu^-$ in $1.1 < m^2(\mu^+\mu^-) < 6.0\,\mathrm{GeV}^2$, and (right axis) $\mathcal{B}(B^0 \to K^{*0}\chi(\mu^+\mu^-))$. Same as Fig. 4 in the Letter but including the $\tau = 0$ and 1 ps limits.

No resonance is seen in explicit searches for $B \to K^* X$, $X \to \mu^+\mu^-$

Resonance Right Around the Di-Muon Threshold ?

Example: Dark photon with $m_{A'} \sim 2m_\mu$



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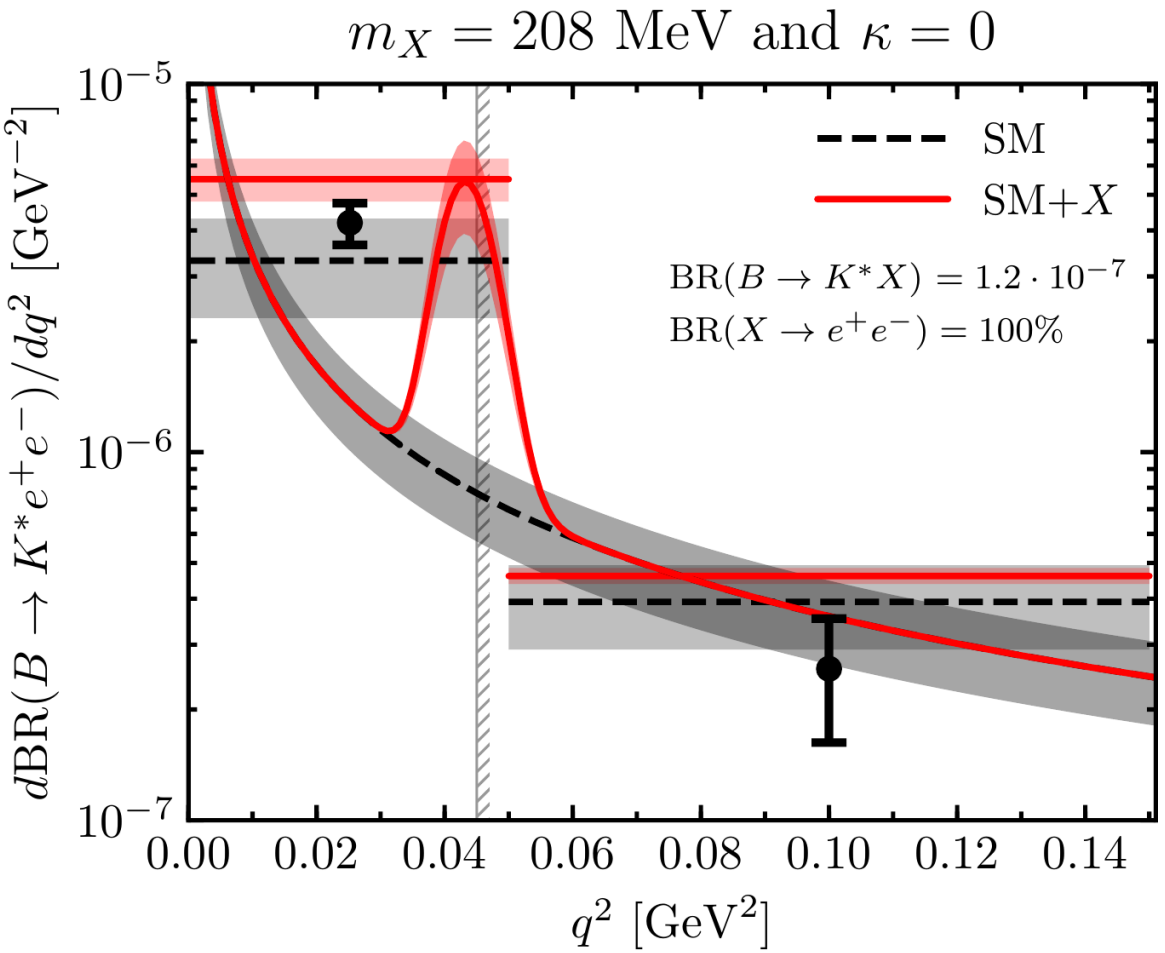
Smoking Gun Signature

Resonance in the di-electron spectrum in $B \to K * e^+ e^-$ right around $q^2 \sim 4m_\mu^2$



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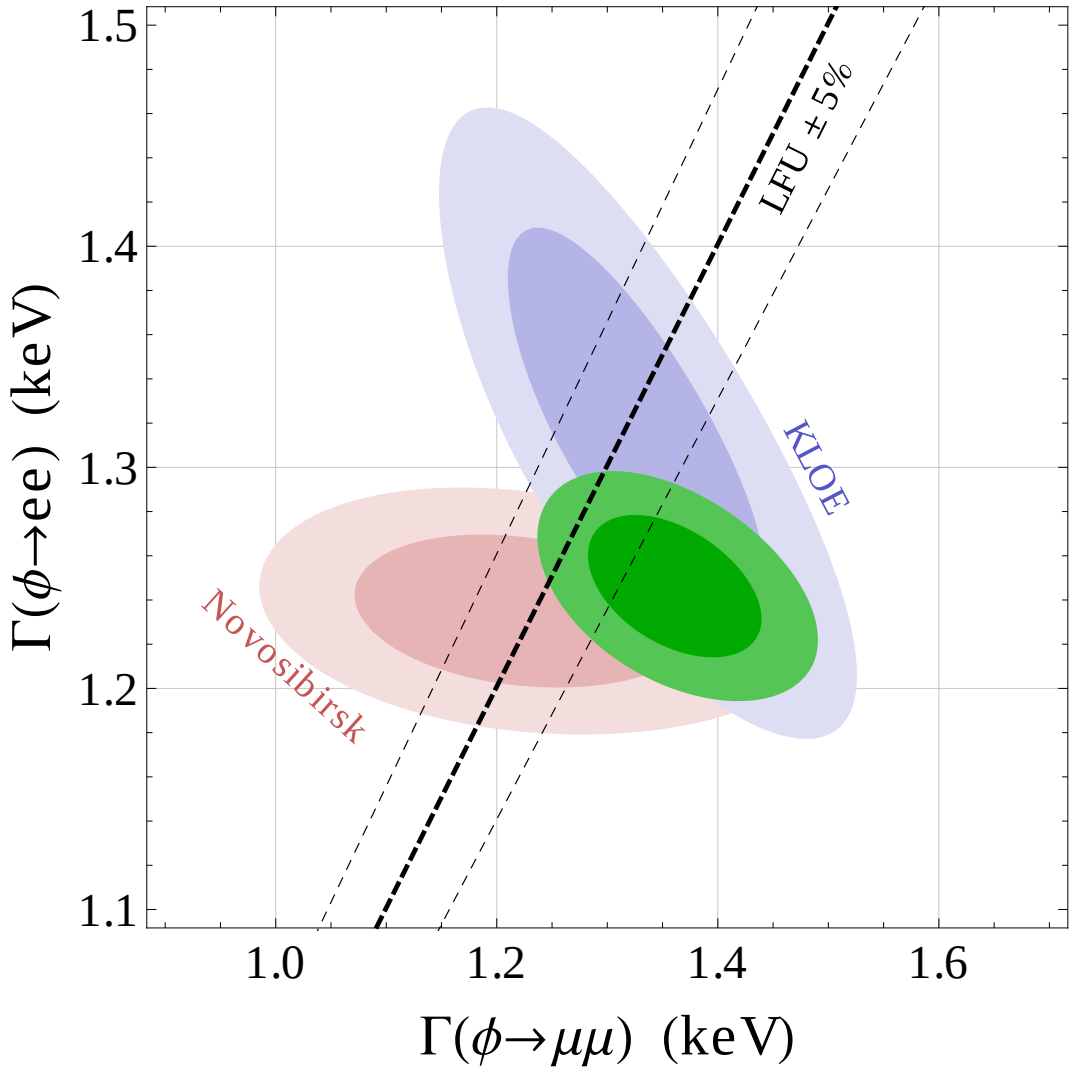
Another Test of LFU: ϕ Decays

LHCb should accumulate enough statistics to measure LFU in $\phi \to \ell\ell$ decays ($q^2 \sim 1$ GeV^2).

With run 2 data several 10,000 $\phi \to \ell\ell$ decays from $D^\pm \to \pi^\pm\phi$, $D^0 \to \pi^+\pi^-\phi$, $D_s^\pm \to \pi^\pm\phi$, ...



Summary

- low q^2 bin in R_{K^*} looks a bit funny ...
- possible New Physics explanations are highly constrained
- predict bump in the di-electron spectrum in $B \to K^* e^+ e^-$
- caveats: many resonances, un-particles, ...
- another important test: LFU in $\phi \to \ell\ell$