On Light Resonance Interpretations of the B Decay Anomalies

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Based on: 1705.03465  FB, U. Haisch, P. Monni
Focus of the talk

In particular, a new constraint from LHC
The light NP ansatz

The possibility that a light resonance could be responsible for the anomaly in $P'_5$ was mentioned by Amarjit Soni at 50th Rencontres de Moriond EW 2015, and subsequently re-emphasised to one of the authors by Brian Batell in a private conversation.

[Uli Haisch]

- Fuyuto, Hou, Kohda: [1512.09026]
- Sala, Straub: [1704.06188]
- Ghosh: [1704.06240]
- Alok, Bhattacharya, Datta, Kumar, Kumar, London: [1704.07397]
- Datta, Liao, Marfatia: [1702.01099]
A simplified model

\[ \mathcal{L} \supset (g_L^{sb} \bar{s}_L V b_L + \text{h.c.}) + \bar{\mu} (g_V^\mu - g_A^\mu \gamma_5) V \mu + g_V^\chi \bar{\chi} V \chi \]

\[ g_\chi \gg g_V^\mu, g_A^\mu \]

\[ \frac{\Gamma_V}{m_V} \approx \frac{g_\chi^2}{12\pi} \]

\[ \text{Br}(V \to \mu\mu) \approx \frac{g_V^{\mu 2} + g_A^{\mu 2}}{g_V^\chi 2} \]

For \( \Gamma_V/m_V \sim 20\% \), \( g_V^\chi \sim 3 \), and \( \text{Br}(V \to \mu\mu) \sim 10^{-3} \)
Z lineshape

ATLAS: [1612.03636]

Fiducial phase space

\[ p_T^\mu > 25 \text{ GeV} \]

\[ |\eta_\mu| < 2.5 \]

\[ 66 < m_{\mu\mu} < 116 \text{ GeV} \]
Derived constraint

95% CL contours for various masses in GeV

\[ m_V = 2.5 \text{ GeV} \]

B anomaly preferred regions taken from: Sala, Straub, [1704.06188] \( g_{bs} = -1.5 \times 10^{-8} \)
Derived constraint

Adding uncorrelated 2.1% luminosity uncertainty

95% CL contours for various masses in GeV

B anomaly preferred regions taken from: Sala, Straub, [1704.06188] $g_{bs} = -1.5 \times 10^{-8}$
\[(g - 2)\mu\]

\[\Delta a_\mu \equiv a^{\text{exp}}_\mu - a^{\text{SM}}_\mu = \frac{x}{12\pi^2} \left[ g^2_V f(x) + g^2_A g(x) \right], \quad \text{with} \quad x \equiv \frac{m^2_\mu}{m^2_V}\]
\( (g - 2)\mu \)

\[ \Delta a_\mu = (287 \pm 80) \times 10^{-11} \quad \text{PDG 2016} \]
The BaBar bound

Brian Shuve [private comm.]  
BaBar [1606.03501]

Benchmark model: gauged $L_\mu - L_\tau$  
Look for $e^+e^- \rightarrow 4\mu$  
For us, recast it by Br
Summary and outlook

- LHC measurements provide relevant constraints for light NP

- Many precision observables: \( m_{\ell\ell}, A_{FB}, \phi^*, \ldots \)

- Use ratios (like normalized distributions) to reduce luminosity & PDF uncertainties

- Careful treatment of higher order effects needed for precise bound
Thank you!