Expected sensitivity on the coupling between quarks and a dark scalar gauge boson

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for the GlueX and JEF experiments

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Baryonic fine structure constant

$\alpha_{B'}$ using the equation for the partial width ratio $\Gamma(\eta \to B'\gamma)/\Gamma(\eta \to \gamma\gamma)$ from S. Tulin, PRD **89**, 114008 (2014) as:

$$\begin{aligned} \alpha_{U'} &= \left[\frac{\alpha}{2}\left(1-\frac{m_{B'}^2}{m_\eta^2}\right)^{-3}\left|\mathcal{F}(m_{B'}^2)\right|^{-2}\frac{1}{\mathcal{B}(B'\to\pi^0\gamma)}\right] \\ &\times \left[\frac{\Gamma(\eta\to\gamma\pi^0\gamma)}{\Gamma(\eta\to\gamma\gamma)}\right] \\ &\times \left[\frac{\Gamma(\eta\to B'\gamma\to\gamma\pi^0\gamma)}{\Gamma(\eta\to\pi^0\gamma\gamma)}\right], \end{aligned} \tag{1}$$

where α is the electromagnetic fine structure constant. The first factor in Eq. (1), which is purely theoretical, contains the phase space, the form factor $\mathcal{F}(m_{U'}^2)$, and the branching fraction of $B' \to \pi^0\gamma$ decay. The branching fraction provided in S. Tulin. The second factor is obtained from the latest measurements PDG. The third factor is determined from the η and B' yields and reconstruction efficiencies $(N_{B'}/\varepsilon(\eta \to B'\gamma \to \pi^0\gamma\gamma))/(N_\eta/\varepsilon(\eta \to \pi^0\gamma\gamma))$.

Baryonic fine structure constant

α_S using the equation for the partial width ratio $\Gamma(\eta \to S\pi^0)/\Gamma(\eta \to \gamma\gamma)$

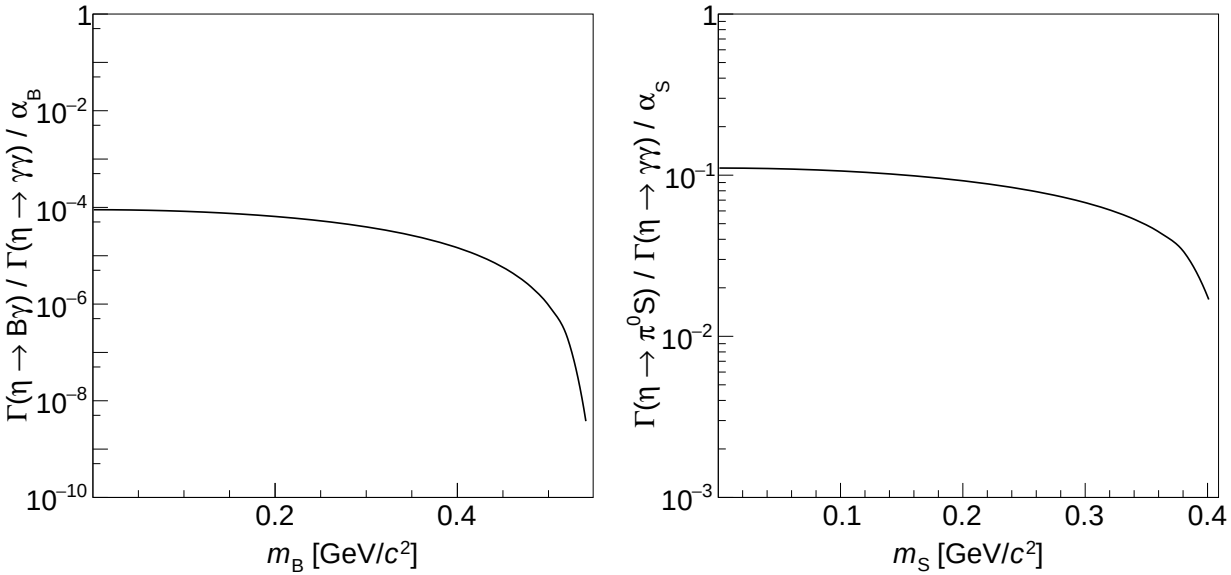
$$\begin{aligned} \alpha_S &= \left[\frac{\alpha}{2}\left(1-\frac{m_S^2}{m_\eta^2}\right)^{-3}\left|\mathcal{F}(m_S^2)\right|^{-2}\frac{1}{\mathcal{B}(S\to\gamma\gamma)}\right] \\ &\times \left[\frac{\Gamma(\eta\to\gamma\pi^0\gamma)}{\Gamma(\eta\to\gamma\gamma)}\right] \\ &\times \left[\frac{\Gamma(\eta\to S\pi^0\to\gamma\pi^0\gamma)}{\Gamma(\eta\to\pi^0\gamma\gamma)}\right], \end{aligned} \tag{2}$$

where α is the electromagnetic fine structure constant. The first factor in Eq. (2), which is purely theoretical, contains the phase space, the form factor $\mathcal{F}(m_S^2)$, and the branching fraction of $S \to \gamma\gamma$ decay. The branching fraction provided in arXiv:1812.05103v1. The second factor is obtained from the latest measurements PDG. The third factor is determined from the η and S yields and reconstruction efficiencies $(N_S/\varepsilon(\eta \to S\pi^0 \to \pi^0\gamma\gamma))/(N_\eta/\varepsilon(\eta \to \pi^0\gamma\gamma))$.

Recasting

$$\frac{\alpha_S}{\alpha_{B'}} = \left[\frac{\mathcal{B}(B' \to \pi^0\gamma)}{\mathcal{B}(S \to \gamma\gamma)}\right] \times \left[\frac{\Gamma(\eta \to S\pi^0 \to \gamma\pi^0\gamma)}{\Gamma(\eta \to B'\gamma \to \gamma\pi^0\gamma)}\right] \times \left[\frac{\Delta M_{\gamma\gamma}}{\Delta M_{\gamma\pi^0}}\right]^{1/4} \quad (3)$$

The first term can be considered equal to 1.



Expected sensitivity

- Red curve: α_S
- Green curve: $g_u = \sqrt{4\pi\alpha_S}$
- Appears not competitif wrt BESIII