# Protected axions in a clockwork gauge symmetry model

Quentin Bonnefoy

based on arXiv:1804.01112
in collaboration with E. Dudas and S. Pokorski

Centre de Physique Théorique - École Polytechnique

Mass: From the Higgs to Cosmology
Cargèse, July 16th 2018

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- **ULA**: $f_a \sim 10^{17}$ GeV, $m_a \sim 10^{-21,-22}$ eV

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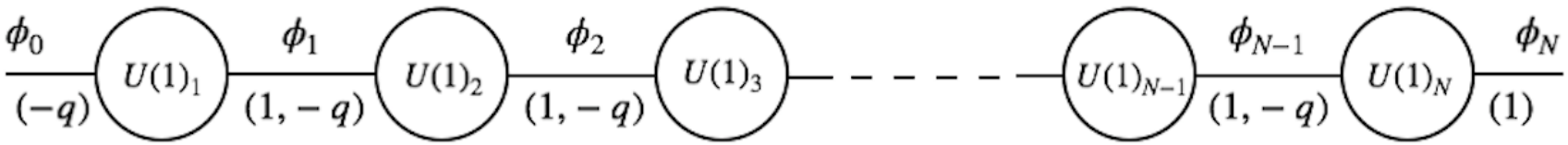


Ahmed & Dillon (2017), Coy Frigerio & Ibe (2017), Choi Im & Shin (2017)

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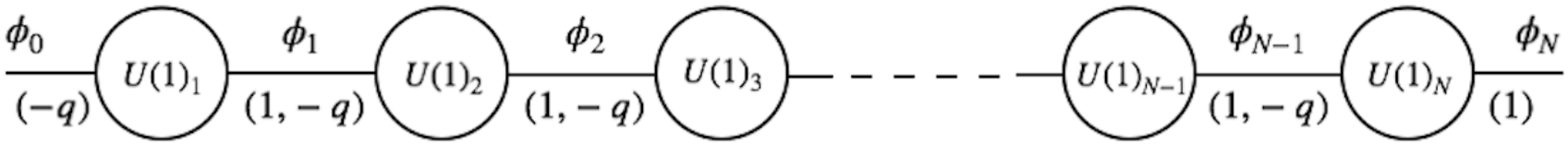


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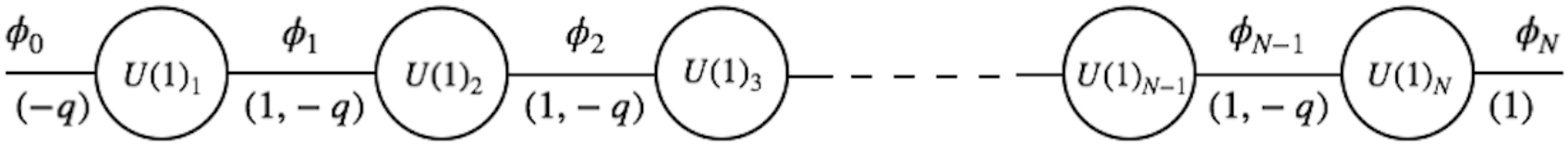


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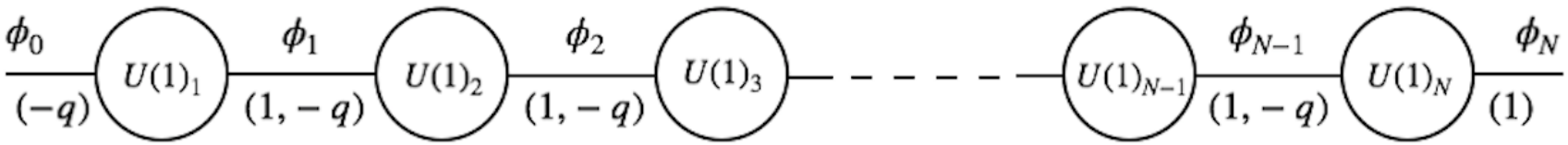


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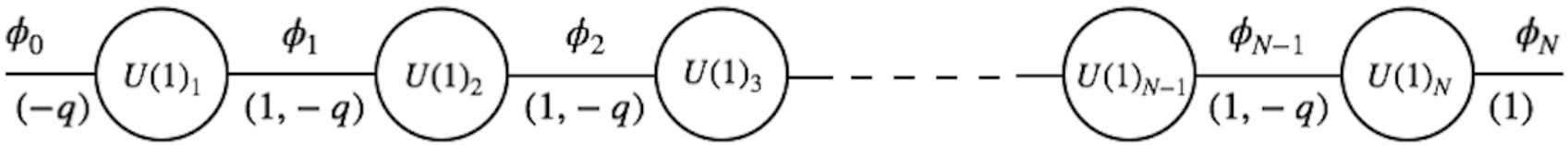


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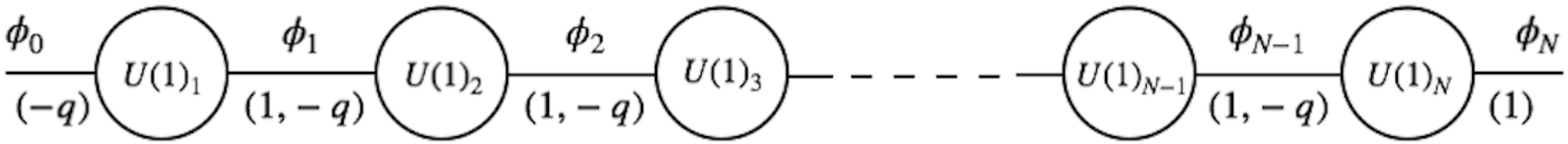


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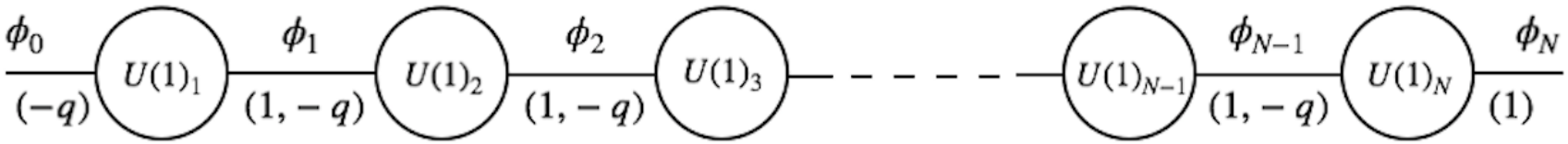


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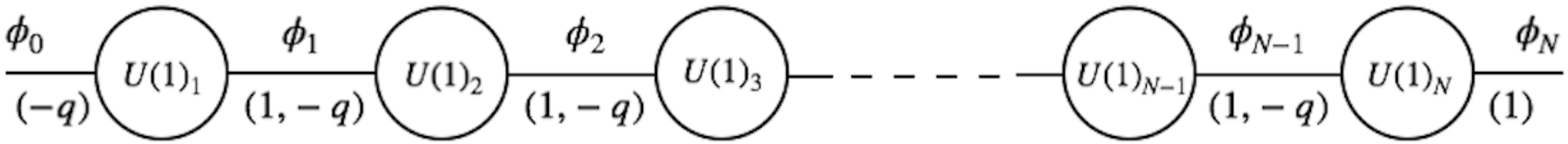


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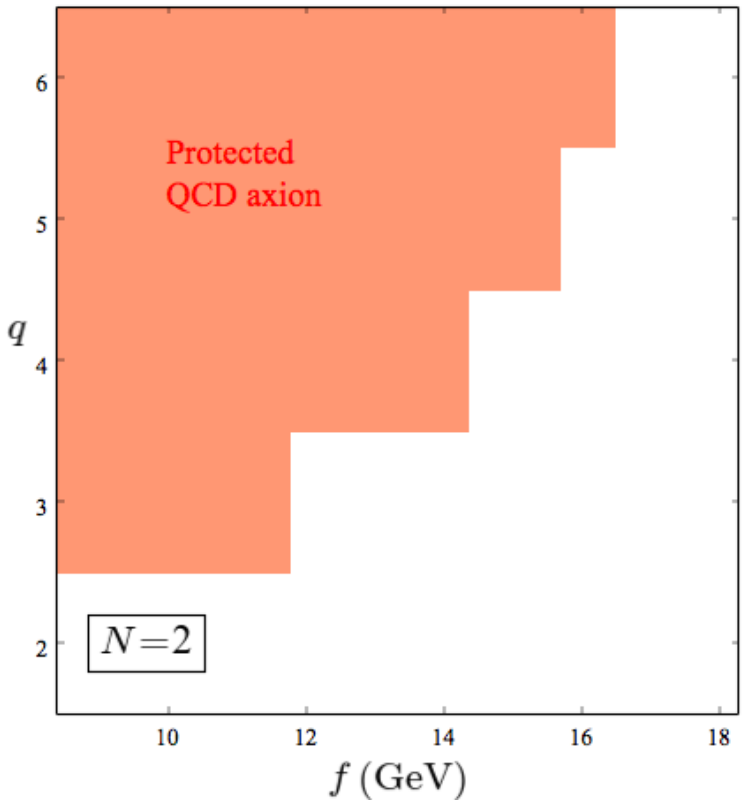
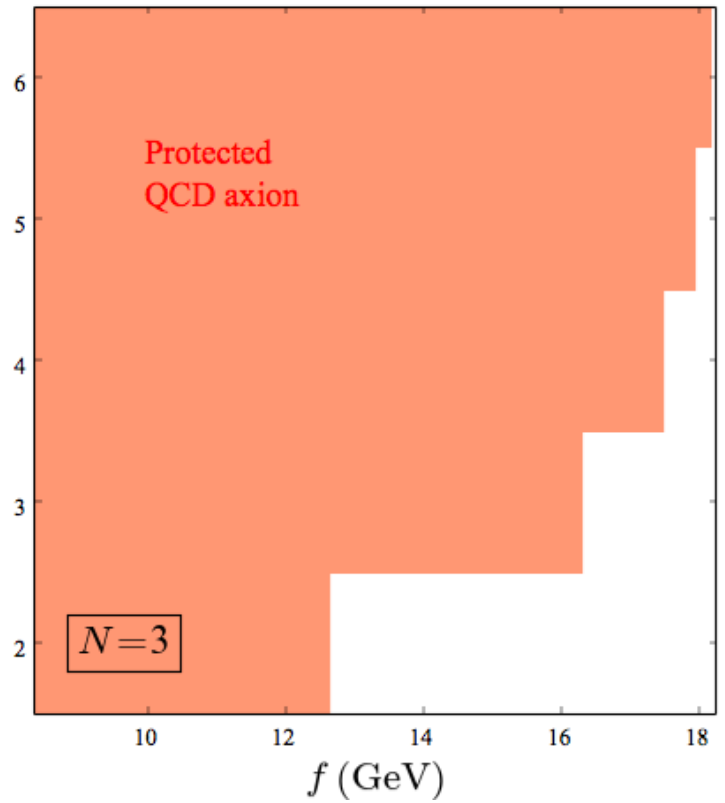
**Use of the profile**: no for the gauge field coupling $aF\tilde{F}$, yes for the spin coupling $\partial a \overline{\psi}\gamma\gamma_5\psi$

Thank you!

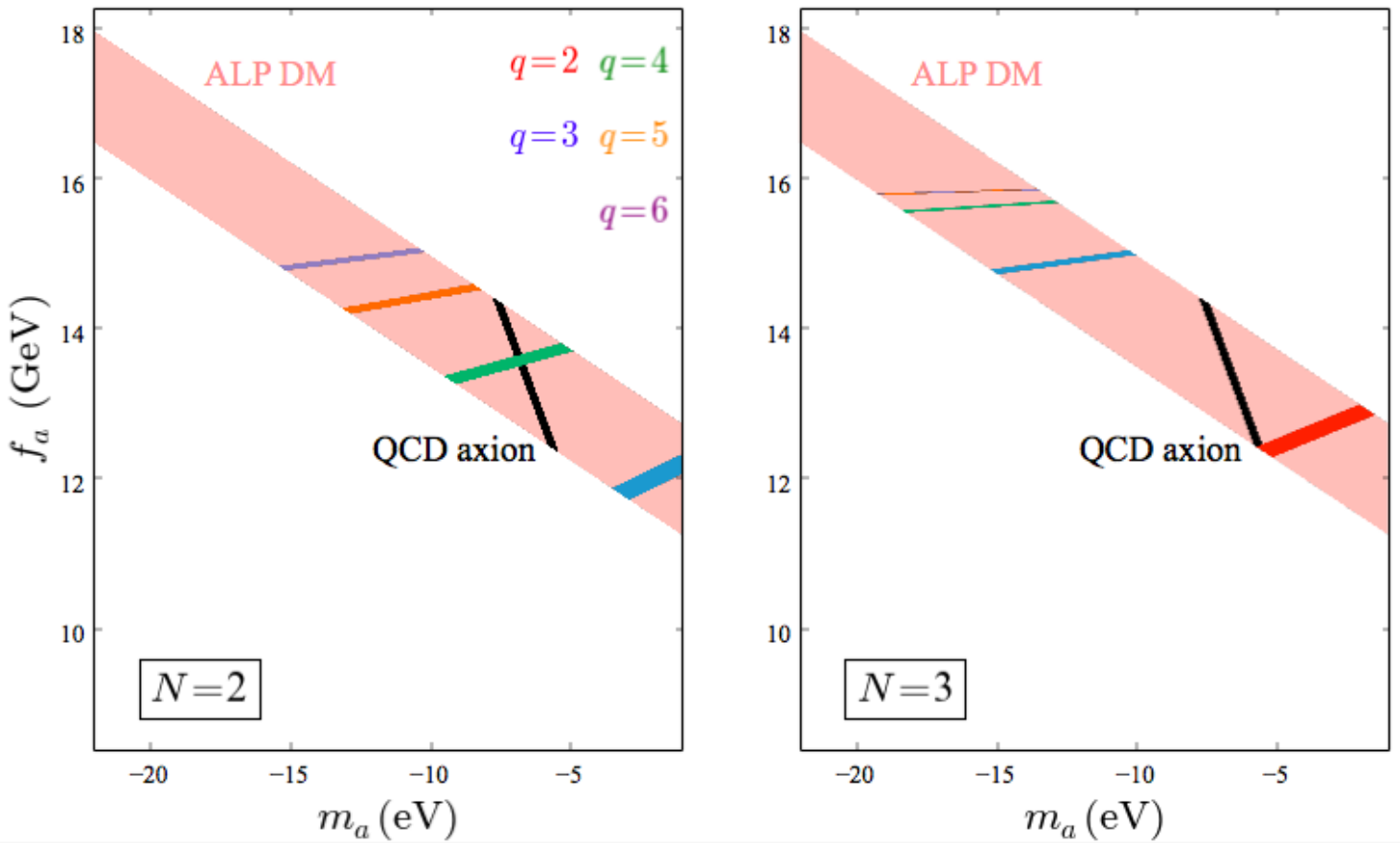
$\theta_{\rm QCD} < 10^{-10}$ if:

$$\left[ m_a^{(\rm QCD)} \sim \frac{m_\pi f_\pi}{2 f_a} \right] > 10^5 \left[ m_a^{(\rm grav)} \sim \left( \frac{f}{M_P} \right)^{\frac{q+\ldots+q^N-1}{2}} \frac{f}{f_a} M_P \right]$$

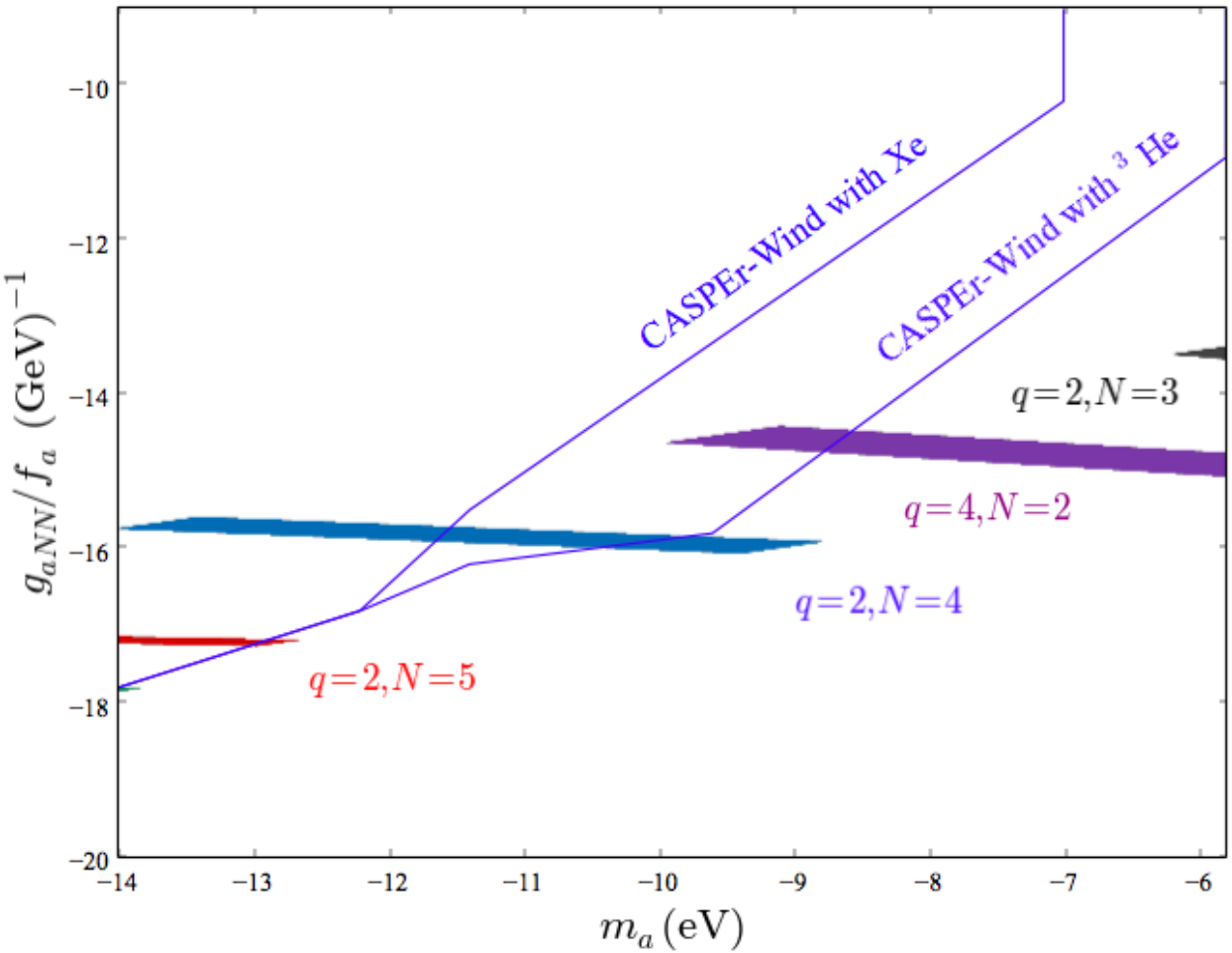


$\Omega_a h^2 = 0.12$ when:



**Detection of spin precession** (with $\frac{\partial_\mu a}{f_a}\overline{N}\gamma^\mu\gamma^5 N$): Coupled at site N



**Detection of spin precession** (with $\frac{\partial_\mu a}{f_a}\overline{N}\gamma^\mu\gamma^5 N$): Coupled at site 0