AXIONRUSH

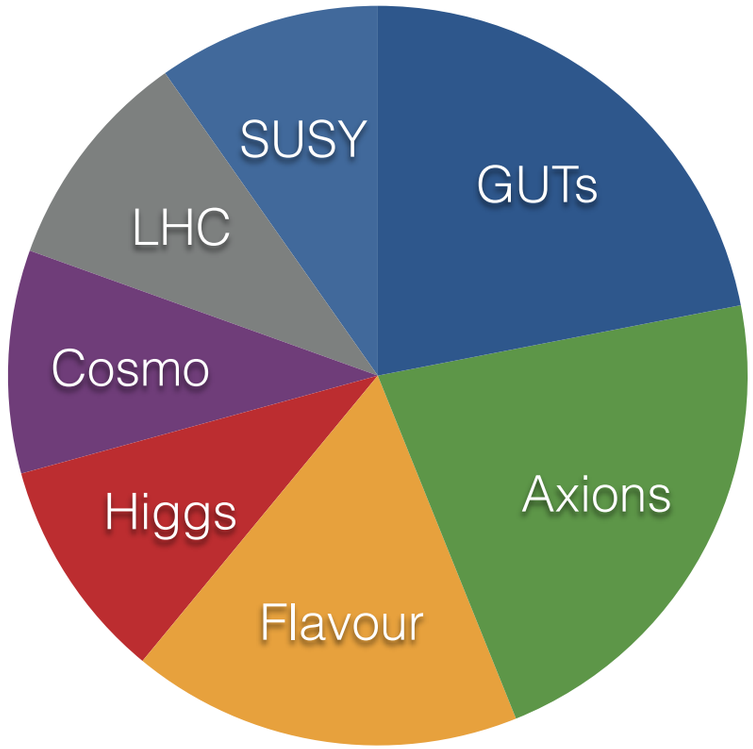
DESY Fellows Meeting - 03.12.19

Luca Di Luzio

Research funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Individual Fellowship AXIONRUSH (grant agreement No 840791)

About myself…

Research area:
hep-ph, beyond the Standard Model

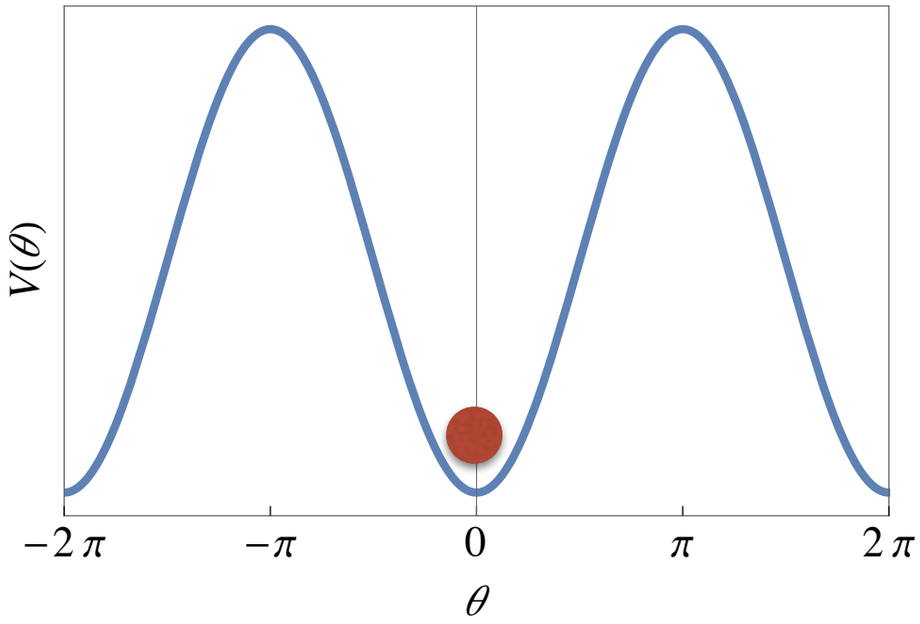


QCD axion

Strong CP problem

$$\delta\mathcal{L}_{\rm QCD} = \theta\,\frac{\alpha_s}{8\pi}G\tilde{G} \qquad |\theta| \lesssim 10^{-10}$$

promote θ *to a dynamical field,*
which relaxes to zero via QCD dynamics



$$\theta \to \frac{a}{f_a} \qquad \textit{with} \qquad \langle a \rangle = 0$$

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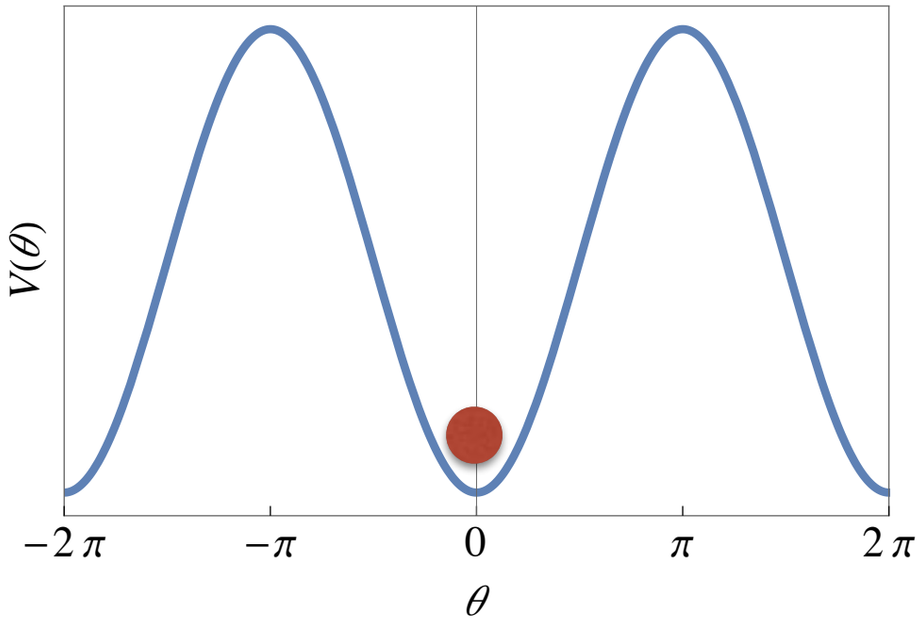

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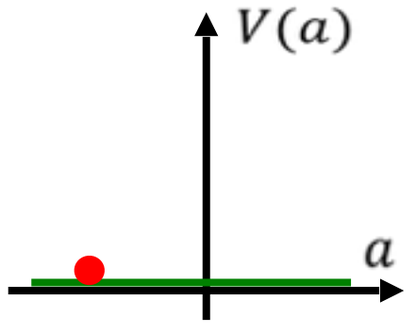
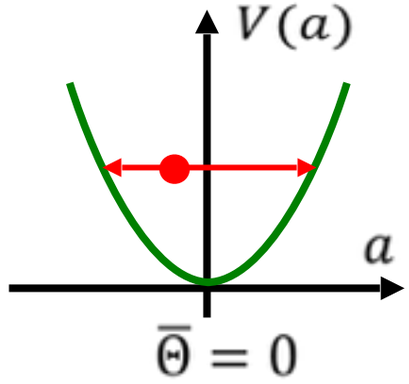
Dark Matter

vacuum re-alignment mechanism:



$T \gg 1$ GeV

[Raffelt]

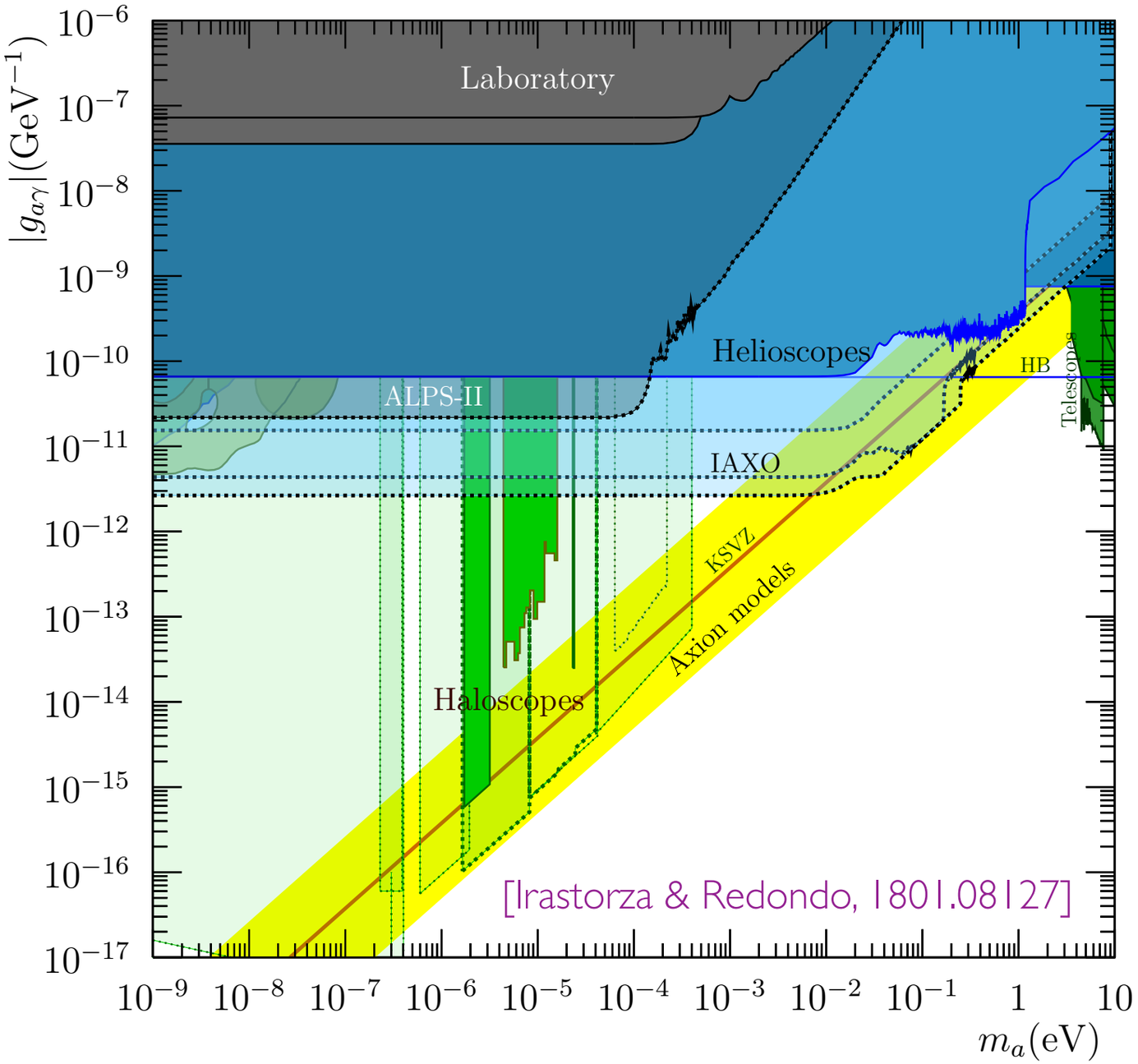


$T \sim 1$ GeV

$w_a = p_a/\rho_a \simeq 0$

$$\ddot{a} + 3H\dot{a} + m_a^2(T) f_a \sin\left(\frac{a}{f_a}\right) = 0$$

In 10 years from now ?



- A great exp. opportunity

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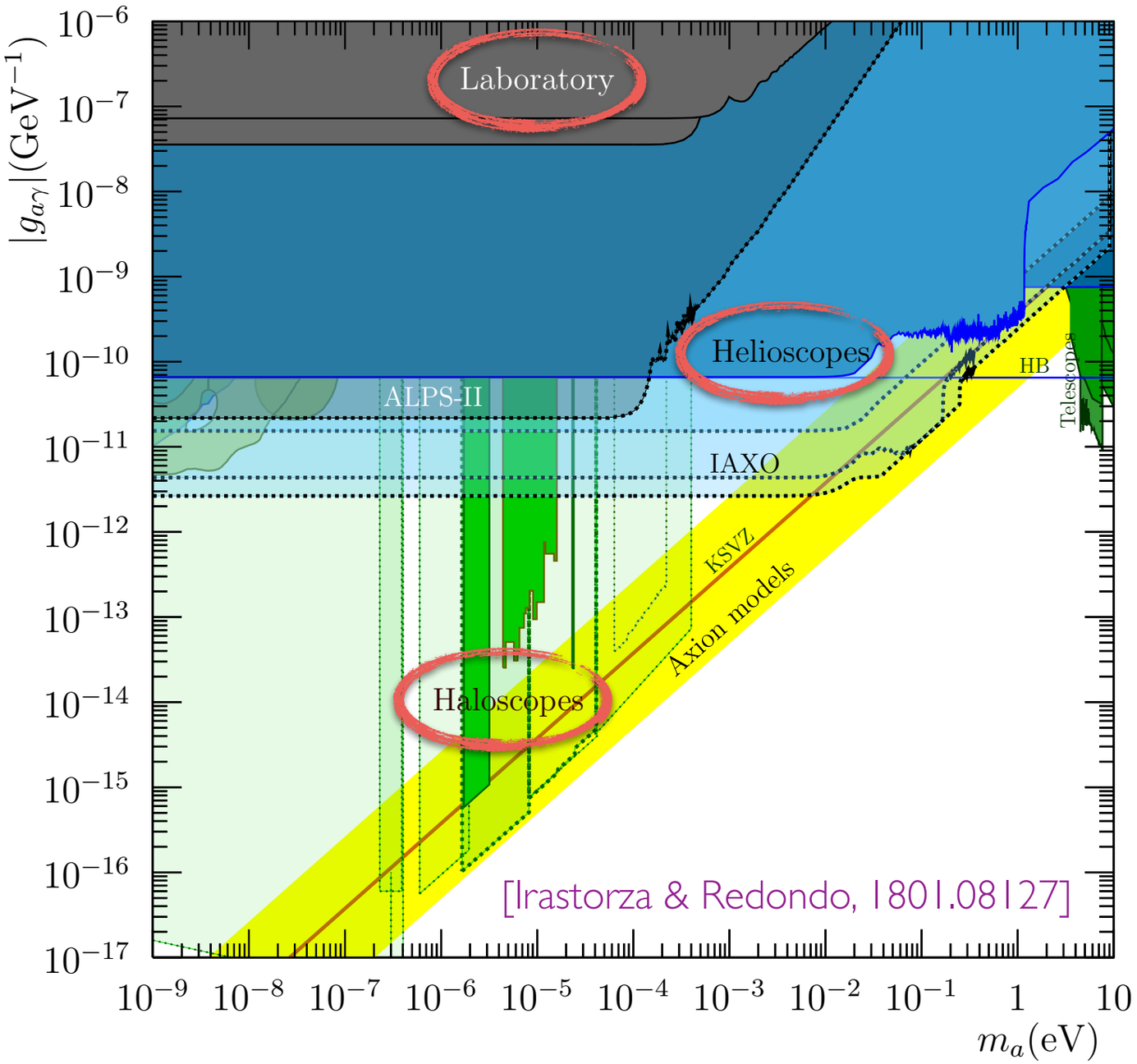
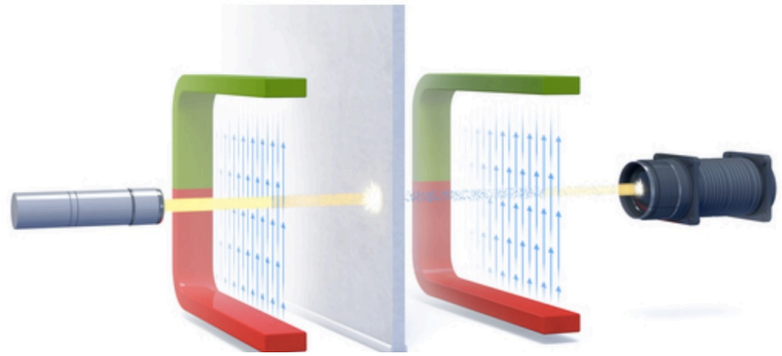
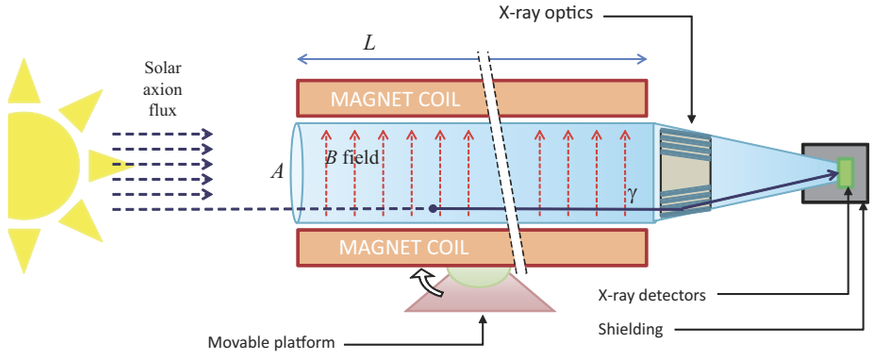
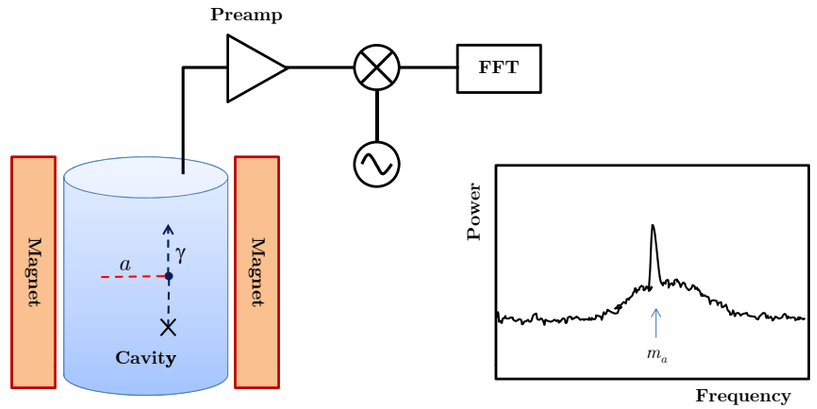


✤ A great exp. opportunity







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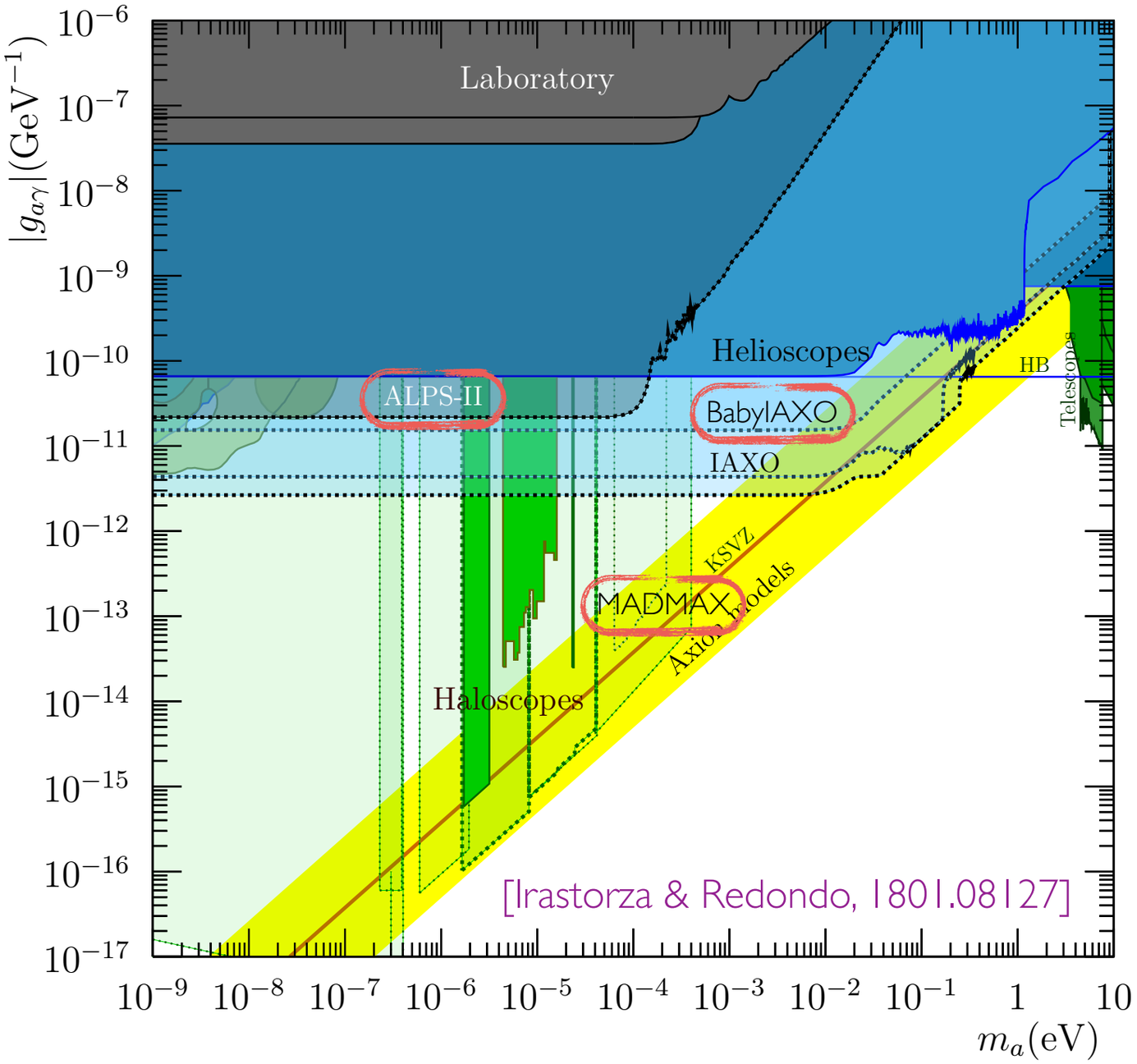

✤ A great exp. opportunity

DESY likely to become the leading axion lab in Europe!

ALPs-II (DESY)
[in construction, data taking ~2021]

Brass (U. Hamburg)
[in costruction, data taking ~2020]

(Baby)IAXO
[prototype @ DESY ?
construction 2020 ? data taking 2024 ?]

MADMAX
[prototype @ CERN 2020-2025 ?
experiment @ DESY 2025-2035 ?]

AXIONRUSH

- Rethinking Ultraviolet Scenarios for Hunting the AXION

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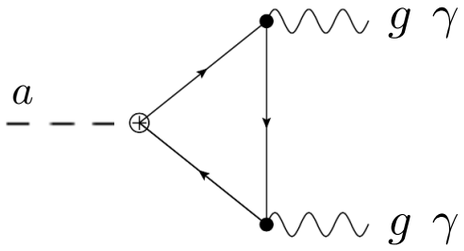
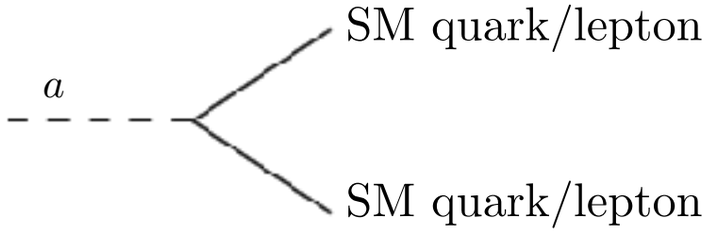
1. Axion couplings from a UV perspective

photons / nucleons / electrons / flavour-violating / CP-violating





$$\frac{\alpha}{8\pi}\frac{C_\gamma}{f_a}aF_{\mu\nu}\tilde{F}^{\mu\nu}$$

$$\frac{\partial_\mu a}{2f_a}\overline{\psi}_i\gamma^\mu(C^V_{ij}+C^A_{ij}\gamma_5)\psi_j$$

$$C_\gamma = E/N - 1.92(4)$$

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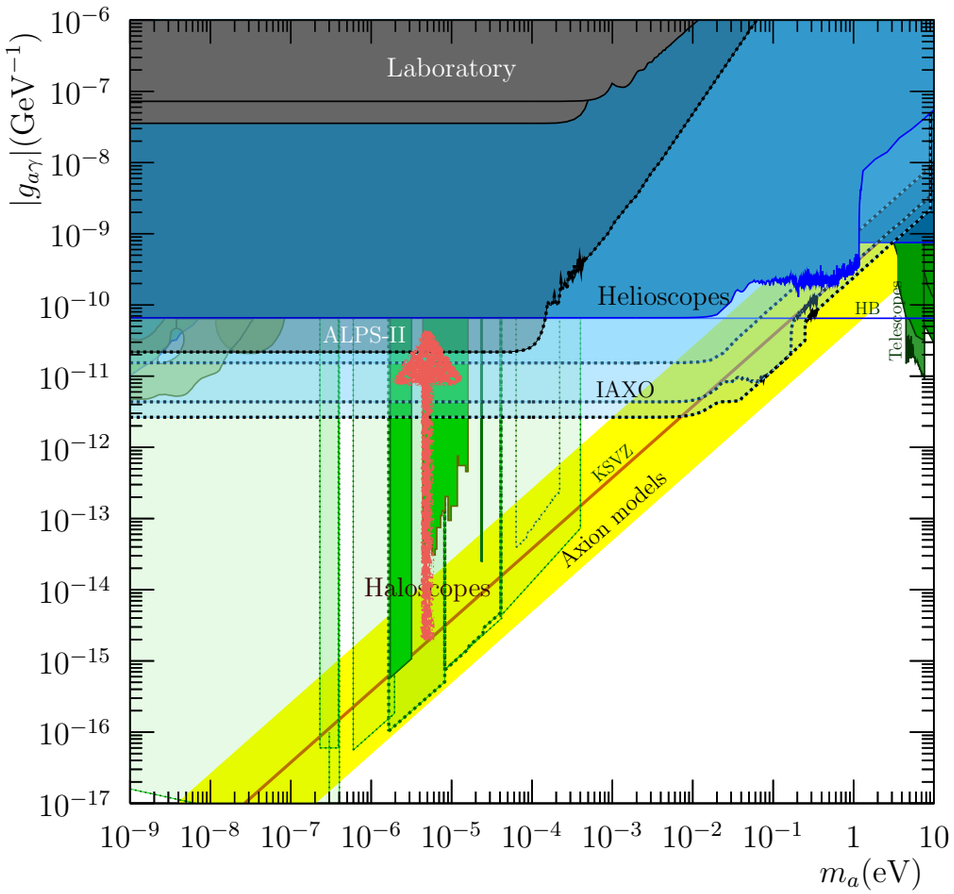
2. Impact on the DESY axion exp. program

   e.g. can a QCD axion be in the reach of ALPS-II ?



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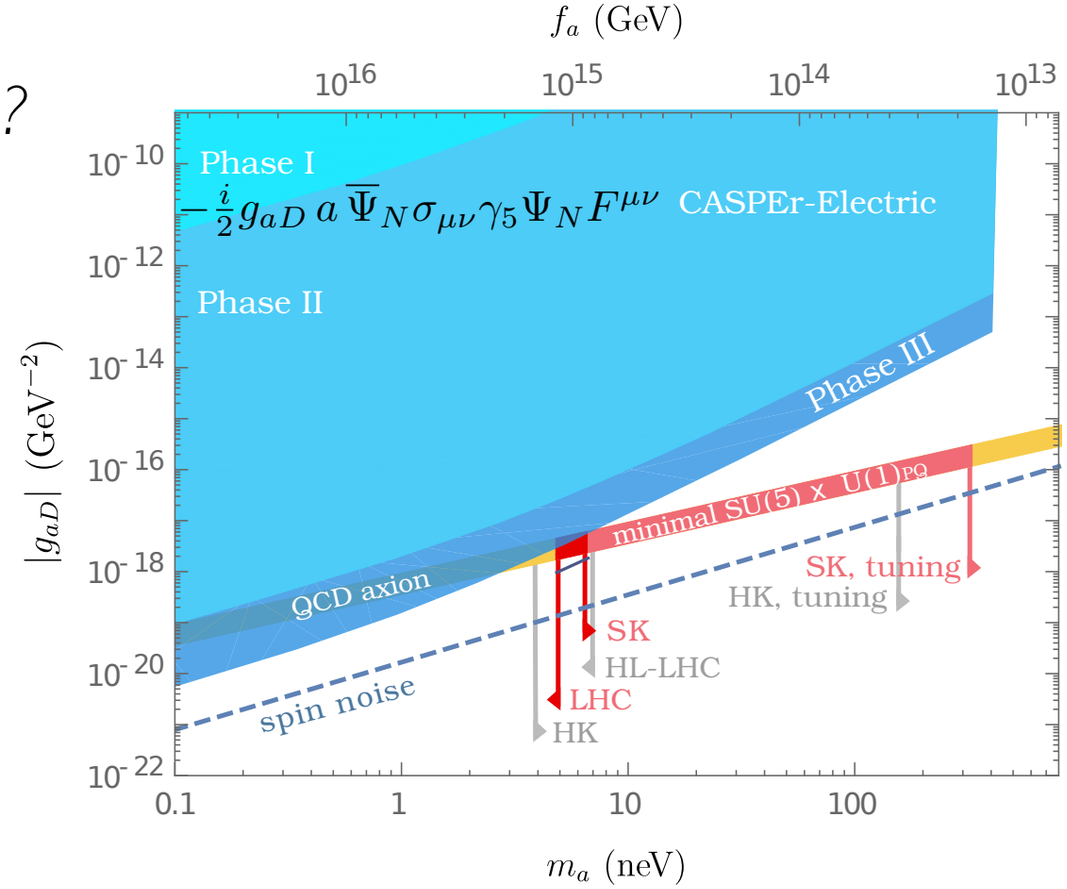
3. Predicting the axion mass

   axion GUTs / GUT-SMASH



[LDL, Ringwald, Tamarit 1807.09796]

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Thanks for your attention !